2022 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.

Copyright

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 *2019 Denver Green Code* by Denver as part of 2022 Denver Green Code updates.

> This symbol indicates deletion of 2019 Denver Green Code language by Denver as part of 2022 Denver Green Code updates.

Effective Use of the 2022 Denver Green Code (DGC)

Arrangement and Format of the 2022 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
5	Site sustainability
6	Water use efficiency
7	Commercial energy
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 which directs the user to Section 1 of the 2022 *Denver Building Code*.

Section 101 identifies which buildings and structures come under the DGC's scope and Section 102 references other adopted I-Codes as applicable.

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

Section 103 [EIS] includes a Project Impact and Opportunity Assessment covering a pre-design building project ecological impact assessment, community engagement inventory, and integrated project approach narrative as part of the Concept submittal.

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. Chapter 4 contains provisions for energy efficiency, demand response, and commissioning for *residential building projects* 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.

SS01 limits the type of sites that can be built upon and the type of development that can occur.

SS01 requires predesign site inventory and assessment.

SS02 to SS09 regulates plantings, mulch and trees on the site.

SS10 contains requirements for stormwater management systems.

SS12 requires the mitigation of heat island effect.

SS13 addresses light pollution.

SS14 addresses transportation impacts.

SS15 addresses building site waste management.

SS16 addresses requirements for soil amendment.

SS17 addresses requirements for bird safe glazing.

SS18 addresses requirements for declining species support.

SS19 addresses requirements for allowable pesticides, fertilizers, herbicides.

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

WE01, WE02 + WE03 reduce or eliminate water use on sites by means of requirements related to landscape design and irrigation system design.

WE04 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.

WE05 regulates water use in ornamental fountains and water features.

WE06 requires water metering/monitoring and data collection.

WE07 to WE08 regulate, reverse osmosis water treatment systems, on-site *reclaimed water* treatment systems, and *graywater* reuse treatment systems.

Where a *reclaimed water* supply is available or is planned to be available within 5 years, Section WE09 requires the installation of a dual water supply plumbing system wherein *reclaimed water* is supplied to urinals and water closets.

WE10 regulates drought water preparedness.

Chapter 7 Commercial Energy. 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.

CE01 through CE33 contain the prescriptive-based energy compliance path. These provisions relate to renewable energy systems, the building envelope, HVAC systems, service water heating, power, lighting and various other equipment. Included are provisions related to energy efficiency, air barriers, on-site renewable energy systems, energy consumption management and automated demand response systems.

CE35 through CE36 contain 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.

EQ01 through EQ15 contain provisions related to indoor air quality, thermal environmental conditions, acoustical control, soil gas control, lighting quality, moisture and glare control. It also includes requirements for daylighting and lighting for presentations.

EQ16 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.

MR01 through MR06 contain provisions related to the human health and environmental impacts of materials. Included are requirements for construction waste management; the extracting, harvesting and manufacturing of materials; refrigerants; embodied carbon dioxide equivalent of steel and concrete materials; the storage and collection of recyclables and discarded goods, composting and the mercury content levels of lamps.

MR07 contains prescriptive-based and performance-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. It includes provisions for life-cycle assessment that address performance metrics, procedures and reporting.

MR09 includes requirements on the design for deconstruction and procurement of salvaged or reused materials.

MR10 includes requirements for dwelling units for deconstruction.

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.

CX01 and CX02 regulate the functional and performance testing and commissioning of building systems.

CX03 regulates the building commissioning process and documentation.

CX04 regulates erosion and sedimentation control during construction.

CX05 regulates indoor air quality during construction.

CX06 regulates moisture control during construction.

CX07 addresses pollution from the idling of construction vehicles during construction.

CX08 addresses contaminant entry into buildings during construction.

CX09 requires post-construction testing for radon in buildings.

CX10 requires construction waste management during construction.

CX11 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.

CX12 requires that a transportation management plan be developed.

CX13 addresses an IAQ maintenance and monitoring plan.

CX14 requires outdoor air ozone air cleaners.

CX15 includes Indoor Environmental Quality Assurance and Awareness.

CX16 covers Occupant Education and Engagement.

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 CE07 and CE17. 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 Increased Equipment Efficiency Approach. This appendix is referenced in CE05, CE10, CE19, CE27 and CE28. This appendix provides mandatory equipment efficiency information for the different types of mechanical equipment utilized for heating and cooling.

Normative Appendix C. Reserved.

Normative Appendix D Building Concentrations. This appendix is referenced in EQ15. 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 2017 edition of Standard 189.1 which resulted in the 2020 edition of Standard 189.1 which forms the technical content for this code.

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 2022 *Denver Green Code* hereinafter referred to as "this code."

101.2 Purpose.

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

101.2.2 This code is intended to provide the technical basis of regulations for *building projects* and *high-performance green building projects*.

101.3 Scope.

101.3.1 This code contains requirements that address *site* sustainability, water use efficiency, energy including 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, their systems and their sites.
2. *Major Renovations, commercial,* their systems and their sites
3. *Major Renovations, residential,* if applicability is activated through separate voluntary written agreement between a property owner and Agency.
4. Relocated existing buildings and temporary structures where specified in this code.

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

1. Manufactured houses (mobile homes).
2. *Building projects* that use none of the following:
   - Electricity.
   - Fossil fuels.
   - Water.
3. Repairs, replacements and alterations that qualify as an Alteration - Level 1 or Alteration - Level 2 as defined in the Denver Existing Building Code Sections 602 and 603.

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

101.4 Compliance Requirements.

101.4.1 General for All *Building Projects* except *residential building projects.* *All building projects* except *residential building projects* shall comply with Chapter 1 Sections 101 and 102; Chapter 3; and Chapter 11, and with minimum requirements outlined in Table 101.4.1.

Table 101.4.1 - Limited Mandatory Use: Quantity of Provisions Required			
		New Construction	***Major Renovations, Commercial***
Chapter 1	Scope and Administration: Ecological Impact Statement (EIS)	**0**	**0**
Chapter 2	Reserved	**n/a**	**n/a**
Chapter 3	Definitions	**n/a**	**n/a**
Chapter 4	Residential Energy [RE]	**0**	**0**
Chapter 5	Site Sustainability [SS]	**4[a]**	**2[ab]**
Chapter 6	Water Use Efficiency [WE]	**1[a]**	**0**
Chapter 7	Commercial Energy [EE]	**1[a]**	**1[a]**
Chapter 8	Indoor Environmental Quality [EQ]	**1[a]**	**1[a]**
Chapter 9	Materials and Resources [MR]	**3[a]**	**1[a]**
Chapter 10	Construction and Plans for Operation [CX]	**2[a]**	**2[a]**
[a]	Chapter 1: EIS statement may be submitted as a substitution provision to satisfy one required provision from any single qualifying chapter. It may not be substituted for more than one qualifying provision.		
[b]	If less than 20% of the site is disturbed, then Chapter 5 Site Sustainability provisions are not required.		
n/a	No criteria associated with this item		

101.4.2 General for *Building Projects* Voluntarily Enrolled in the Denver Green Code Enhanced Use Program. *Building projects shall comply with* Chapter 1 Sections 101, 102, 103; Chapter 3; Chapter 11, and with one of the following:

1. Option 1: The *building project* shall comply with Chapter 1 Sections 101, 102, 103; Chapter 3; and Chapters 4 through 11. Within each of these chapters, *building projects* shall comply with all required provisions and a minimum number of elective provisions in accordance with Table 101.4.2.

   Exception: *Residential building projects* complying with Chapter 4 shall not be required to comply with Chapter 7. *Building projects* other than *residential building projects* shall comply with Chapter 7 and shall not be required to comply with Chapter 4.

	Table 101.4.2 - Enhanced Use As Written Path: Compliance Path Option 1: Required and Elective Provision Requirements Compliance Path Option 4: Required and Elective Provision Requirements for Chapters 1, 4, 5, 6, 8, 9, and 10			
			New Construction	***Major Renovations, Commercial***
Chapter 1: SCOPE AND ADMINISTRATION			**All provisions required**	**All provisions required**
	101	General	Required	Required
	102	Applicability	Required	Required
	EIS	Project impact + Opportunity Assessment	Required	Required
Chapter 4: RESIDENTIAL ENERGY [RE]			**All required provisions plus one of the following: a. 3 electives b. RE01 c. RE02 d. RE03**	**All required provisions plus one of the following: a. 1 elective b. RE01 c. RE02 d. RE03**
	RE01	Energy Rating Approach	Elective	Elective
	RE02	Zero Net Energy Approach	Elective	Elective
	RE03	Residential Passive House Approach	Elective	Elective
	RE04	Duct and air handler location	Required	Required, if in scope
	RE05	Drain water heat recovery units	Elective	Elective
	RE06	HVAC System Cleaning	Required	Required
	RE07	Thermostat	Elective	Elective
	RE08	Operations and Commissioning	Elective	Elective
	RE09	Functional testing of lighting controls	Elective	Elective
Chapter 5: SITE SUSTAINABILITY [SS]			**All required provisions plus 2 elective provisions**	**All required provisions plus 2 elective provisions**
	SS01	Predesign Site Inventory and Assessment	Required	Required
	SS02	Invasive Plants	Required	Required
	SS03	Existing Native or Adapted Plants	Elective	Elective
	SS04	Minimum Vegetative Area	Elective	Elective
	SS05	Mulching of Shrub Bed/Planting Areas	Required	Required, if in scope
	SS06	Only Functional (Active) Turfgrass	Required	Required, if in scope
	SS07	Landscaping Design and Maintenance	Required	Required, if in scope
	SS08	Established Tree Preservation	Required	Required, if in scope
	SS09	Rock Mulch Allowances	Required	Required, if in scope
	SS10	Stormwater Management	Required	Required
	SS11	Coal Tar Sealants	Required	Required
	SS12	Mitigation of Heat Island Effect	Required	Required

	SS13	Reduction of Light Pollution	Required	Required
	SS14	Mitigation of Transportation Impacts	Required	Required
	SS15	Site Construction Waste Management Plan	Required	Required
	SS16	Soil Amendment	Elective	Elective
	SS17	Bird Friendly Materials	Elective	Elective
	SS18	Declining Species Support	Elective	Elective
	SS19	Allowable Pesticides	Elective	Elective
Chapter 6: WATER EFFICIENCY [WE]			**All required provisions plus 1 elective provision**	**All required provisions plus 1 elective provision**
	WE01	Site Water Use Reduction	Required	Required
	WE02	Site Water Use Reduction - Stretch	Elective	Elective
	WE03	No Irrigation	Elective	Elective
	WE04	Building Water Use Reduction	Required	Required, if in scope
	WE05	Special Water Features	Required	Required
	WE06	Water Consumption Measurement	Required	Required
	WE07	Reverse Osmosis Water Treatment	Elective	Elective
	WE08	On-Site Graywater Systems	Elective	Elective
	WE09	Dual Water Supply Plumbing	Elective	Elective
	WE10	Drought Preparedness	Elective	Elective
Chapter 7: COMMERCIAL ENERGY [CE]			**All required provisions plus one of the following: a. 15 electives b. CE35 c. CE36**	**All required provisions plus one of the following: a. 8 electives b. CE35 d. CE36**
Energy Prescriptive Approach	**CE01**	Continuous Air Barrier	Elective	Elective
	CE02	Enhanced DEC C406 Credit Requirements	Elective	Elective
	CE03	Energy Consumption Management	Required	Required
	CE04	Demand Response	Elective	Elective
	CE05	Renewables Approach	Elective	Elective
	CE06	Battery Storage	Elective	Elective
	CE07	Building Envelope	Elective	Elective
	CE08	SHGC of Vertical Fenestration	Required	Required, if in scope
	CE09	Building Envelope Trade-Off Option	Elective	Elective
	CE10	Minimum Equipment Efficiencies	Required	Required
	CE11	Ventilation Controls for Densely Occupied Spaces	Elective	Elective
	CE12	Duct Leakage Tests	Elective	Elective
	CE13	Economizers	Elective	Elective

	CE14	Minimum HVAC Equipment Performance Ratings	Elective	Elective
	CE15	Fan System Power	Elective	Elective
	CE16	Exhaust Air Energy Recovery	Elective	Elective
	CE17	Duct Insulation	Required, if in scope	Required, if in scope
	CE18	Automatic Control of HVAC and Lights in Hotel/Motel Guest Rooms	Elective	Elective
	CE19	Equipment Efficiency	Elective	Elective
	CE20	Insulation for Spa Pools	Required, if in scope	Required, if in scope
	CE21	High Output Service Water Heating Systems	Elective	Elective
	CE22	Drain water heat recovery	Elective	Elective
	CE23	Interior Lighting Power Densities (LPDs)	Elective	Elective
	CE24	Exterior Lighting Power Densities (LPDs)	Elective	Elective
	CE25	Horticulture Lighting	Elective	Elective
	CE26	Lighting Controls	Elective	Elective
	CE27	Other Equipment	Elective	Elective
	CE28	Supermarket Heat Recovery	Elective	Elective
	CE29	ENERGY STAR Requirements for Equipment not Covered by Federal	Elective	Elective
	CE30	ENERGY STAR Requirements for Equipment Covered by Federal	Elective	Elective
	CE31	Programmable Thermostats	Elective	Elective
	CE32	Refrigerated Display Cases	Elective	Elective
	CE33	Supersede C405.12 OF THE DEC	Elective	Elective
	CE34	Reserved	Reserved	Reserved
	CE35	Zero Net Energy Approach	Elective	Elective
	CE36	Commercial Passive House Approach	Elective	Elective
Chapter 8: INDOOR ENVIRONMENTAL QUALITY [EQ]			**All required provisions plus 3 elective provisions**	**All required provisions plus 3 elective provisions**
	EQ01	Indoor Air Quality	Required	Required
	EQ02	Minimum Ventilation Rates	Required	Required
	EQ03	Outdoor Air Delivery Monitoring	Required	Required, if in scope
	EQ04	Filtration and Air Cleaner Requirements	Elective	Elective
	EQ05	Building Pressure - Mechanical Exhaust	Elective	Elective
	EQ06	Humidity Control	Elective	Elective
	EQ07	Building Entrances	Elective	Elective
	EQ08	Thermal Environmental Conditions for Human Occupancy	Elective	Elective
	EQ09	Acoustical Control	Elective	Elective
	EQ10	Soil-Gas Control	Elective	Elective
	EQ11	Lighting Quality	Elective	Elective

	EQ12	Moisture Control (Envelope)	Elective	Elective
	EQ13	Glare Control (Manual)	Elective	Elective
	EQ14	Glare Control (Automatic)	Elective	Elective
	EQ15	Materials (Emissions)	Elective	Elective
	EQ16	Daylighting	Elective	Elective
			-	-
Chapter 9: MATERIALS AND RESOURCES [MR]			**All required provisions plus 2 elective provisions**	**All required provisions plus 2 elective provisions**
	MR01	Building Construction Waste Management	Required	Required
	MR02	Embodied CO2e of concrete materials	Elective	Elective
	MR03	Embodied CO2e of steel materials	Elective	Elective
	MR04	Refrigerants	Elective	Elective
	MR05	Storage Areas and Collection of Recyclables	Required	Required
	MR06	Mercury Content Levels of Lamps	Required	Required, if in scope
	MR07	Building Materials (Environmental Impacts)	Elective	Elective
	MR08	Design for Deconstruction	Elective	Elective
	MR09	Procurement of Salvaged Materials	Elective	Elective
	MR10	Design for Deconstruction - Dwelling Units and Accessory Structures	Elective	Elective
Chapter 10: CONSTRUCTION AND PLANS FOR OPERATION [CX]			**All required provisions plus 3 elective provisions**	**All required provisions plus 3 elective provisions**
	CX01	Functional and performance testing and commissioning	Required	Required
	CX02	Acoustical Control	Elective	Elective
	CX03	Building Project Commissioning Process + Documentation	Required	Required
	CX04	Erosion and Sedimentation Control (ESC) (during construction)	Required	Required, if in scope
	CX05	IAQ Construction Mgmt (during constr., incl. flush-out)	Elective	Elective
	CX06	Moisture Control (during construction)	Required	Required
	CX07	Construction Activity Pollution Prevention: Limits Idling of Construction Vehicles	Required	Required
	CX08	Construction Activity Pollution Prevention: Protection of Occupied Areas (contaminant entry into occupied buildings during construction)	Required	Required, if in scope
	CX09	Soil-Gas Control (Testing) requires post-construction testing for radon in buildings.	Elective	Elective

	CX10	Construction Waste Management Plan	Required	Required
	CX11	Plans for Operation 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.	Elective	Elective
	CX12	Transportation Management Plan	Elective	Elective
	CX13	IAQ maintenance and monitoring	Elective	Elective
	CX14	Outdoor air ozone air cleaners	Elective	Elective
	CX15	Indoor Environmental Quality Assurance and Awareness	Elective	Elective
	CX16	Benchmarking Operational Water and Waste	Elective	Elective

2. Option 2: The *building project* shall achieve Platinum Certification using any version of the US Green Building Council's (USGBC) Leadership in Energy and Environmental (LEED) program for which certification is actively supported and issued by the USGBC and Green Business Certification Inc. (GBCI). LEED is administered and supported by the GBCI. Group-R *building projects* including *residential building projects* shall achieve Platinum Certification with the LEED for Homes, LEED Residential Building Design and Construction (BD+C), or LEED BD+C program. All other *building projects* shall achieve Platinum Certification with the LEED BD +C program.
3. Option 3: The *building project* shall achieve Zero Net Energy in accordance with RE02 for *residential building projects* or CE35 for all other *building projects*.
4. Option 4: The *building project* or *residential building project* shall comply with Chapter 1 Sections 101, 102, 103; Chapter 3; Chapter 5; Chapter 6; Chapter 8; Chapter 9; Chapter 10; and Chapter 11. 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 101.4.2. In addition, the *building project* shall achieve Passive House Certification in accordance with RE03 or CE36.

   Exception: *Residential building projects* complying with Chapter 4 RE03 shall not be required to comply with Chapter 7 CE36. *Building projects* other than *residential building projects* shall comply with Chapter 7 CE36 and shall not be required to comply with Chapter 4 RE03.

101.4.3 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.

101.4.4 Normative Appendices. The normative appendices to this code are considered to be integral parts of this code.

101.4.5 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.

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

SECTION 102
APPLICABILITY

102.0 Effective Date. The effective date of this code is May 1, 2023.

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. The following codes shall be considered to be part of the requirements of this code: *Denver Commercial Building Code*, *Denver Energy Code*, *Denver Existing Building Code*, *Denver Fire Code*, *Denver Fuel Gas Code*, *Denver Mechanical Code*, *Denver Plumbing Code* and *Denver 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 codes listed in Section 102.4, the provisions of this code or the Denver 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 Chapter 1 of *2022 Denver Building Code,* the provisions of Chapter 1 of *2022 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 Other adopted Denver regulations under any Agency. Where both this code and regulatory provisions adopted by the City and County of Denver through any Agency including but not limited to the Department of Parks and Recreation or Department of Transportation and Infrastructure apply to subject matter that is within the scope of a *building project*, the provisions of other regulations shall supersede this code in the event of a conflict. In all other cases, complementary and / or additive provisions of both regulations shall apply.

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

102.7 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 *Denver Building Code*, the *Denver Existing Building Code* or the *Denver Fire Code*.

102.8 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.

SECTION 103

PROJECT IMPACT AND OPPORTUNITY ASSESSMENT

EIS: ECOLOGICAL IMPACT STATEMENT

103.1 General. A predesign *building project* ecological impact assessment, community engagement inventory, and integrated project approach narrative shall be submitted as part of a mandatory concept site development plan. The assessment, inventory and narrative shall comply with Section 103.2:

Exception: Alterations that occur inside the building envelope and do not affect building site.

103.2 Evaluating Ecological Impact.

103.2.1 Ecological Impact Statement (EIS). The purpose of a *site* inventory and assessment of ecological attributes is to quantify impacts, both positive and negative, that the project will have on the site. In addition, an assessment shall be provided of attributes unique to the site in the context of the Denver region, and their associated potential to positively contribute to, or to take away from if not consciously addressed, the health of the evolving ecology of Denver as a single, complete living system. The assessment shall address how the site fits within, supports, and contributes to the system as a whole, speaking to specific characteristics and opportunities unique to the site within the broader context of regional Denver. The assessment shall also identify ways in which Denver is functioning successfully as a system supporting resident life as well as wildlife, and opportunities to improve parts of the system currently in decline. The following nine topics must be evaluated in the EIS at both the project-to-site scale, and the site-to-Denver region scale, including detailed description of how these systems are functioning ecologically. The EIS must be submitted with the permit application [or formal] Site Development Plan application, and include information on the following items and how they influenced the project design:

1. **Topography.**
    a. Contour mapping.
    b. Unique topographic features.
    c. Slope stability risks.
2. **Hydrology.**
    a. Flood hazard areas.
    b. Delineated wetlands, lakes, streams, shorelines, estuaries.
    c. Onsite stormwater collection, storage capacity and reuse opportunities including procedural outline to obtain water rights.
    d. Onsite opportunity for greywater storage and reuse.
    e. Onsite opportunity for blackwater treatment, storage and reuse.
3. **Climate.**
    a. Solar exposure.
    b. Heat island effect potential.
    c. Prevailing winds.
    d. Monthly precipitation.

e. Seasonal temperature ranges.

4. Vegetation and Animal Habitat.

a. Primary vegetation types.

b. Greenfield areas.

c. *Significant trees* and *significant vegetation.*

5. *Significant wildlife habitat.*

a. Threatened or endangered species habitats and corridors.

b. Invasive plant species.

c. Beneficial species and biodiversity.

d. Migratory bird reliance / utilization or interruption.

6. Soils.

a. Site soils survey.

b. Healthy soils and previously developed or disturbed soils.

c. Earthwork balance strategy.

7. Human use.

a. View corridors.

b. Existing and planned adjacent transportation infrastructure.

c. Adjacent properties including previously developed land, greenspaces, and wildlife habitats.

d. Demolition and construction materials with existing recycle or reuse potential.

e. Opportunities to encourage socioeconomic diversity within the neighborhood.

f. Opportunities for passive and active community engagement and education related to positively supportive measures for ecosystem health.

8. Human health effects.

a. Proximity of vulnerable populations.

b. Adjacent physical activity opportunities.

c. Proximity to major sources of air pollution.

d. Proximity to, scale, and extent of natural green spaces, and opportunities to co-occupy these spaces without negatively impacting health of wildlife.

9. Air quality or air pollution potential

a. Waste (toxic, medical, industrial, etc.) generation potential.

PART 2—ADMINISTRATION AND ENFORCEMENT

Sections 104 through 109 are reserved. Chapter 1 of *Denver Building Code* shall govern the administration and enforcement of the DGC.

CHAPTER 2

RESERVED

CHAPTER 3

DEFINITIONS, ABBREVIATIONS AND ACRONYMS

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

Terms that are not defined in this chapter, but that are defined in standards that are referenced in this code (***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.

301.2 Definitions.

Agency: the Building Permitting and Inspections Services Agency of the City and County of Denver

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 City.

air, makeup: see definition in ANSI/ASHRAE Standard 62.1.

air, outdoor: see definition in ANSI/ASHRAE Standard 62.1.

air, transfer: see definition in 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 definition in ANSI/ASHRAE/IES Standard 90.1.

automatic: see definition in ANSI/ASHRAE/IES Standard 90.1.

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

baseline building performance: see definition in 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.

bird friendly material: A material or assembly that has or has been treated to have a maximum threat factor of 25 in accordance with the American Bird Conservancy Bird Collision Deterrence Material Threat Factor Table, or with the

American Bird Conservancy Bird-friendly Materials Evaluation Program at Carnegie Museum's Avian Research Center test protocol.

bird hazard installations: Monolithic glazing installations that provide a clear line of sight on the exterior of buildings, including, but not limited to, glass awnings, glass handrails and guards, glass wind break panels, or glass acoustic barriers.

breathing zone: see definition in 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 created in Chapter 1 Section 102.2 of the Denver Building Code.

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

carbon dioxide equivalent (CO_2e): a measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO_2e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO_2). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO_2. The following GWP values are used based on a 100-year time horizon: 1 for CO_2, 25 for methane (CH_4), and 298 for nitrous oxide (N_2O).

children's facility*:* A building or part of a building that, as part of its function, is regularly occupied by children under the age of 18 years; and required to obtain and use an occupancy permit as a condition of performing that function. This includes but is not limited to a child day care center, family day care home, nursery school, recreational center, or classroom.

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

climate zone: see definition in Normative Appendix A.

combined energy efficiency ratio (CEER* [I-P]*) ($CCOP_C$* [SI]*): the 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 *Agency*, 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*.]

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

concrete: mixture of cementitious material, fine aggregate, coarse aggregate, and water, with or without admixtures.

concrete, lightweight: concrete containing lightweight aggregate and having an equilibrium density, determined by ASTM C567.

conditioned space: see definition in ANSI/ASHRAE/IES Standard 90.1.

construction documents: see definition in ANSI/ASHRAE/IES Standard 90.1.

contaminant: see definition in ANSI/ASHRAE Standard 62.1.

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

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

***demand response signal*:** a signal that indicates a price or a request to modify electricity consumption for a limited time period.

demand responsive control: a control capable of receiving and automatically responding to a *demand response signal*.

densely occupied space: those *spaces* with a design occupant density greater than or equal to 25 people per 1000 ft^2 (100 m^2).

design professional: see definition in 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 definition in ANSI/ASHRAE/IES Standard 90.1.

dynamic glazing: see definition in ANSI/ASHRAE/IES Standard 90.1.

***ecologically beneficial landscape*:** A native and/or adapted landscape that does some or all of the following:

- does not require supplemental irrigation, or
- requires minimal irrigation only for specifically identified functional uses (e.g., community playing fields or agriculture);
- is biodiverse;
- supports local species and ecosystem health;
- is heat resistant;
- is drought resistant;
- beneficially utilizes stormwater while also supporting stormwater management;
- provides beauty, interest, and shade benefits.

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 definition in ANSI/ASHRAE/IES Standard 90.1.

environmental product declaration (EPD): independent third-party multi-attribute product declaration or certification containing documentation consistent with ISO Standards 14025 and 21930, with at least cradle-to-gate scope.

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 definition in ANSI/ASHRAE/IES Standard 90.1.

fenestration area: see definition in ANSI/ASHRAE/IES Standard 90.1.

***financial renewable energy power purchase agreement (PPA)**:* A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's

renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

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

fly-through conditions: One or more panels of glass that provide a clear line of sight through such elements creating the illusion of a void leading to the other side, including parallel glass elements, at a distance of 17 feet (5182 mm) or less, or a convergence of glass sides creating a perpendicular, acute, or obtuse corner.

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.

functional (active) turf: irrigated turf grass area that provide recreational benefits to the community or are a part of vegetated and/or structural controls of stormwater management systems.

generally accepted engineering standard: see definition in 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.

graywater: (see water, graywater)

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.

grid-flexible control: an automatic control that can receive and automatically respond to demand response requests from, and send information back to, a utility, electrical system operator, or third-party demand response program provider.

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

gross wall area: see definition in 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 project: a building and site 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, water-efficient and energy-efficient systems, and, water-efficient and ecologically beneficial landscapes.

high risk surface bird friendly material: A material or assembly that has or has been treated to have a maximum threat factor of 15 in accordance with the American Bird Conservancy Bird Collision Deterrence Material Threat Factor Table, or with the American Bird Conservancy Bird-friendly Materials Evaluation Program at Carnegie Museum's Avian Research Center test protocol.

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).

high traffic: those areas used regularly for foot traffic such as walkways, paths, trails, or vehicle traffic such as driveways and access roads.

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 definition in 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).

lighting power allowance: see definition in 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 Agency
>
> ***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; and an 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).

major renovation, commercial: a building project alteration that qualifies as an alteration – level 3 as defined in Sec. 604 of the Denver Existing Building Code or a building project addition containing the lesser gross floor area of the following: (i) 100,000 gross floor area or greater, or (ii) gross floor area greater than 50% improvement of the existing project gross floor area

major renovation, residential: a building project renovation that qualifies as an alteration, as defined in Chapter 2 Definitions of the Denver Residential Code, where the work area exceeds 50 percent of the building's gross floor area; or an addition containing the lesser of the following: (i) gross floor area of 750 square feet or greater, or (ii) gross floor area greater than 50% of the existing project gross floor area.

maintenance plan: see *maintenance program* defined 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 definition in ANSI/ASHRAE/IES Standard 90.1.

mulched recreation area. An area of land covered with natural mulch or wood chips that is open to the public for picnic or recreational use.

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.

natural, organic or "non-synthetic": a substance that is derived from mineral, plant, or animal matter and does not undergo a "synthetic" process as defined in the Organic Foods Production Act, 7 U.S.C. § 6502(21).

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

nonpotable water: *(see water, nonpotable)*

nonresidential: see definition in ANSI/ASHRAE/IES Standard 90.1.

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

non-tradable: applications that can only be used for the specific application and cannot be traded between applications or with other non-tradable applications such as building façades, automated teller machines, guardhouses, loading for law enforcement, drive through windows, or parking near retail. The allotment is in a use-it-or-lose-it format. Thus, the baseline power for these applications is the lesser of the wattage input for these applications or the product of the lighting power density for these applications and the area/length of these applications.

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 of a building is designed.

occupiable space: see definition in 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*.

organic pest management: The act of managing or controlling pests through the use of mechanical, cultural, or, biological processes, or through the use of natural, organic, or non-synthetic substances.

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

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 definition in 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.

physical renewable energy power purchase agreement (PPA): a contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

plants, adapted: *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.

plants, invasive: 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.

plants, native: *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.

plants, rainfall-ET_c compatible: *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.

playing field: an area of land maintained exclusively for athletic or sporting use.

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*.)

potable water: (see water, potable)

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 definition in ANSI/ASHRAE/IES Standard 90.1.

projection factor (PF): see definition in 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 definition in ANSI/ASHRAE/IES Standard 90.1.

proposed design: see definition in 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)*.

reclaimed water: *(see water, reclaimed)*

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 definition in ANSI/ASHRAE/IES Standard 90.1.

renewable energy certificate (REC): a market-based instrument that can be bought, sold or exchanged 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 project: 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, and the associated site.

roof: see definition in ANSI/ASHRAE/IES Standard 90.1.

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

roof monitor: see definition in ANSI/ASHRAE/IES Standard 90.1.

salvaged material: materials include those that can be repurposed or reused elsewhere including doors, lighting, sinks, tubs, wood flooring, lumber, roof tiles, stone, brick, ironwork, mirrors, windows, appliances, cabinets, and hardware.

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

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

semiheated space: see definition in ANSI/ASHRAE/IES Standard 90.1.

service water heating: see definition in 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:

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.

significant tree: a tree with a DBH (diameter at breast height, measured at four and one half feet (4.5') above grade) of 18 inches or greater and which is not identified by a licensed arborist as damaged, diseased, or a safety hazard due to potential root, trunk, or primary limb failure, or new exposure to wind after having grown in a closed, forested situation.

significant vegetation: vegetation supporting an ecosystem of local, regional, or state significance, or, vegetation performing water quality treatment in accordance with existing city criteria including guidelines published by the Department of Transportation and Infrastructure."

significant wildlife habitat: areas including seasonal concentration areas; rare vegetation communities or specialized habitats for wildlife; movement corridors; and the habitat of species of conservation concern, including any species listed as Threatened, Endangered, or of Special Concern by the U.S. Fish and Wildlife Service or Colorado Parks and Wildlife.

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

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

skylight: see definition in ANSI/ASHRAE/IES Standard 90.1.

skylight effective aperture: see definition in 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 the following:

a. heating or cooling of a structure or building;

b. heating or pumping of water;

c. industrial, commercial, or agricultural processes; or

d. generation of electricity.

solar heat gain coefficient (SHGC): see definition in 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 definition in 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.

stormwater harvesting: the use of site design practices to intentionally route stormwater to a landscape area or stormwater management system such that it reduces the irrigation demand of the area receiving the stormwater. Stormwater harvesting is an alternative source of water.

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

task lighting: see definition in ANSI/ASHRAE/IES Standard 90.1.

tradable: applications including uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas. Thus, the allowed lighting power density of these applications is multiplied by the associated area or length to yield the baseline power.

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 definition in ANSI/ASHRAE/IES Standard 90.1.

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

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

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

vertical fenestration: see definition in 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 daylit 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.

vulnerable population: a group or community at a higher risk for poor health as a result of the barriers it experiences to social, economic, political and environmental resources, as well as limitations due to illness or disability.

wall: see definition in ANSI/ASHRAE/IES Standard 90.1.

wall area, gross: see definition in 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. 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, graywater: is that portion of wastewater that, before being treated or combined with other wastewater, is collected from fixtures within residential, commercial, or industrial buildings or institutional facilities for the purpose of being put to beneficial uses. Sources of *graywater* are limited to discharges from bathroom and laundry room sinks, bathtubs, showers, and laundry machines. *Graywater* does not include the wastewater from toilets, urinals, kitchen sinks, dishwashers, or nonlaundry utility sinks (considered blackwater). State of Colorado Regulation 86 (Graywater Control)

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

water, potable: also known as finished water, comes from multiple sources and is treated to levels that that meet state and federal standards for consumption. State of Colorado Regulation 11 (Water Quality)

water, reclaimed: is domestic wastewater that has received secondary treatment by a domestic wastewater treatment works (centralized system or a localized system) and such additional treatment as to enable the wastewater to meet the standards for approved uses. State of Colorado Regulation 84 (Reclaimed Water Control)

water, stormwater: is water that originates from precipitation (storm), including heavy rain and meltwater from hail and snow. As it flows across the surface of impervious surfaces, such as streets, sidewalks, parking lots, and roof tops where it picks up contaminants such as oil residue from cars, litter, and debris. https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Department-of-Transportation-and-Infrastructure/Programs-Services/Wastewater-Management

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), clothes washer (residential* and *commercial): the quantity of water in gallons (litres) used to wash each cubic foot (cubic metre) of machine capacity.

water factor (WF), 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 ABBREVIATIONS AND ACRONYMS

µg	microgram
AC	alternating current
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASE	*annual sunlight exposure*
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
BIFMA	The Business and Institutional Furniture Manufacturer's Association
BMS	building management system
BoD	*Basis of Design*
BPF	building performance factor
Btu	British thermal unit
Btu/h	British thermal unit per hour
BUG	backlight, uplight, and glare
CAC	ceiling attenuation class
CCOP	*combined coefficient of performance*
CDPH	California Department of Public Health
CEER	*combined energy efficiency ratio*
CFC	Chlorofluorocarbon
cfm	cubic feet per minute (ft^3/min)
CH_4	methane
c.i.	continuous insulation
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	carbon dioxide
CO_2e	*carbon dioxide equivalent*
CSA	Canadian Standards Association
cSTC	composite sound transmission class
Cx	commissioning
dB	decibel
db	dry bulb
dBA	decibel, A-weighting
dBC	decibel, C-weighting
DBC	Denver Building Code
DCBC	Denver Commercial Building Code
DC	direct current
DCV	*demand control ventilation*
DEC	Denver Energy Code
DFC	Denver Fire Code
DFGC	Denver Fuel Gas Code
DGC	Denver Green Code

DMC	Denver Mechanical Code
DPC	Denver Plumbing Code
DR	demand responseDRC Denver Residential Code
EISA	Energy Independence and Security Act
EMS	Energy Management System
EPAct	U.S. Energy Policy Act
EPD	environmental product declaration
ESC	erosion and sedimentation control
ET_c	*evapotranspiration*
ET_o	*maximum evapotranspiration*
ETS	environmental tobacco smoke
fc	footcandle
FF&E	furniture, fixtures, and equipment
FPT	*functional and performance testing*
ft	foot
ft^2	square feet
gal	gallon
gpm	gallons per minute
GWP	global warming potential
h	hour
ha	hectare
HCFC	hydrochlorofluorocarbon
HID	high-intensity discharge
HVAC	heating, ventilation, and air conditioning
HVAC&R	heating, ventilation, air conditioning, and refrigeration
Hz	hertz
IA	Irrigation Association
IAPMO	International Association of Plumbing and Mechanical Officials
IAQ	indoor air quality
IEQ	indoor environmental quality
IES	Illuminating Engineering Society
IIC	impact insulation class
in.	inch
I-P	inch-pound
ISR	impact sound rating
kg	kilogram
km	kilometre
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
L	litre

lb	pound
LCA	*life-cycle assessment*
LCI	life-cycle inventory
L_{eq}	hourly average sound pressure level
L_{max}	*maximum sound pressure level*
LPD	lighting power density
Ls	*liner system*
LZ	*lighting zone*
m	metre
MDF	medium density fiberboard
MERV	minimum efficiency reporting value
mg	milligram
mi	mile
min	minute
mm	millimetre
mph	miles per hour
M&V	measurement and *verification*
N_2O	nitrous oxide
NA	not applicable
NAECA	National Appliance Energy Conservation Act
NEC	National Electrical Code
NIC	noise isolation class
NISR	normalized impact sound rating
NNIC	normalized noise isolation class
NPLV	nonstandard part-load value
NR	not required
OITC	outdoor-indoor transmission class
O&M	operations and maintenance
OPR	*owner's project requirements*Pa Pascal
PCI	Performance Cost Index
PF	*projection factor*
ppm	parts per million
RCR	room cavity ratio
REC	*renewable energy certificate*
s	second
SCAQMD	South Coast Air Quality Management District
sDA	*spatial daylight autonomy*
SHGC	*solar heat gain coefficient*
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SRI	*solar reflectance index*
STC	sound transmission class
SWAT	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
VAV	*variable air volume*
VOC	volatile organic compound
VRF	variable refrigerant flow system
VT	visible transmittance
wb	wet bulb
WF	*water factor*
yr	year

CHAPTER 4

RESIDENTIAL ENERGY

401.1 Scope. This section specifies requirements for energy use, regulation and efficiency for *residential building projects* and appliances, and for *on-site renewable energy systems*.

401.2 Compliance. *Building projects* shall comply with Chapter 4 in accordance with Section 101.4.

401.3 Reserved.

RE01: ENERGY RATING APPROACH

401.4 Energy Rating Approach. The rated design of the *building project* shall have an Energy Rating Index score of less than or equal to 45 without onsite power production when compared to the *ERI reference design* determined in accordance with ANSI/RESNET/ICC 301. All space heating and cooling systems, water heating, cooking equipment and clothes dryers shall be electric.

401.4.1 Verification by approved *Agency*. Verification of compliance with this section shall be completed by an *approved* third party.

401.4.2 Documentation. Documentation showing how the ERI for the *residential building project* 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 Compliance software tools. Software tools used for determining ERI shall be Approved Software Rating Tools in accordance with ANSI/RESNET/ICC 301.

401.4.2.2 Compliance report. Compliance software tools shall generate a report documenting that the ERI of the rated design complies with RE01 or RE02. The compliance documentation shall include the following information:

1. Address or other identification of the *residential building project*.
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 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 RE01 or RE02.

RE02: ZERO NET ENERGY APPROACH

401.5 Zero Net Energy Approach. The rated design, documentation, and verification of the *building project* shall comply with RE01 and have an Energy Rating Index score of less than or equal to 0 with onsite power production when compared to the *ERI reference design* determined in accordance with ANSI/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 ANSI/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 airflow.

RE03: RESIDENTIAL PASSIVE HOUSE APPROACH

401.6 Passive House Approach. New *residential building projects* shall achieve Passive House certification in accordance with Section 401.6.1 or 401.6.2.

401.6.1 Passive House Institute US (PHIUS) Certification. Achieve certification with the PHIUS+ 2021 Passive Building Standard and provide documentation in accordance with Section 401.6.1.1.

401.6.1.1 Documentation. Documentation shall be provided to the *building official* demonstrating the following.

1. Prior to the issuance of a building permit, documentation of a PHIUS+ 2021 Certification Contract 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+ 2021 Standard.

401.6.2 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 Documentation. Documentation shall be provided 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.

RE04: DUCT AND AIR HANDLER LOCATION

401.7 Duct and air handler location. Ducts and air handlers shall not be installed in unconditioned space outside the *building thermal envelope*.

407.1 Ducts and air handlers located in conditioned space. Ductwork and air handlers inside *conditioned space,* must comply with the following:

1. The duct and air handler system shall be located completely within the *continuous air barrier* and within the building thermal envelope.

2. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

   a. A *continuous air barrier* installed between unconditioned space and the duct.

   b. Insulation installed in accordance with DEC Section R402.2.7.

   c. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

   d. R5 rigid insulation board installed against the bottom of the floor joist between the joist and the drywall or soffit material.

3. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:

   a. A *continuous air barrier* installed between unconditioned space and the duct.

   b. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.

   c. The remainder of the cavity insulation shall be fully insulated to the drywall side.

Exception: Ducts in ventilated attics. Supply and return air ducts located in unconditioned attic or ceiling spaces shall comply with the following to be considered inside conditioned space:

1. The duct shall not be flex duct and shall be installed on the bottom cord of the truss or rafter closest to the drywall separating conditioned space from unconditioned space.
2. Five inches of closed cell foam, having a minimum R-value of an R-30 shall cover the duct or plenum run from the drywall or other boundary separating conditioned space from the duct or plenum. The closed cell foam shall be installed from the drywall or other boundary up one side of the duct or plenum, over the top of the duct or plenum, down the other side of the duct or plenum to the drywall or other boundary separating conditioned space from the duct or plenum. Thus, completely enclosing the duct or plenum within an air barrier

RE05: DRAIN WATER HEAT RECOVERY UNITS

401.8 Drain water heat recovery units. A drain water heat recovery system shall be installed in dwelling units that have two or more full bathrooms with showers that drain to a location where the system can recover heat from the water leaving the bathrooms. The drain waste heat recovery system shall be installed in accordance with manufacturer instructions after all cold water take off branches and before delivery to the hot water heater. Drain

water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi 13.8 kPa) for individual units connected to three or more showers.

RE06: HVAC SYSTEM CLEANING

401.9 HVAC System Cleaning. Prior to certificate of occupancy, all dwelling units governed by the Denver Residential Code shall have the entirety of the HVAC system cleaned, and documentation of such cleaning shall be provided at final mechanical inspection.

RE07: THERMOSTAT

401.10 Thermostat. The thermostat controlling the primary heating or cooling system of a dwelling unit shall be configured to set back or temporarily operate the system in accordance with Denver Energy Code (DEC) Section R408.13. If a demand response program requiring activation of controls is offered by the utility serving the property, controls shall be activated to receive signals and allow full functionality. If compliance with DEC Section R408.13 is selected to satisfy minimum DEC compliance requirements, then RE07 shall not be counted to satisfy Denver Green Code (DGC) Enhanced Use requirements outlined under DGC Section 101.4.2.m

402.1 General. RE08 and RE09 provides maintenance information and the commissioning of, and the functional testing requirements for, new residential mechanical and lighting systems.

402.1.1 Building operations and maintenance information. When RE08 and / or RE09 compliance is selected, building operations and maintenance documents shall be provided to the owner and shall consist of manufacturers' information, specifications and recommendations; programming procedures and data points; narratives; and other means of illustrating to the owner how the equipment and systems are intended to be installed, maintained and operated. Required regular maintenance for equipment and systems shall be clearly stated on a readily visible label that includes the title or publication number for the operation and maintenance manual for that particular model and type of product.

RE08: OPERATIONS AND COMMISSIONING

402.1.2 Mechanical systems commissioning and completion requirements. Prior to the final mechanical and plumbing inspections, the *registered design professional or approved Agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with the provisions of this section.

Construction document notes shall indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *building official* upon request in accordance with Section 402.1.2.4.

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

1. A narrative description of the activities that will be accomplished during each phase of *commissioning,* including the personnel intended to accomplish each of the activities.
2. A listing of the specific equipment, appliances, or systems to be tested and a description of the tests to be performed.
3. Functions to be tested.
4. Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.
5. Measurable criteria for performance.

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

402.1.2.2.1 Air systems balancing. Each supply air outlet and *zone* terminal device shall be equipped with means for air balancing in accordance with ACCA Manual D.

402.1.2.2.2 Hydronic systems balancing. Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed, or pump speed shall be adjusted to meet design flow conditions.

402.1.2.3 Functional performance testing. Functional performance testing specified in Sections 402.1.2.3.1 through 402.1.2.4.1 shall be conducted.

402.1.2.3.1 Equipment. Equipment functional performance testing shall demonstrate the installation and operation of components, systems and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems are confirmed.

402.1.2.3.2 Controls. HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated and adjusted and operate in accordance with approved plans and specifications.

402.1.2.4 Final commissioning report. A report of test procedures and results identified as "Final Commissioning Report" shall be delivered to the building owner or owner's authorized agent and to the Agency. The report shall be organized with mechanical system and service hot water system findings in separate sections to allow independent review. The report shall include the following:

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

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

402.1.2.4.1 Acceptance of report. Buildings, or portions of a building, shall not receive a final building inspection until the *building official* has received the Final Commissioning Report from the building owner or owner's authorized agent.

RE09: FUNCTIONAL TESTING OF LIGHTING CONTROLS

402.1.3 Functional testing of lighting controls. Automatic lighting controls shall comply with this section.

402.1.3.1 Functional testing. Prior to passing final building inspection, the *registered design professional* or *approved Agency* shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the *construction documents* and manufacturer's instructions. Functional testing shall be in accordance with Sections 402.1.3.1.1 through 402.1.3.2.2.1.

402.1.3.1.1 Occupant sensor controls. Where *occupant sensor controls* are provided, the following procedures shall be performed:

1. Certify that the *occupant sensor* has been located and aimed in accordance with manufacturer recommendations.
2. For projects with seven or fewer *occupant sensors*, each sensor shall be tested.
3. For projects with more than seven *occupant sensors,* testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent and in no case fewer than one of each combination shall be tested unless the *building official* or design professional requires a higher percentage to be tested. Where 20 percent or more of the tested controls fail, all remaining identical combinations shall be tested.

   For *occupant sensor controls* to be tested, verify the following:

   3.1. Where *occupant sensor controls* include status indicators, verify correct operation.

   3.2. The controlled lights turn off or down to the permitted level within the required time.

   3.3. For auto-on *occupant sensor controls*, the lights turn on to the permitted level when an occupant enters the space.

   3.4. For manual-on *occupant sensor controls*, the lights turn on only when manually activated.

   3.5. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

402.1.3.2 Drawings. Construction documents shall include the location and type of each lighting control.

402.1.3.2.1 Manuals. An operating and maintenance manual shall be provided and include the following:

1. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.

2. Operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended re-lamping shall be clearly identified.

402.1.3.2.2 Report. A report of test results shall be provided and include the following:

1. Results of functional performance tests.

2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.

402.1.3.2.2.1 Acceptance of report. Buildings, or portions of buildings shall not receive a final inspection until the *building official* has received the Final Commissioning Report from the building owner or owner's authorized agent.

CHAPTER 5

SITE SUSTAINABILITY

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

501.2 Compliance. *Building projects* shall comply with Chapter 5 in accordance with Section 101.4.

501.3 Provisions.

SS01: PREDESIGN SITE INVENTORY AND ASSESSMENT

501.3.2 Predesign Site Inventory and Assessment. 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 Plants.

SS02: INVASIVE PLANTS

501.3.3.1 Invasive Plants. *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 landfill. *Invasive plants* shall not be planted on the *building project site*.

SS03: EXISTING NATIVE OR ADAPTED PLANTS

501.3.3.2 Existing Native or Adapted Plants.

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 greenspace that complies with DRMC Article XIII

SS04: MINIMUM VEGETATIVE AREA

501.3.3.3 Minimum Vegetative Area. 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

SS05: MULCHING OF SHRUB BED/PLANTING AREAS

501.3.3.4 Mulching of Shrub Bed/Planting Areas. Shrub bed/planting areas shall be mulched to a depth of 2 to 4 inches. Perennials and groundcover areas shall be mulched with a 3-inch 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 to 6 inches away from tree trunks and shall not be in contact with the base of other woody landscape plants.

Exception: Rock mulch shall be permitted in accordance with limitations outlined in SS09.

SS06: ONLY FUNCTIONAL (ACTIVE) TURFGRASS

501.3.3.5 Only Functional (Active) Turfgrass. New living turfgrass shall only be installed in areas where it serves as *functional (active) turf*.

Exception: Turfgrass serving, maintained, or regulated by the Department of Parks and Recreation (DPR) or the Department of Transportation and Infrastructure (DOTI) shall meet the rules, standards, and best practices of those agencies.

a. Functional (Active) Turf areas must be located at least 10 feet from a street, installed on slopes less than 25%, not installed within street medians, along streetscapes (tree lawns) or at the front entryways to commercial sites, neighborhoods, or subdivisions; and
b. Except where a water budget is used for the entire site, Kentucky Bluegrass (Poa pratensis) and other turf grasses, with equal to or greater than 10 gallons per ft^2 shall not be installed unless providing benefit in the following use areas:
    1. Active/Programed Recreation Turf, Athletic Field Turf, Parkway Turf, Cemeteries and Mortuaries, Golf Course Play Turf, Playground Turf or Resident Area Turf as defined below.
        a. Active programed recreation turf shall meet the criteria in DPR guidelines for the area of installation:
            i. Golf Course Play Turf: means irrigated cool season turf grass used in golf course driving ranges, tee boxes, fairways, greens, and roughs. Non golf play area should be in low water drought tolerant and/or native grasses
        b. Multifamily (Multi-unit) 3 units and greater Resident Area Turf: means up to 200 ft^2 of irrigated turf grass per dwelling unit at multi-family residential properties, single-family attached

properties, commercial/multi-family mixed use properties, extended stay hotels/motels, or assisted living and rehabilitation centers. Resident Area Turf must be in areas residents have access to for active use and therefore shall not be located in streetscape frontages, parking lots, roundabouts, medians driveways and other non-accessible or exclusive use area such as commercial courtyards.

c. Single family (One-unit) and Duplex (Two-unit) Resident Area Turf: means up to 45% of the landscape on the property or 500 ft^2, whichever is smaller. Resident Area Turf must be in areas residents have access to for active use and therefore shall not be located in streetscape frontages, parking lots, roundabouts, medians driveways and other non-accessible or exclusive use area such as commercial courtyards.

2. Functional (Active) Turf areas shall be *hydro zoned* as defined in section 601.3.1.2.1 (6.3.1.2.1).

SS07: LANDSCAPING DESIGN AND MAINTENANCE

501.3.3.6 Landscaping Design and Maintenance. New construction and *major renovation*s of a one- or two-family dwelling, multi-family and commercial *building projects* shall meet all applicable requirements in Section 501.3.3.6.1 through Section 502.3.3.6.5.

501.3.3.6.1 Minimum Landscape Area. Minimum landscape areas shall be in addition to all other landscape provided to satisfy the requirement of other City of Denver regulations. Landscape area is considered to be at grade or located on roofs.

a. New construction of a one- or two- family dwellings: Minimum landscaping area of 25% of the site's net area shall be landscaped per the design requirements.

b. New multi-family *building projects*: Minimum landscaping area of 15% of the site's net area shall be landscaped per the design requirements.

c. New commercial *building projects*: Minimum landscaping area of 10% of the site's net area shall be landscaped per the design requirements.

501.3.3.6.2 Design Parameters and Definitions:

a. Tree Equivalent (TE):
   i. Minimum size deciduous tree (1 TE) at time of planting shall be 2-inch caliper, measured 4 inches above the ground
   ii. Minimum size ornamental and flowering trees (1 TE) shall be at least 1- and 1/2-inches caliper measured 4 feet above the ground
   iii. Minimum size evergreen trees (1 TE) shall be a minimum of 5 feet in height
   iv. Tree substitution for 10 shrubs to one tree is available when trees are infeasible. Up to 50% of the required trees may be substituted by shrubs.

b. Shrub Equivalent (SE):
   v. Minimum size of a shrub (1 SE) is defined as one large shrub (average mature width 5 feet or greater) at time of initial planting
   vi. Two medium shrubs (average mature width is 3 to 5 feet) at time of initial planting
   vii. Four small shrubs (average mature width is less than 3 feet) at time of initial planting
   viii. Up to 50% of the required shrubs may be substituted by groundcovers and/or vines of equal size.

501.3.3.6.3 Minimum Tree and Shrub Count: Provide 90% coverage of landscape area with plant material within three years of installation, and 100% coverage of landscape area within five years of installation, including the minimum number of specific plants required to achieve this based on those selected, but in no case less than at least one (1) TE plus five (5) SE per every 500 ft^2 of required minimum landscaping area, rounding down to the nearest whole number if equal to or less than 0.49 and rounding up if the number is 0.50 or greater.

501.3.3.6.4 Landscape Design:

b. Plant Species Diversity: Landscaping shall consist of any combination of perennials, groundcover, shrubs, trees, grasses and/or up to 15% annuals:
   i. On each one- or two- family dwelling residential lot with pervious area greater than 500 ft^2 a minimum of 10 species shall be planted.
   ii. On each one- or two- family dwelling residential lot with pervious area greater than 1000 ft^2 minimum of 20 species shall be planted.
   iii. On multifamily and commercial project sites with pervious area greater than 500 ft^2 a minimum of 10 species shall be planted.
   iv. On multifamily and commercial project sites with pervious area greater than 1000 ft^2 a minimum of 20 species shall be planted.

c. Plant spacing and clustering: Provide spacing appropriate for mature growth.

d. Evergreen Trees: Evergreen trees shall not be located within 12 feet of a public way.

501.3.3.6.5 Maintenance: All landscaping materials shall be weeded, pruned for plant structure and health, organically mulched, and maintained as often as necessary to keep a well maintained and healthy landscape. Mowing and trimming are permitted annually prior to April 1 and/or after October 1, but not between April 1 and October 1. Native plants shall not be cut shorter than 6". Replacement of damaged or dead plant materials shall occur within 30 days of such event during the growing season of April 1 to October 1 unless this date falls within the months of July or August, during which planting shall be prohibited. In such cases, planting shall occur during the first 30 days of September. At all other times outside of April 1 through October 1, replacement shall occur within 45 days of the start of the following growing season. In no event shall replacement time exceed one year. Trash, litter, and weeds shall be removed promptly within 30 days. All maintenance shall be performed in compliance with, and to meet all requirements of, the Associated Landscape Contractors of Colorado's certification process for contractors for Sustainable Landscape Management.

SS08: ESTABLISHED TREE PRESERVATION

501.3.3.7 Established Tree Preservation. Starting 180-days prior to development permit application, any healthy established long-lived tree not otherwise noxious, diseased, or decayed as defined in the rules and regulations of the city forester or the Denver Zoning Code shall be preserved in the minimum required primary street setbacks and side street setbacks for all project types. An established tree is considered any tree meeting the definition in Denver Revised Municipal Code Chapter 57.

No more than 20% of an existing tree canopy may be removed to accommodate construction activities. Pruning shall be completed by a licensed and insured tree contractor. Protection of canopy and root zones and monitoring of pruning shall be under the direction of a registered consulting arborist for any tree to be preserved.

Exception: More than 20% of a tree canopy, or an entire tree may be removed for the purpose of development if approved in writing by the city forester.

SS09: ROCK MULCH ALLOWANCES

501.3.3.8 Rock Mulch Allowances. Rock mulch, such as gravel or decomposed granite, shall be limited to *high-traffic* unplanted areas not required as accessible routes plus no greater than 10% of the total landscaping area (ft^2) including for decorative or edging purposes. The material used as rock mulch shall have a *solar reflective index (SRI)* value of 29 or greater (or an initial solar reflectance (SR) of 0.33 or greater) and be sized

between 1/2 inch to 2 inches to mitigate spillover onto neighboring surfaces.

Exceptions:

1. Rock mulch associated with stormwater management systems.

2. Rock Mulch as Growing Media: For the purpose of protecting native bee habitat, supporting adjacent plant health, or otherwise positively contributing to the health and survival of associated plant, insect, or wildlife habitat, rock mulch sized between 1/8" and 3/8" such as pea gravel or decomposed granite shall be permitted in perennial planting beds as either a top dressing or mixed with soil media.

SS10: STORMWATER MANAGEMENT

501.3.4 Stormwater Management. Stormwater management systems shall be provided on the building *site*.
501.3.4.1 Projects shall comply with the following:

a. Stormwater management systems shall be included on site, designed to existing city criteria as well as the additional criteria listed below, dependent on the extent of soil disturbing activity during project development:

    1. Projects disturbing >1.0 acres of soil shall *infiltrate* or *evapotransporate* all rainfall from events up to 0.3 inches within 72 hours.
    2. Projects disturbing between 0.5-1.0 acres of soil shall meet both *detention* and *water quality* requirements of the Denver Storm Drainage Design & Technical Criteria Manual.
    3. Projects disturbing <0.5 acres shall meet *detention* requirements in the Denver Storm Drainage Design & Technical Criteria Manual and include downspout filters on all downspouts.

b. Stormwater management systems shall include the following non-structural stormwater controls, as appropriate:

    1. Multifamily residential buildings with 30 or more units shall provide a minimum of one pet waste station per 150 feet of building perimeter. Building perimeter shall include street frontage, alley frontage, and frontage alongside pedestrian passages, interior amenity spaces, courtyards, and other spaces internal to the site.
    2. Residential buildings with designated pet waste areas and/or dog runs must include *water quality* treatment of stormwater discharge from those areas.
    3. All buildings with >20 parking spaces must include a maintenance plan for biannual street sweeping.

c. Structural controls that are part of the stormwater management system that are vegetated shall use plant species listed in Denver's Ultra Urban Green Infrastructure Guidelines.

501.3.4.2 Reserved.

501.3.4.3 Reserved.

501.3.4.4 Reserved.

501.3.4.5 Reserved.

SS11: COAL TAR SEALANTS

501.3.4.6 Coal Tar Sealants. The use of tar sealants shall be prohibited in any application exposed to stormwater, wash waters, condensates, irrigation water, snowmelt, or ice melt.

SS12: MITIGATION OF HEAT ISLAND EFFECT

501.3.5 Mitigation of Heat Island Effect.

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

a. Existing trees and vegetation or new *biodiverse plantings* of *native plants* and *adapted plants*, which shall be planted either prior to the final approval by the *Agency* or in accordance with a conditional approval to require planting no later than 12 months after the final approval by the *Agency* so as to provide the required shade no later than ten years after the final approval. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

b. Paving materials with a minimum initial *solar reflectance index* (*SRI*) of 29. A default *SRI* value of 35 for new concrete without added color pigment is allowed to be used instead of measurements.

c. *Open-graded (uniform-sized) aggregate*, *permeable pavement*, *permeable pavers*, and *porous pavers (open-grid pavers)*. *Permeable pavement* and *permeable pavers* shall have a percolation rate of not less than 2 gal/min·ft^2 (100 L/min·m^2).

d. Shading through the use of structures

e. Parking under a building, provided that the *roof* of the building complies with the provisions of Section 501.3.5.3.

f. Buildings or structures that provide shade to the *site hardscape*. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

501.3.5.2 (5.3.5.2) Reserved.

501.3.5.3 (5.3.5.3) Roof covering materials shall comply with the Denver Green Buildings Ordinance [GBO] Rules and Regulations: Article III.

501.3.5.4 Reserved.

SS13: REDUCTION OF LIGHT POLLUTION

501.3.6 Reduction of Light Pollution.

501.3.6.1 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 and 501.3.6.3 of this code.

501.3.6.2 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.

b. All other luminaires shall meet the maximum allowable backlight and glare ratings in Table 501.3.6.2B.

c. Internally illuminated exterior signage do not exceed a luminance of 200 cd/m2 (nits) during nighttime hours and 2000 cd/m2 (nits) during daytime hours.

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
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
≥2	G0	G1	G2	G3
[3]≥1 and < 2	G0	G0	G1	G1
[3]≥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
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]≥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

a. 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.
b. 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.
c. 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.
d. Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

TABLE 501.3.6.3
MAXIMUM ALLOWABLE UPLIGHT FOR FAÇADE LIGHTING

	LZ0	LZ1	LZ2	LZ3
Total fixture lumens per ft^2 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 Uplight. All exterior lighting shall meet one of the following uplight requirements:

a. Exterior luminaires shall meet the maximum allowable Uplight Ratings of Table 501.3.6.2B.
b. Exterior lighting shall meet the uplight requirements of Table 501.3.6.3.

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.

SS14: MITIGATION OF TRANSPORTATION IMPACTS

501.3.7 Mitigation of Transportation Impacts.

501.3.7.1 Pedestrian and Bicycle Connectivity.

501.3.7.1.1 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 building projects* shall not be less than 3 feet (1 m) in width.

501.3.7.1.2 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 Bicycle Parking.

501.3.7.2.1 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:

1. *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 *Agency* 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 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 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 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 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 Documentation. *Construction documents* shall include plans and details showing compliance with Sections 501.3.7.2.1 through 501.3.7.2.5.

SS15: SITE CONSTRUCTION WASTE MANAGEMENT PLAN

501.3.8 Building Site Waste Management.

501.3.8.1 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.

SS16: SOIL AMENDMENT

501.3.9 Soil Amendment. 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 ft^2 of permeable areas. A minimum application rate of 12 cubic yards per 1,000 ft^2 is required for amended topsoil.

Exceptions:

1. Native grass seeded areas with an application rate of 2 cubic yards per 1,000 ft^2 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 stormwater quality structures where a geotechnical engineer provides recommendations on soil conditions.

SS17: BIRD FRIENDLY MATERIALS

501.3.10 Bird friendly materials. Bird friendly materials shall be required in accordance with Sections 501.3.10.1 through 501.3.10.6.

501.3.10.1 Exterior glazing. The exterior glazing, and any associated openings, shall be constructed with *bird friendly materials* up to 45 feet from grade plus an additional 45 feet up from any elevated landscaped amenities decks within 90 feet (27,432mm) above grade.

Exception: Materials other than *bird friendly materials* that do not exceed an aggregate of 10 ft^2 (0.93 m^2) within 100 ft^2 of exterior wall.

501.3.10.2 Bird hazard installations. Bird hazard installations shall be constructed of *bird friendly materials* regardless of their height above grade.

501.3.10.3 Fly-through conditions. Fly-through conditions located 90 feet (27,432mm) or less above grade shall be constructed with *bird friendly materials*.

501.3.10.4 High Risk Surface Bird Friendly Materials. The exterior wall envelope, and any associated openings, installed within 50 feet (15240 mm) or less of attractants including but not limited to trees, shrubs, prairie, grassland, or open water (including green roofs with this type of vegetation) shall be constructed with *high-risk bird friendly materials*.

501.3.10.5 Bird traps. No portion of the exterior wall envelope, and any associated openings with bird trap conditions listed in 501.3.10.5 a. through c. shall have a threat factor exceeding 25 regardless of height above grade.

a. Transparent exterior railings where all surfaces are exposed to exterior.

b. Transparent-sided walkways (e.g., skyways, covered walks with glass on two sides).

c. Any condition that offers a view from exterior to exterior that is 17 ft. or less across, such as a small atrium or glazed corners.

501.3.10.6 Reflective exterior features in site design. No mirrors shall be placed in or near planted areas or water features, or in locations where they would reflect trees, plants, or water.

SS18: DECLINING SPECIES SUPPORT

501.3.11 Declining Species Support. A project must preserve threatened or endangered (T & E) species and their habitats as identified in Section 103.1 Ecological Impact Statement by avoiding development of areas that contain habitat or migration corridors for plant and animal species identified on Colorado state endangered lists or on the International Union for Conservation of Nature Red List of Threatened Species as critically endangered or endangered. A project must comply with 501.3.11.1 through 501.3.11.5.

501.3.11.1 Do not develop greenfield within ¼ mile (1320 feet (402 m) of areas designated by U.S. Fish and Wildlife Service (USFWS) as riparian corridors, lakes or wetlands defined as critical habitat for threatened or endangered species, except if part of a conservation effort.

501.3.11.2 Do not develop greenspace within 100 feet (30.48 m) of areas designated by U.S. Fish and Wildlife Service (USFWS) as riparian corridors, lakes or wetlands defined as habitat not defined as critical for threatened or endangered species, except if part of a conservation effort.

501.3.11.3 Designate the full extent of threatened and endangered species habitat on the site as a vegetation and soil protection zone (VSPZ). All listed animals and plants must be protected from damage or removal. If threatened and endangered species are identified on site, all construction, development, and maintenance activities within the VSPZ shall only occur during seasons/times when the animal species is not present to minimize impacts.

501.3.11.3.1 Vegetation and soil protection zones (VSPZ) must meet the following requirements:

a. Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation or wildlife habitat. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
b. VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
c. Educate all construction and maintenance personnel about the locations and protective measures of the VSPZ. In construction documents, outline educational measures to be administered to contractor
d. VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend one and one-half feet (1.5') from the base of the trunk for every one inch (1") of tree diameter or the dripline, whichever is greater. The diameter of the tree shall be measured at four and one-half feet (4.5') above grade (referred to as diameter breast height). VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
e. No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
f. Avoid planting regional invasive plant species, and when found onsite treat or remove.

501.3.11.4 Develop a plan for site maintenance that defines the process avoiding impacts during site maintenance to threatened and endangered species and their habitats. The plan shall include the coordination and collaboration with a State wildlife Agency and the City Agency to exchange information and acquire expertise in determining potential impacts to species of concern, and threatened or endangered animal and plant species. Restoration activities may occur within this zone to increase the quality of the habitat.

501.3.11.5 Pollinator Support. Select landscaping that supports pollinator diversity and health for 75% of plantings.

501.3.11.5.1 Plant native and adapted species that flower at different times of year and plant in clumps rather than single plants in accordance with SS05.

501.3.11.5.2 Avoid pesticide use in compliance with SS19. When SS18 is selected, projects must also comply with provisions of SS19.

501.3.11.5.3 Avoid planting regional invasive plant species, and when found onsite treat or remove.

SS19: ALLOWABLE PESTICIDES

501.3.12 Organic Landscape Plan for Allowable Pesticides, Fertilizers, Herbicides. A project must develop an integrated landscape management plan that employs organic protocols to avoid using toxic pesticides, fertilizers and herbicides. The plan shall specify use of nonchemical methods, contain a definition of emergency conditions and universal notification (advance notice of not less than 72 hours under normal conditions and 24 hours in emergencies before a pesticide, other than a least-toxic pesticide is applied). Comply with 501.3.12.1 through 501.3.12.3.

501.3.12.1 Appropriate plant selection. Design and install a landscape system in accordance with requirements in 501.3.3.6 Landscape Design and Maintenance Requirements.

501.3.12.2 Fertilizers and Soil Amendments. Use only fertilizer and amendment products that are certified by the Organic Materials Review Institute (OMRI) or approved equivalent.

501.3.12.3 Integrated pest management (IPM). Employ physical, mechanical, cultural, and biological controls to prevent pest presence. Routinely inspect and monitor for pests. Use minimum risk chemical pesticides, pesticide in the most minimum use possible. The pesticide shall only be used in targeted locations and for only targeted species when necessary in accordance with 501.3.12.3.1 and 501.3.12.3.2.

501.3.12.3.1 Limited Use Pesticides. The use of glyphosate, chlorpyrifos, and neonicotinoid pesticides shall be limited to individual plant spot application where no other effective, minimum risk pesticide is available, for all applications including but not limited to lawn, ornamental planted landscape, agricultural landscape, playground, *mulched recreation areas, children's facility*, grounds of a *children's facility*, or *playing field*.

501.3.12.3.2 Allowable Pesticides. Allowable pesticides are listed at C.F.R. §§ 205.601 and 12 205.602; or a pesticide designated a "minimum risk pesticide" listed in 40 C.F.R. § 152.25(f).

CHAPTER 6

WATER USE EFFICIENCY

601.1 Scope. This section specifies requirements for *potable water* and *non-potable water* use efficiency, both for the *site* and for the building, and water monitoring.

601.2 Compliance. *Building projects* shall comply with Chapter 6 in accordance with section 101.4.

601.3 Provisions.

WE01: SITE WATER USE REDUCTION

601.3.1 Site Water Use Reduction. 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 7.5 gallons per ft^2 or less water budget of potable water used per year after establishment, excluding areas of existing high quality landscape and/or mature trees as approved by the Agency. Establishment may be defined by up to three years after initial planting. Alternative on-site 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. Designs and maintenance plans shall be generated in collaboration with a certified ecologist familiar with regional conditions. 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.
f. Maintenance specifications shall require that maintenance be performed by Associated Landscape Contractors of Colorado (ALCC) certified contractor(s); that the associated maintenance plan including this stipulation be available onsite upon request by the Agency prior to issuance of Certificate of Occupancy; and that records of maintenance operations and water consumption measurements be maintained onsite for the first five years after issuance of Certificate of Occupancy, available upon request by the Agency.

601.3.1.1 Landscape Design. A minimum of 80% of the area of the *improved landscape* shall achieve 90% plant coverage at three years, and 100% plant coverage at five years, of plants comprised entirely of *biodiverse plantings* of the following approved plants. The remaining maximum of 20% of the area of the *improved landscape* shall achieve 90% plant coverage at three years, and 100% plant coverage at five years, of any mix of plant material including but not limited to *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. A front range Colorado city's adopted xeric plant lists approved by the *Agency*.
    4. City and County of Denver's Department of Transportation and Infrastructure's Ultra Urban Green Infrastructure Guidelines and Green Continuum of Streets.

Exceptions:

1. The area of dedicated athletic fields, golf courses, driving ranges, and areas dedicated for production of food for human consumption, 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*.
3. *Wetland* and riparian areas that use *wetland* and riparian Colorado plantings.

601.3.1.2 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 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 within this code.

601.3.1.2.1 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*. *Functional (active) turfgrass* areas shall be on their own *hydrozones.*
    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 *functional (active) turfgrass* or *ground cover* areas with vegetation maintained at 8 in. (203 mm) or less in height.
    6. If the sprinkler is a pop-up configuration, then it 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 Automatic Irrigation Controls. Project *site* irrigation system(s) 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. 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.

WE02: SITE WATER USE REDUCTION - STRETCH

601.3.1.2.3 Additional Site Water Use Reduction. Meet all WE01 requirements and additionally provide a landscape site plan that is at 5 gallons per ft^2 or less water budget of *potable water* used per year. *Alternate on-site sources of water* may be substituted to increase yearly water supply.

WE03: NO IRRIGATION

601.3.1.2.3 Use of Potable Water. 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 WE01 - Section 601.3.1.1. item 'b'. Irrigation shall be from one or more of the following systems:

   a. On-site *reclaimed water* treatment systems complying with WE08.

   b. Above-ground irrigation systems

2. Irrigation of plants that are used on green roofs and other similar applications.

WE04: BUILDING WATER USE REDUCTION

601.3.2 Building Water Use Reduction.

601.3.2.1 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:

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. Dual-flush flushometer valve types shall not be installed.

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 0.8 gal. For dual-flush, the full-flush volume shall not exceed 1.0 gal per flush. 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 0.35 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 1.0 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 1.5 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 m^2), an additional flow of 1.5 gpm shall be permitted for each multiple of 2600 in.^{2} (1.7 m^2) of floor area or fraction thereof.

j. **Water-bottle filling stations.** *Water-bottle filling stations* shall be part of or shall be installed adjacent to all drinking fountains locations installed indoors on the premises.

TABLE 601.3.2.1
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	Shall not be installed.
Water closets (toilets)—single-flush tank-type	Single-flush volume of 0.8 gal.
Water closets (toilets)—dual-flush tank-type	Full-flush volume of 1.0 gal.
Urinals	Flush volume 0.125 gal.
Public lavatory faucets	Flow rate—0.35 gpm (1.35 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate—1.0 gpm.
Residential kitchen faucets	Flow rate—1.8 gpm (6.8 L/min) [a]
Residential showerheads	Flow rate—1.5 gpm.
Residential shower compartment (stall) in *dwelling units* 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).

601.3.2.2 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 3.2 gal/ft^3 of drum capacity (0.43 L/L of drum capacity) with load sensing capability.
   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 701.4.7.3.2. (CE30)]

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 3.2 gal/ft^3 of drum capacity normal cycle (0.43 L/L of drum capacity normal cycle). [See also the energy efficiency requirements in Sections 701.4.7.3.2. (CE30)]

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 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. 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 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 ft^2 of vegetated roof area per year and shall be either a drip or spray type irrigation system.

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

a. 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. Dishwashers that comply with the requirements of the ENERGY STAR Program for Commercial Dishwashers,

c. Boilerless/connectionless food steamers that consume no more than 2.0 gal/h (7.5 L/h) in the full operational mode,

d. Combination ovens that consume not more than 10 gal/h (38 L/h) in the full operational mode,

e. Air-cooled ice machines that comply with the requirements of the ENERGY STAR Program for Commercial Ice Machines, and

f. Dipper wells equipped with an in-line flow restrictor limiting flow to 0.3 gpm.

601.3.2.6 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 use the following:

a. 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. 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. Digital imaging and radiography systems where the digital networks are installed.

d. 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. Only dry vacuum pumps unless fire and safety codes (**Informative Note:** e.g., *Denver Fire Code*) for explosive, corrosive, or oxidative gases require a liquid ring pump.

f. 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. Food service operations within medical and laboratory facilities must comply with Section 601.3.2.5.

WE05: SPECIAL WATER FEATURES

601.3.3 Special Water Features. 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 *Agency*. 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.

WE06: WATER CONSUMPTION MEASUREMENT

601.3.4 Water Consumption Measurement.

601.3.4.1 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 ft^2 (5000 m^2), 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*, stormwater) to the *building project* that exceeds the thresholds listed in Table 601.3.4.1A. 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.

TABLE 601.3.4.1A
WATER SUPPLY SOURCE MEASUREMENT THRESHOLDS

WATER SOURCE	MAIN MEASUREMENT THRESHOLD
Potable water	1000 gal/day (3800 L/day)
Municipally *reclaimed water*	1000 gal/day (3800 L/day)
Alternate sources of water, excluding stormwater harvesting	500 gal/day (1900 L/day)

TABLE 601.3.4.1B
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	>10,000 ft^2 (929m^2)
Separate campus or project buildings	Consumption > 1000 gal/day (3800 L/day)
Separately leased or rental *space*	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

601.3.4.2 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 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 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 CX11- Section 1001.3.2.1.2.

601.3.5 Reserved.

WE07: REVERSE OSMOSIS WATER TREATMENT SYSTEMS

601.3.6 Reverse Osmosis Water Treatment Systems. 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.

WE08: ON-SITE GRAYWATER SYSTEMS

601.3.7 On-Site Reclaimed Water Treatment Systems. On-site *reclaimed water* treatment systems, including *graywater* reuse treatment systems and wastewater 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.

601.3.7.1 *Graywater* Reuse Treatment Systems. *Graywater* systems shall comply with State of Colorado, Department of Public Health and Environment, Code of Colorado Regulations, City and County of Denver Graywater Treatment Works Regulations, City and County of Denver Building Permit Policy for Graywater Treatment Works Systems (Denver Plumbing Code (DPC) Sections 1301 and 1302, and Chapter 14), DPHE Regulation 86- Graywater Control Regulations. Within Regulation 86, the commission authorizes two uses for *graywater* – subsurface irrigation and indoor toilet/urinal flushing. These shall be considered separate provisions within this Code when choosing project electives in accordance with Section 101.4.2, #1.

WE09: DUAL WATER SUPPLY PLUMBING

601.3.8 Dual Water Supply Plumbing.

601.3.8.1 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.

WE10: DROUGHT PREPAREDNESS

601.3.9 Drought Preparedness. The building *site* and/or *building project* shall comply with two of the following sections: 601.3.9.1, 601.3.9.2, 601.3.9.3, or 601.3.9.4.

601.3.9.1 Sprinkler Efficiency. Where sprinklers are installed for project landscaping, all spray sprinkler bodies shall have an internal pressure regulator and be WaterSense® labeled and paired with efficient spray nozzles that have a matched precipitation rate that is rated a 1 inch/hr or less as found on Denver Water's list for rotary/high-efficiency nozzles.

601.3.9.2 Waterless Toilets. Commercially manufactured waterless toilets certified by the National Sanitation Foundation (NSF) and compliant with NSF 41 shall be used in all private restrooms and count for a minimum of 20% of the provided fixtures in public restrooms. Rough plumbing for optional future conventional water flushing fixtures shall be installed per accordance with the DPC. Proper ventilation to the outside must be designed.

a. Capacity: The volume of the unit shall be sufficient to accommodate the number of occupants, frequency and kind of use, and maintenance of ideal composting conditions. The volume of the unit must include sufficient area for the use of composting materials which must not be toxic to the process or hazardous to persons and which must be used in sufficient quantity to assure proper decomposition.
b. Treatment Systems: Treatment systems including the addition of any materials, the turning of drums, and the utilization of heating elements and timers shall be managed per manufacturer instruction.
c. Waste Removal: Waste from the unit must be properly disposed of at 75% capacity by adhering to the methods provided by the manufacturer and acceptable to the Denver Department of Public Health and Environment. Disposal methods must prevent contamination of water and not cause a public health nuisance. Waste shall be disposed of only after such time as the material is thoroughly and completely decomposed and rendered noninfectious. Total and fecal coliform organisms shall not exceed the levels specified in NSF Standard Number 41.
d. Maintenance: Adequate access to service and maintenance of all necessary components of the waterless toilet and its accessories shall be provided. Composting toilets shall be maintained and operated in a sanitary condition, to control vectors, abatement of odors, and management of leachate. Screening, mechanical parts and structural soundness shall be kept in working order.
e. Low Temperature: Where systems will be installed in low temperatures (below 60-degrees), design and installation must address the effects of the low temperature to optimize the composting process.

601.3.9.3 High Water End-Uses.

a. Swimming Pools: All indoor and outdoor pools shall be outfitted with a semi-automatic or automatic pool cover to prevent evaporation during times of non-use. Placement and use of a pool cover shall be included in the building project's maintenance plan and communicated to users in pool area. Chemical pool covers do not comply.
b. Commercial Kitchen: Pre-Rinse spray valves must meet DOE regulations for maximum flow rate (gpm) allowable per product class. Restrict flow rates on dipper wells to 0.1gpm or eliminate dipper wells from design.

601.3.9.4 Waterless Urinal. Urinals shall be non-flushing and nonwater. Nonwater urinals shall comply with ASME A112.19.19 (vitreous china) or IAPMO Z124.9 (plastic) as appropriate.

CHAPTER 7

COMMERCIAL ENERGY

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

701.2 Compliance. *Building projects* shall comply with Chapter 7 in accordance with Section 101.4.

701.3 Provisions.

701.3.1 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 *Denver Energy Code* (DEC).

CE01: CONTINUOUS AIR BARRIER

701.3.1.1 Continuous Air Barrier. Building envelope airtightness shall comply with DEC Denver Amendment Sections C402.5.2 and C402.5.3, with the following modifications and additions:

1. The measured air leakage rate of the building envelope shall not exceed 0.25 cfm/ft^2 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 semi-heated space.
2. The exceptions to Sections C402.5.2 and C402.5.3 are allowed where the measured air leakage rate exceeds 0.25 cfm/ft^2 but does not exceed 0.40 cfm/ft^2.

CE02: ENHANCED DEC C406 CREDIT REQUIREMENT

701.3.2 Enhanced DEC C406 Credit Requirements. *Building projects* shall meet the minimum number of credit points in Table 701.3.2A, superseding Table C406.1A of the DEC, in addition to meeting all applicable prescriptive requirements in CE01 through CE33. Compliance requires the installation of *on-site renewable energy systems*.

TABLE 701.3.2A
DENVER GREEN CODE CREDIT REQUIREMENTS

Building Type	Credit Requirement for *All-Electric Properties*[a]	Credit Requirement for All Other *Buildings*
Multifamily	11	44
Healthcare/Hospital	11	44
Hotel/Motel	11	40
Office	11	35
Retail	11	39
School	11	28
Warehouse	11	52
All Other	11	44
a: Where the *all-electric property* complies with sections C406.12 and C406.13.		

CE03: ENERGY CONSUMPTION MANAGEMENT

701.3.3 Energy Consumption Management.

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

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

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

TABLE 701.3.3.1A
ENERGY SOURCE THRESHOLDS

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

TABLE 701.3.3.1B
SYSTEM ENERGY USE THRESHOLDS

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

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

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

Exception: Portions of buildings used as *residential.*

CE04: DEMAND RESPONSE

701.3.4 Demand Response. *Building projects* shall contain control systems that are capable of reducing building equipment loads to lower electric peak demand of the building in accordance with Denver Energy Code (DEC) Section C406.16. If a demand response program requiring activation of controls is offered by the utility serving the property, controls shall be activated to receive signals and allow full functionality. If compliance with DEC Section C406.16 is selected to satisfy minimum DEC compliance requirements, then CE04 shall not be counted to satisfy Denver Green Code (DGC) Limited Mandatory Use requirements outlined under DGC Section 101.4.1 or DGC Enhanced Use requirements outlined under DGC Section 101.4.2.

701.3.4.2 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 EQ02, or that would cause adverse building pressurization.

701.3.4.3 Lighting. For *building projects* with interior lighting control systems controlled at a central point, such systems shall be programmed to allow 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 CE23. 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.

701.4 PRESCRIPTIVE APPROACH.

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

CE05: RENEWABLES APPROACH

701.4.1.1 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/ft^2 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/ft^2 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 *Agency* 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/m^2·day (1.2 kBtu/ft^2/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/ft^2 (75 kWh/m^2) of *conditioned space* each year until the cumulative purchase totals 70 kWh/ft^2 (750 kWh/m^2) of *conditioned space*.

CE06: BATTERY STORAGE

701.4.1.2 Battery Storage Systems. All newly constructed buildings that include on-site PV system shall also have a battery storage system meeting the minimum qualification requirements. The rated energy capacity and the rated power capacity shall be not less than the values determined by Table 7.4.1.2-A. Where the building includes more than one of the space types listed in Table 7.4.1.2-A, the total battery system capacity for the building shall be determined by applying Equations 7.4.1.2-B and 7.4.1.2-C to each of the listed space types and summing the capacities determined for each space type .

Exceptions:

1. No battery storage system is required if the installed PV system rated capacity is less than 0.25 Watts per square foot of conditioned floor area .
2. No battery storage system is required in buildings with PV system capacity of 10 kW or less.
3. For multi-tenant buildings, the energy capacity and power capacity of the battery storage system shall be based on the tenant spaces with more than 5,000 square feet of conditioned floor area. For single-tenant buildings with less than 5,000 square feet of conditioned floor area, no battery storage system is required.

EQUATION 7.4.1.2-B - BATTERY STORAGE RATED ENERGY CAPACITY

$kWhbatt = kWPVdc \times B / D^{0.5}$

WHERE:

kWhbatt = Rated Useable Energy Capacity of the battery storage system in kWh

kWPVdc = PV system capacity in kWdc

B = Battery energy capacity factor specified in Table 7.4.1.2 for the building type

D = Rated single charge-discharge cycle AC to AC (round-trip) efficiency of the battery storage system

EQUATION 7.4.1.2-C - BATTERY STORAGE RATED POWER CAPACITY

$kWbatt = kWPVdc \times C$

WHERE:

kWbatt = Power capacity of the battery storage system in kWdc

kWPVdc = PV system capacity required by section 701.4.1 in kWdc

C = Battery power capacity factor specified in Table 7.4.1.2 for the building type

Table 7.4.1.2-A Battery Storage Capacity Factors (Storage to PV Ratio)

	B - Energy Capacity (Wh / W PV)	C - Power Capacity (W / W PV)
Grocery	1.03	0.26
Highrise Multifamily	1.03	0.26
Office	1.68	0.42
Retail	1.03	0.26
School	1.87	0.46
Warehouse	0.93	0.23

CE07: BUILDING ENVELOPE

701.4.2 Building Envelope. The *building envelope* shall comply with the requirements in DEC Tables C402.1.4 and C402.4, with the following modifications to values in the tables. These adjustments shall also be applicable where the intent is to comply with the component performance alternative of DEC 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 DEC Table C402.4.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in DEC Table C402.4
3. *Spaces* that meet the requirements of EQ16 - Section 801.4.1, regardless of *space* area, are exempt from the *SHGC* criteria for *skylights*.

Informative Notes:

1. U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix A.

2. SS12 - Section 501.3.5.3 of this code includes additional provisions related to *roofs*.

TABLE C402.1.4

CLIMATE ZONE	5	
	All Other	Group R
Roofs		
Insulation entirely above deck	U- 0.030	U- 0.030
Metal buildings	U- 0.033	U- 0.033
Attic and other	U- 0.020	U- 0.020
Walls, above grade		
Mass	U- 0.855	U- 0.076
Metal building	U- 0.475	U- 0.475
Metal framed	U- 0.052	U- 0.052
Wood framed and other	U- 0.049	U- 0.049
Walls, below grade		
Below-grade wall	C- 0.113	C- 0.087
Floors		
Mass	U- 0.054	U- 0.049
Joist/framing	U- 0.031	U- 0.031
Slab-on-grade floors		
Unheated slabs	F- 0.49	F- 0.49
Heated slabs	F- 0.59	F- 0.59
Opaque doors		
Nonswinging door	U- 0.30	U- 0.30
Swinging door	U- 0.35	U- 0.35
Garage door < 14 % glazing	U- 0.30	U- 0.30

TABLE C402.4

CLIMATE ZONE	5
VERTICAL FENESTRATION	
	U-FACTOR FOR VERTICAL CURTAIN WALLS, STOREFRONT, AND SITE-BUILT FENESTRATION TYPE AW PRODUCTS[a]
FIXED FENESTRATION	0.32

OPERABLE FENESTRATION	0.41
ENTRANCE DOORS	0.57
ALL OTHER VERTICAL FENESTRATION	0.27
SKYLIGHTS	
U-FACTOR	0.48
SHGC	0.38

NR = No Requirement, PF = Projection Factor.

a. AW Products shall mean metal windows with an AW Performance Class Rating in accordance with AAMA/WDMA/CSSA 101/I.S.2/A440.

701.4.2.1 Reserved.

701.4.2.2 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 DEC Tables C402.1.3 and C402.1.4.

701.4.2.3 High-Speed Doors. *High-speed doors* that are intended to operate on average at least 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h·ft^2·°F (6.81 W/m^2·K). Opening rate, closing rate, and average cycles per day shall be included in construction drawings. DEC Table C402.1.3 shall not apply to *high-speed doors* complying with all criteria in this section.

701.4.2.4 Reserved.

701.4.2.5 Vertical Fenestration Area. *Vertical fenestration area* shall comply with DEC Sections C402.4.1 and C402.4.1.1.

701.4.2.6 Reserved.

CE08: SHGC of VERTICAL FENESTRATION

701.4.2.7 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 are used.

TABLE 701.4.2.7
SHGC MULTIPLIERS FOR PERMANENT PROJECTIONS

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

CE09: BUILDING ENVELOPE TRADE-OFF OPTION

701.4.2.8 Building Envelope Trade-Off Option. The *building envelope* component performance alternative of DEC Section C402.1.5 shall not be utilized unless the procedure incorporates the modifications and additions noted in CE07 and CE08.

701.4.2.9 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 CE08.

$SHGC_C$ = the *SHGC* criteria from CE07 and CE08.

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 CE08.

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

CE10: MINIMUM EQUIPMENT EFFICIENCIES

701.4.3.1 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 CE30. Where equipment efficiency is not defined/listed in Normative Appendix B or in CE30, 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." Products shall meet HVAC equipment efficiency requirements of CE11.

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." All units shall meet minimum requirements of C403.3.2.

g. Table 6.8.1-16, "Electrically Operated DX-DOAS Units, Single Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements." All units shall meet minimum requirements of C403.3.2.

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 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.

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

$B = 0.0015 \times LvgEvap + 0.934$.

LIFT = LvgCond – LvgEvap.

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

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

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

- 36.00°F £ LvgEvap £ 60.00°F.
- LvgCond £ 115.00°F.
- 20.00°F £ LIFT £ 80.00°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.

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

$B = 0.0027 \times LvgEvap + 0.982$.

LIFT = LvgCond – 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.

CE11: VENTILATION CONTROLS FOR DENSELY OCCUPIED SPACES

701.4.3.2 Ventilation Controls for Densely Occupied Spaces. The requirements in this section supersede those in DEC 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 CE16.
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; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

The *DCV* system shall be designed to be in compliance with ASHRAE Standard 62.1, Section 6.2.7.1. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV*. All CO_2 sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

a. *Spaces* with CO_2 sensors or air-sampling probes leading to a central CO_2 monitoring station shall be provided with at least one sensor or probe for each 10,000 ft^2 (1000 m^2) of floor *space*. Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.

b. *Outdoor air* CO_2 concentrations shall be determined by one of the following:

1. *Outdoor air* CO_2 concentrations shall be dynamically measured using one or multiple CO_2 sensors. The CO_2 sensor locations shall be identified on the *construction documents*.
2. When documented statistical data on the local ambient CO_2 concentrations are available, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.

c. Occupant CO_2 generation rate assumptions shall be shown in the design documents.

CE12: DUCT LEAKAGE TESTS

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

CE13: ECONOMIZERS

701.4.3.4 Economizers. Systems shall include economizers meeting the requirements in DEC Section C403.5, except as modified by the following:

TABLE 701.4.3.4
MINIMUM SYSTEM SIZE FOR
WHICH AN ECONOMIZER IS REQUIRED

CLIMATE ZONES	COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED[1]
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 240,000 Btu/h (70 kW) per building or 10% of the building's air economizer capacity, whichever is greater.

All the exceptions in DEC Section C403.5 shall apply except as modified by the following:

a. 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.

CE14: MINIMUM HVAC EQUIPMENT PERFORMANCE RATINGS

701.4.3.5 Minimum HVAC Equipment Performance Ratings. All building projects with any of the following classes of equipment must meet the following minimum performance ratings at AHRI rated conditions. The following HVAC equipment performance requirements in Tables 701.4.3.5(1) and 701.4.3.5(2) shall supersede the performance requirements in DEC Table 403.3.2 (1) and Table 403.3.2 (2):

TABLE 701.4.3.5(1)

ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS [c, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEADING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
Air Conditioner, air-cooled	<65,000 Btu/h	All	Split system, three phase and applications outside US single phase	16.0 SEER before 1/1/2023 16.5 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
			Single-package, three-phase and applications outside US single phase	16.0 SEER before 1/1/2023 16.5 SEER2 after 1/1/2023	
Space constrained, air-cooled	≤ 30,000 Btu/h	All	Split system, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
			Single-package, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
Small duct, high velocity, air-cooled	<65,000 Btu/h	All	Split system, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 12.1 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.2 EER, 12.9 IEER before 1/1/2023 12.6 EER, 16.2 IEER after 1/1/2023	AHRI 340/360
		All Other		11.0 EER, 12.7 IEER before 1/1/2023 12.6 EER, 16.0 IEER after 1/1/2023	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		11.0 EER, 12.4 IEER before 1/1/2023 12.4 EER, 16.0 IEER after 1/1/2023	AHRI 340/360
		All Other		10.8 EER, 12.2 IEER before 1/1/2023 12.2 EER, 15.8 IEER after 1/1/2023	

TABLE 701.4.3.5(2)

ELECTRICALLY OPERATED AIR-COOLED UNITARY HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	HEADING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
Air cooled (cooling mode)	<65,000 Btu/h	All	Split system, three phase and applications outside US single phase	14.0 SEER before 1/1/2023 14.3 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
			Single-package, three-phase and applications outside US single phase	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	
Space constrained, air-cooled (cooling mode)	≤ 30,000 Btu/h	All	Split system, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
			Single-package, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 11.7 SEER2 after 1/1/2023	
Single duct, high velocity, air-cooled (cooling mode)	<65,000 Btu/h	All	Split system, three phase and applications outside US single phase	12.0 SEER before 1/1/2023 12.0 SEER2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER, 12.2 IEER before 1/1/2023 12.2 EER, 16.0 IEER after 1/1/2023	AHRI 340/360
		All Other		10.8 EER, 12.7 IEER before 1/1/2023 12.2 EER, 15.8 IEER after 1/1/2023	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		10.6 EER, 11.6 IEER before 1/1/2023 11.8 EER, 16.0 IEER after 1/1/2023	AHRI 340/360
		All Other		10.4 EER, 11.4 IEER before 1/1/2023 11.8 EER, 15.8 IEER after 1/1/2023	
	≥ 240,000 Btu/h	Electric resistance (or none)		9.5 EER, 10.6 IEER before 1/1/2023 11.0 EER, 15.0 IEER after 1/1/2023	
		All Other		9.3 EER, 10.4 IEER before 1/1/2023 10.8 EER,	

				14.8 IEER after 1/1/2023	
Air cooled (heating mode)	≤ 65,000 Btu/h	All	Split system, three phase and applications outside US single phase	8.2 HSPF before 1/1/2023 8.5 HSPF2 after 1/1/2023	AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023
			Single package, three phase and applications outside US single-phase	8.0 HSPF before 1/1/2023 7.6 HSPF2 after 1/1/2023	
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	All	47F db/43F wb outdoor air	3.30 COP_H before 1/1/2023 3.6 COP_H after 1/1/2023	AHRI 340/360
			17F db/15F wb outdoor air	2.4 COPH	
	≥ 135,000 Btu/h and < 240,000 Btu/h	All	47F db/43F wb outdoor air	3.20 COP_H before 1/1/2023 3.45 COPH after 1/1/2023	AHRI 340/360
			17F db/15F wb outdoor air	2.3 COP_H	
	≥ 240,000 Btu/h	All Other	47F db/43F wb outdoor air	3.20 COP_H	
			17F db/15F wb outdoor air	2.2 COP_H	

CE15: FAN SYSTEM POWER

701.4.3.6 Fan System Power and Efficiency.

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

701.4.3.6.2 Fan Efficiency. The fan efficiency requirements defined in DEC 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 DEC Section C403.8.3 shall apply.

TABLE 701.4.3.6.2
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 Low Capacity Fans. The fan efficiency requirements defined in DEC Section C403.8.5 shall be used, except that Table C403.8.5 shall be superseded by the requirements in Table 701.4.3.6.2.

CE16: EXHAUST AIR ENERGY RECOVERY

701.4.3.7 Exhaust Air Energy Recovery. The exhaust air energy recovery shall comply with the requirements defined in DEC Section C403.7.4, including the requirements in Tables C403.7.4.2 (1) and C403.7.4.2 (2). The energy recovery effectiveness shall not be less than 60%, and this shall supersede the requirement of the DEC.

701.4.3.8 Kitchen Exhaust Systems. The requirements in DEC Section C403.7.5 shall apply, except as follows:

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

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

TABLE 701.4.3.8.1
MAXIMUM NET EXHAUST FLOW RATE PER LENGTH OF HOOD

TYPE OF HOOD	LIGHT-DUTY EQUIPMENT		MEDIUM-DUTY EQUIPMENT		HEAVY-DUTY EQUIPMENT		EXTRA-HEAVY-DUTY EQUIPMENT	
	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear meter
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).

701.4.3.8.2 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.

CE17: DUCT INSULATION

701.4.3.9 Duct Insulation. Duct insulation shall comply with the minimum requirements in Normative Appendix A, Tables A-2 and A-3. These requirements supersede the requirements in DEC Section C403.12.1.

CE18: AUTOMATIC CONTROL OF HVAC AND LIGHTS IN HOTEL/MOTEL GUEST ROOMS

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

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

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

701.4.3.10.3 HVAC Set-Point Control. Within 30 minutes of all occupants leaving the guest room, HVAC set points shall be automatically raised by at least 5°F (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 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 Automatic Control. Captive keycard systems shall not be used to comply with Section 701.4.3.10.

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

CE19: EQUIPMENT EFFICIENCY

701.4.4.1 Equipment Efficiency. All *building projects* shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.8, and with the applicable ENERGY STAR requirements in CE29 and CE30. These requirements supersede the requirements in DEC Table C404.2.

CE20: INSULATION FOR SPA POOLS

701.4.4.2 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.

CE21: HIGH OUTPUT SERVICE WATER HEATING SYSTEMS

701.4.4.3 High Output Service Water Heating Systems. These requirements shall supersede the requirements of DEC 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 DEC 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.)

CE22: DRAIN WATER HEAT RECOVERY

701.4.4.4 Drain water heat recovery. Drain water heat recovery (DWHR) systems shall be installed for building projects that meet one of the following requirements:

1. Drain water heat recovery (DWHR) systems shall be installed in all commercial buildings and buildings with R-2 occupancies whenever there are four or more showers on a shared drain line. The DWHR system must be installed on at least 80 percent of drains not located on the ground floor. The DWHR devices shall be one of the following types of systems:
    a. DWHR devices installed on individual drains
    b. Distributed systems serving multiple floors
    c. Central or ganged systems connected to a single or manifold DWHR device
    d. Central heat pump water heaters that use waste water for heat rejection
2. Commercial buildings with at least fifty (50) dwelling units that have at least 5 laundry washer machines

located in a common area shall have drain water heat recovery installed on the laundry machines. Laundromat facilities that contain at least ten commercial washer and dryer machines shall include drain water heat recovery on the laundry equipment.

701.4.4.4.1 Drain water heat recovery installation requirements. All DWHR systems that are installed shall meet the following requirements:

1. All DWHR systems shall be meet IPC requirements of ¼" per linear foot for proper drainage. Drain water heat recovery shall be installed on laundry systems in R-2 and commercial buildings that include four or more laundry washing machines.
2. Vertical DHWR units shall be compliant with CSA B55.2. In addition, DWHR systems shall meet the following requirements:
    a. Have a minimum rated effectiveness of 42 percent, and
    b. The DWHR shall be installed within 1 degree of the rated slope.
2. Sloped DWHR units shall be compliant with the following testing and labeling requirements:
    a. The heat transfer medium shall be either *potable water* or contains fluids recognized as safe by the Food and Drug Administration (FDA) as food grade.
    b. Bear a label with the word "Caution" followed by the following statements:
        i. The heat-transfer medium shall be *potable water* or other nontoxic fluid recognized as safe by the FDA
        ii. The maximum operating pressure of the heat exchanger shall not exceed the maximum operating pressure of the *potable water* supply.

701.4.5 Reserved.

701.4.6 Lighting. The lighting shall comply with DEC Sections C405.2 through C405.4, with the following modifications and additions.

701.4.6.1 Lighting Power Allowance

CE23: INTERIOR LIGHTING POWER DENSITIES (LPDS)

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

CE24: EXTERIOR LIGHTING POWER DENSITIES (LPDS)

701.4.6.1.2 Exterior LPDs. The exterior *lighting power allowance* shall be determined using DEC Section C405.4.1, with the following modification. The LPDs from DEC Table C405.5.2(2) shall be multiplied by the appropriate LPD factor from Table 701.4.6.1.2.

TABLE 701.4.6.1.2
LIGHTING POWER ALLOWANCE FACTORS

	LIGHTING ZONE				
	LZ0	LZ1	LZ2	LZ3	LZ4
For *tradable* areas, uncovered parking areas: parking areas and drives with measured *SRI* < 29 or without *SRI* 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 *SRI* ³ 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

CE25: HORTICULTURE LIGHTING

701.4.6.1.3 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 2.2 µmol/J rated in accordance with ANSI/ASABE S640.

CE26: LIGHTING CONTROLS

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

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

701.4.6.3 Automatic Controls for Egress and Security Lighting. Lighting in any area within a building that is required to be continuously illuminated for reasons of building security or emergency egress shall not exceed 0.1 W/ft^2 (1 W/m^2). Additional egress and security lighting shall be allowed, provided it is controlled by an *automatic* control device that turns off the additional lighting.

701.4.6.4 Controls for Exterior Sign Lighting. All exterior sign lighting, including internally illuminated signs and lighting on externally illuminated signs, shall comply with the requirements of Sections 701.4.6.4.1 or 701.4.6.4.2.

Exceptions:

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

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

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

701.4.6.4.2 All other sign lighting shall include the following:

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

b. Controls to automatically turn off during *daylight hours.*

701.4.6.5 Parking and Outdoor Sales Lighting. This section supersedes DEC Section C405.2.7 for lighting serving uncovered parking areas and open areas in outdoor sales lots. Outdoor luminaires serving uncovered parking areas and open areas in outdoor sales lots shall be controlled by all of the following:

a. Luminaires shall be controlled by a device that automatically turns off the luminaire during *daylight hours*.

b. Luminaires shall be controlled by a timeclock or other control that automatically turns off the luminaire according to a timed schedule.

c. For luminaires having a rated input wattage of more than 50 W and where the bottom of the luminaire is mounted 24 ft (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.

CE27: ELECTRICAL EQUIPMENT EFFICIENCY

701.4.7 Other Equipment. The other equipment shall comply with DEC Sections C405.6 through C405.10, with the following modifications and additions.

701.4.7.1 Equipment Efficiency. All *building projects* shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in CE30.

CE28: SUPERMARKET HEAT RECOVERY

701.4.7.2 Supermarket Heat Recovery. Supermarkets with a floor area of 25,000 ft^2 (2500 m^2) 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.

CE29: ENERGY STAR REQUIREMENTS FOR EQUIPMENT NOT COVERED BY FEDERAL

701.4.7.3.1 ENERGY STAR Requirements for Equipment not Covered by Federal Appliance Efficiency Regulations (outlined in Normative Appendix B). 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 WE04 - Section 601.3.2.5].
    4. Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers.
    5. Commercial griddles: ENERGY STAR Program Requirements for Commercial Griddles.
    6. Commercial ovens: ENERGY STAR Program Requirements for Commercial Ovens [see also water efficiency requirements in WE04 - Section 601.3.2.5].

CE30: ENERGY STAR REQUIREMENTS FOR EQUIPMENT COVERED BY FEDERAL

701.4.7.3.2 ENERGY STAR Requirements for Equipment Covered by Federal Appliance Efficiency Regulations (outlined in Normative Appendix B). 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. Building projects shall include a statement of intent to install products only meeting the specifications in 701.4.7.3.2a through 701.4.7.3.2.f below for any equipment not 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 MOST EFFICIENT Program Requirements for Clothes Washers [see also the water efficiency requirements in WE04 - Section 601.3.2.2].
    2. Clothes dryers: ENERGY STAR MOST EFFICIENT Program Requirements for Clothes Dryers.
    3. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.
    4. Dishwashers: ENERGY STAR MOST EFFICIENT Program Requirements Product Specifications for *Residential Dishwashers* [see also the water efficiency requirements in WE04 - Section 601.3.2.2].
    5. Refrigerators and freezers: ENERGY STAR MOST EFFICIENT Program Requirements for Refrigerators and Freezers.
    6. 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 CE10].
    2. *Residential* boilers: ENERGY STAR Program Requirements for Boilers [see also the energy efficiency requirements in CE10].
    3. *Residential* central air conditioners: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in CE10].
    4. *Residential* ceiling fans: ENERGY STAR Program Requirements for *Residential* Ceiling Fans.
    5. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.
    6. *Residential* warm air furnaces: ENERGY STAR Program Requirements for Furnaces.
    7. *Residential* geothermal heat pumps: ENERGY STAR Program Requirements for Geothermal Heat Pumps.

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

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

e. Commercial Food Service:
    1. Commercial refrigerators and freezers: ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers.

2. Commercial ice machines: ENERGY STAR Program Requirements for Commercial Ice Machines.

f. Other Products:

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

Exception: Projects shall be exempt from specifying Energy Star Most Efficient appliances as required above if it can be shown either that ADA requirements result in no qualifying products, or that no qualifying products are available. Projects shall be exempt from specifying Energy Star appliances as required above if it can be shown either that ADA requirements result in no qualifying products, or that no qualifying products are available.

CE31: PROGRAMMABLE THERMOSTATS

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

CE32: REFRIGERATED DISPLAY CASES

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

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

CE33: SUPERSEDE C405.12 OF DEC

701.4.9 The following requirements shall supersede Section C405.12 of the DEC:

701.4.9.1 Energy monitoring. New buildings with a gross *conditioned floor area* of 10,000 ft^2 (929 m^2) or larger shall be equipped to measure, monitor, record, and report energy consumption data in compliance with Sections 701.4.9.1.1 through 701.4.9.1.3.

Exception: R-2 occupancies and individual tenant spaces are not required to comply with this section provided that each space has its own utility services and meters.

701.4.9.1.1 Electrical energy metering. For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by DEC C405.12.2.

701.4.9.1.2 End-use metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in DEC Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in DEC **Table C405.12.2** shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.

2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.

3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 ft^2 (232 m2) where a dedicated source meter complying with DEC C405.12.3 is provided.

701.4.8.1.3 Disaggregation of end uses. -Plug loads, including appliances rated less than 25 kVA shall be monitored as follows:

(a) For buildings with plug loads exceeding 25 kVA in an area less than 5,000 ft^2 shall be separately monitored
(b) For buildings with service greater than 250 kVA, plug load measurements shall be separated (disaggregated) by floor, type, or area

CE34: RESERVED

CE35: ZERO NET ENERGY APPROACH

701.6 Zero Net Energy Approach. *Buildings* shall be provided with an *onsite renewable energy system(s)* capable of annual renewable energy production no less than the annual energy use of the *building* as calculated in accordance with Section C407, Appendix SE or Appendix PT of the *Denver Energy Code*. System specifications and system *renewable energy* production calculations demonstrating that the system meets the requirements of this section shall be included in the construction documents in accordance with C103.2 of the Denver Energy Code. Only all-electric buildings are eligible for this approach.

Exception:

1. Verifiable documentation has been provided to the *building official* demonstrating that the site does not have sufficient physical space for an *onsite renewable energy system* that meets the requirements of this section and,

2. Documentation has been submitted to the building official showing that the *building* is provided with any combination of off-site and *onsite renewable energy system(s)* sized to meet the requirements of this section and in accordance with the following:

   a. For off-site solar owned by the building owner, proof of ownership and documentation of the kWh having been delivered each year shall be provided in order to receive the Certificate of Occupancy.

   b. For *financial renewable energy power purchase agreements* and *physical renewable energy power purchase agreements* documentation of the following shall be provided with the construction documents:
      i. kWh having been delivered each year.
      ii. The contract, subscription, lease, or purchase of a share in either a voluntary renewable energy program offered by Xcel Energy, or a *renewable energy facility* for which a dedicated renewable energy resource located in Public Service Company of Colorado territory is dedicated for that customer program, and which has dedicated customer capacity or energy to fulfill that customer's subscription. The term of purchase shall be no less than five (5) years and must be renewed a minimum of every five (5) years for the life of the building for purposes of compliance with this rule. In addition to self-certification of the contract the kWh delivered each year under the contract shall be reported.

   The *building official* may request copies of contracts to verify compliance.

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

701.6.2 Documentation. Within 36 months of the issuance of the certificate of occupancy, the project team must 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.

CE36: COMMERCIAL PASSIVE HOUSE APPROACH

701.7 Passive House Approach. *Buildings* shall achieve Passive House certification in accordance with Section 701.6.1 or 701.6.2

701.7.1 Passive House Institute US (PHIUS) Certification. Achieve certification with the PHIUS CORE COMM Passive Building Standard and provide documentation in accordance with Section 701.7.1.1.

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

1. Prior to the issuance of a building permit, documentation of a PHIUS CORE COMM 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 CORE COMM Standard

701.7.2 Passive House Institute (PHI) Certification. Achieve certification with the PHI Passive House Standard provide documentation in accordance with Section 701.7.2.1.

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

801.2 Compliance. *Building projects* shall comply with Chapter 8 in accordance with Section 101.4

801.3 Provisions

EQ01: INDOOR AIR QUALITY

801.3.1 Indoor Air Quality. Buildings shall comply with the design requirements of ANSI/ASHRAE Standard 62.1, Sections 4 through 6, including applicable normative appendices, with the modifications and additions indicated within this code. 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 [EQ02] through 801.3.1.6 EQ06] supersede such requirements in the *Denver Mechanical Code*.

EQ02: MINIMUM VENTILATION RATES

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

EQ03: OUTDOOR AIR DELIVERY MONITORING

801.3.1.2 Outdoor Air Delivery Monitoring.

801.3.1.2.1 System Design for Outdoor Air Intake Measurement. Each mechanical ventilation system shall be configured to allow for the measurement of the *outdoor air* intake for use in testing and balancing, recommissioning, and *outdoor air* monitoring as required in Section 801.3.1.2.2.

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

a. The device shall employ methods described in ANSI/ASHRAE Standard 111.

b. The device shall have an accuracy of ±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.

EQ04: FILTRATION AND AIR CLEANER REQUIREMENTS

801.3.1.3 Filtration and Air Cleaner Requirements.

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

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

1. **Wetted Surfaces.** Particulate matter filters or air cleaners having a minimum efficiency reporting value (MERV) of not less than 8 when rated in accordance with ANSI/ASHRAE Standard 52.2 shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an *occupiable space*. These requirements supersede the requirements in ASHRAE Standard 62.1, Section 5.8.
2. **Particulate Matter Smaller than 10 Micrometers (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 *Agency*. 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 EQ04, 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.

EQ05: BUILDING PRESSURE – MECHANICAL EXHAUST

801.3.1.4 Building Pressure. The requirements in EQ05 supersede the requirements in ASHRAE Standard 62.1, Section 5.9.2. *Building projects* shall be designed in accordance with the following subsections.

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

Exception: Buildings requiring smoke control in accordance with Denver Fire Code Section.

801.3.1.5 Reserved.

EQ06: HUMIDITY CONTROL

801.3.1.6 Humidity Control. The requirements in this section supersede the requirements in ASHRAE Standard 62.1, Section 5.9.1. Mechanical air-conditioning and evaporative cooling systems shall be designed in accordance with EQ05, as applicable. When EQ06 is selected, projects must also comply with EQ05.

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 Reserved.

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

801.3.1.7 Reserved.

EQ07: BUILDING ENTRANCES

801.3.1.8 Building Entrances. 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.

EQ08: THERMAL ENVIRONMENTAL CONDITIONS FOR HUMAN OCCUPANCY

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

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

EQ09: ACOUSTICAL CONTROL

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

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

EQ10: SOIL-GAS CONTROL

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

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 Soil-Gas Control Systems.

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

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. 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 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. The gas-permeable layer and soil-gas conveyance pipe shall comply with Table 801.3.4.1.2 and (a), (b), or (c) as applicable.

a. **Stone Aggregate Layer.** The gas-permeable layer shall be a uniform layer not less than 4 in. (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.

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.

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
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) 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 cm^2/m) of pipe or matting length.

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

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

a. **Pipe Placement.** Nonperforated Schedule 40 pipe, as defined by ASTM D1785, shall extend from within the gas-permeable layers to the point of exhaust above the *roof*. The vent pipe size shall not be reduced at any point between its connection to the gas permeable layers and the exhaust terminal above the *roof*. Such piping shall be labeled on each floor level of the building with the words "radon vent" or "soil-gas vent" in the prevailing language at the location.
b. **Multiple Vented Areas.** Where interior footings divide a gas-permeable layer into two or more unconnected areas, such areas shall be interconnected by piping below the slab or membrane or above the slab or membrane. Such piping shall be nonperforated and of a size indicated in Table 801.3.4.1.3.
c. **Provision for Fan.** Soil-gas venting systems shall include a fan or a dedicated *space* for the future installation of a fan. The fan and soil-gas vent piping on the discharge side of the fan shall not be installed within or under occupied *spaces*. A dedicated *space* having a vertical height of not less than 48 in. (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.

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

TABLE 801.3.4.1.3
VENT PIPE DIAMETER PER VENTED AREA

VENT PIPE DIAMETER	MAXIMUM VENTED AREA PER VENT PIPE
3 in. (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 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*.

EQ11: LIGHTING QUALITY

801.3.5 Lighting Quality. The interior lighting and lighting controls shall be installed to meet the requirements of Sections 801.3.5.1 and 801.3.5.2. 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 Enclosed Office Spaces. Lighting for at least 90% of enclosed office *spaces* with less than 250 ft^2 (23.3 m^2) 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 Multi-occupant 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.

EQ12: MOISTURE CONTROL (ENVELOPE)

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

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

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

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

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

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

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

801.3.6.3 Reserved.

EQ13: GLARE CONTROL (MANUAL)

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

View fenestration shall have one or more operable glare control devices capable of reducing the *visible light transmittance* (VLT) of the *fenestration* assembly to 3% or less or blocking all direct sunlight. 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 opaque movable interior window blinds, curtains, and shades; movable exterior louvers, screens, and awnings, moveable exterior shades, and blinds; and *dynamic glazing*. Where fabric shades are used, the openness factor shall be tested according to current version of Standard EN14500.

Exceptions:

1. Where permanent interior or exterior obstructions, such as buildings, structures, overhangs, and fins, block a direct beam of sunlight from passing through the *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.
2. *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 10% of the regularly occupied floor area as determined per IES LM-83-12.

EQ14: GLARE CONTROL (AUTOMATIC)

801.3.8 Automatic Glare Control. Glare control provided to comply with EQ13 shall be *automatic* for spaces in Table 801.4.1.2A. Occupants shall have the capability to temporarily override *automatic* methods of glare control for periods not exceeding two hours.

EQ15: MATERIALS (EMISSIONS)

801.3.9 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 V1.2 (commonly referred to as California Section 01350), Section 4.3, GREENGUARD Environmental Institute GGPS.001 standard for building materials and finishes; or Green Seal® standards and shall be compared to 100% of the selected standard's its corresponding listed limit. In addition, the modeling for the building shall include, at a minimum, the criteria listed in Normative Appendix D of this code. Emissions of materials used for modeling VOC concentrations shall be obtained in accordance with the testing procedures of CDPH/EHLB/Standard Method V1.2, GREENGUARD Environmental Institute GGPS.001 standard for building materials and finishes or equivalent; or Green Seal® standards unless otherwise noted below.

a. Tile, strip, panel, and plank products, including vinyl composition tile, resilient floor tile, linoleum tile, wood floorstrips, 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.

EQ16: DAYLIGHTING

801.3.10 Daylighting. 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 Prescriptive Requirements.

801.4.1 Daylighting.

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

a. The *space* is in a building with three stories or fewer above grade.

b. The *space* area is greater than 2500 ft^2 (232 m^2).

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 Minimum Daylight Area. Not less than 50% of the floor area shall be in the *daylight area* as defined in Chapter 3. For the purposes of Section 801.4.1.1.1, the definition of *daylight area* shall be modified such that partitions and other obstructions that are less than the ceiling height are disregarded. *Daylight areas* shall be under *skylights*, under *roof monitors*, 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 Visible Transmittance (VT) of Skylights and Roof Monitors. The visible transmittance of *skylights* and *roof monitors* for *daylight areas* used to comply with Section 801.4.1.1.1 shall not be less than 0.15 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 Skylight Optical Diffusion Characteristics. *Skylights* used to comply with Section 801.4.1.1.1 shall have a glazing material or diffuser that has a measured haze value greater than 90% when tested according to ASTM D1003 or other test method approved by the *Agency*.

Exceptions:

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

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

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

Classroom/training room
Conference /meeting/multipurpose room/social meeting spaces/event centers*
Lounge/breakroom
Enclosed office and open plan office
Library reading area*
Patient rooms and physical therapy rooms within a healthcare facility*
Gym, fitness center, enclosed swimming pool*
Worship facility
Laboratory
Personal services (Salon, barber)
Exhibit spaces*

* All spaces with an asterisk are required to have automatic glare controls if elective is pursued.

TABLE 801.4.1.2B
MINIMUM SIDELIGHTING EFFECTIVE APERTURE

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

801.4.1.3 Shading for Offices. For office *spaces* 80 ft^2 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, sunshades, light shelves, and any other permanent device. Any *vertical fenestration* that employs a combination of interior and external shading is allowed to be separated into multiple segments for compliance purposes. Each segment shall comply with the requirements for either external or internal.

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 *Agency*, 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 CE07 - Section 701.4.2.5.
5. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Exception (3) of CE07 - Section 701.4.2.5.
6. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

801.4.2 Reserved.

801.4.3 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 Performance Requirements.

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

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

The *sDA* within each *space* shall be calculated in accordance with the methodology of IES LM 83. Calculations shall be made on the basis of 28 fc (300 lux) for all *spaces*, with the exception of the following *space* types, which shall be calculated on the basis of 14 fc (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 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 ft^2 (23 m^2).
2. *Vertical fenestration* with automatically controlled shading devices in compliance with Section 701.4.2.5, Exception (2).
3. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Section 701.4.2.5, Exception (3).

801.5.2 Reserved.

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

a. Lighting system and controls shall be capable of illuminating *permanently installed* white boards to at least an average of 28 fc (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 Scope. This section specifies requirements related to the environmental and human health impacts of materials, including resource conservation, reduced life-cycle impacts of building materials, impacts on the atmosphere, product transparency, and waste management.

901.2 Compliance. *Building projects* shall comply with Chapter 9 in accordance with Section 101.4.

901.3 Provisions.

MR01: CONSTRUCTION WASTE MANAGEMENT

901.3.1 Construction Waste Management .

901.3.1.1 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 reused, recycled, repurposed, and/or composted instead of disposed in landfills or incinerators. 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. All employees at the site must be trained on proper disposal of materials.

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 Reserved.

901.3.1.3 Construction and Demolition Waste Management Plan. Prior to issuance of a demolition, roofing, or building permit including renovations and additions over 2,500 ft^2 and demolitions over 1,000 ft^2, a preconstruction waste management plan shall be submitted to the *owner* and to the Agency, and conspicuously posted on the construction site in both English and Spanish. Substantive changes to the plan, including changes to hauler, receiving facility, weight or volume increases of 15% or more, must be approved by the building official. 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*, and

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.

901.3.1.4 Construction and Demolition 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.

MR02: EMBODIED CARBON DIOXIDE: CONCRETE

901.3.2.1 Embodied CO2e of concrete materials. Projects shall comply with either Section 901.3.2.1.1 or 901.3.2.1.2.

Exception: Projects using precast concrete and concrete masonry units are not required to comply with this section.

901.3.2.1.1 CO2e Mixture Limit. The total CO2e of the concrete mixes used in the project shall not exceed the value given in Table 901.3.2.1 based on the compressive strength of the product. CO2e content shall be documented by a product specific Type III Environmental Product Declaration (EPD) for each product. 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 and be available in a publicly accessible database.

Exceptions:

1. Projects where no concrete suppliers with product-specific EPDs for concrete are located within 100 miles of the project site, shall use Type III industry-wide EPDs in accordance with Section 901.4.1.4 for compliance with this section and provide an inventory of CO2e values for all concrete mixes to the *Agency*.
2. Projects where the total use of new concrete is less than 50 cubic yards.

TABLE 901.3.2.1
CO2e LIMITS FOR CONCRETE

MINIMUM SPECIFIED COMPRESSIVE STRENGTH f', psi	MAXIMUM kg/m (SI^3)	HIGH-EARLY STRENGTH MAXIMUM kg/m3 (SI)	LIGHTWEIGHT CONCRETE MAXIMUM kg/m3 (SI)
up to 2499	222	305	578
2500-3499	336	439	578
3500-4499	376	490	626
4500-5499	409	533	675
5500-6499	433	566	N/A
6500 and greater	485	631	N/A

Informative Note: Values in this table represent limits for concrete produced in the United States and are based on the 50th percentile of EPDs collected by Building Transparency as of April 2021. They may or may not pertain to concrete production in other countries, and therefore CO2e, is always based on the unique availability in any location at any particular time of aggregate, cement, supplements, admixtures and other factors

901.3.2.1.2 CO2e Project Total Limit. Project Total CO2e ($CO2e_{proj}$) of all concrete placed at the building project shall not exceed the project limit ($CO2e_{allowed}$) determined using Table 901.3.2.1 and Equation 901.3.2.2

Equation 901.3.2.1.2:

$CO2e_{proj} < CO2E_{allowed}$

where

$CO2E_{proj} = \text{å}CO2E_n\ v_n$ and $CO2E_{allowed} = \text{å}CO2E_{lim}\ v_n$

and

n = the total number of concrete mixtures for the project

$CO2E_n$ = the global warming potential for mixture n per mixture EPD, kg/m^3

$CO2E_{lim}$ = the global warming potential limit for mixture n per Table 901.3.2.1, kg/m^3

v_n = the volume of mixture n concrete to be placed

MR03: EMBODIED CARBON DIOXIDE: STEEL

901.3.2.2 Embodied CO2e for steel products. Structural steel, hollow steel section, steel plate, and concrete reinforcing steel bar products used in the building project shall comply with Sections 901.3.2.2.1 and 901.3.2.2.2.

901.3.2.2.1 EPD Disclosure. Product-specific Type III Environmental Product Declarations (EPDs) shall be submitted for a minimum of 75% of steel products, based on cost or weight. Type III EPDs used for compliance with this section shall be certified as complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930 and be available in a publicly accessible database.

901.3.2.2.2 Steel Performance. A minimum of 75% of steel products listed in this section, based on cost or weight, shall be produced in a facility or facilities that comply with one or more of the following:

1. A minimum of 80% of steel products listed in this section, based on cost, shall not exceed the total CO2e values in Table 901.3.2.2 based on product type.
2. On the date of procurement is independently, or as part of an aggregation of facilities, a Green Power Partner in the US EPA Green Power Partnership program, or an equivalent renewable power procurement registry for production outside of the United States.
3. Not less than 50% of the energy sourced for production at the facility is a renewable energy resource as documented from one or more of the following:
   a. On-site renewable energy system
   b. Off-site renewable energy system owned by the production facility owner
   c. Community renewable energy facility Physical Renewable Energy PPA
   d. Financial Renewable Energy PPA

TABLE 901.3.2.2
CO2e LIMIT PER STEEL PRODUCT

	STEEL PRODUCT	MILL kg CO2e/kg (a)	FABRICATION kg CO2e/kg (b)
Structural Steel	Structural Sections	1.49	1.83
	Hollow Structural Sections	2.57	2.99
	Plate	2.21	2.60
Concrete Reinforcing Steel Bars		0.89	1.01

a. Use this column to determine compliance when an EPD declares mill-only material (cradle to mill gate).

b. Use this column to determine compliance when an EPD declares mill material plus U.S. industry average fabrication impacts (cradle to fabricator gate).

MR04: REFRIGERANTS

901.3.3 Refrigerants. Chlorofluorocarbon (CFC) and hydrochlorofluorocarbons (HCFC) based refrigerants in HVAC&R systems are prohibited. 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.

MR05: STORAGE AREAS AND COLLECTION OF RECYCLABLES

901.3.4 Areas for Storage and Collection of Recyclables and Discarded Goods.

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

901.3.4.2 Compost. Areas must be provided that serve the entire building and are dedicated to the collection and storage of compostable materials. Educational signage indicating which materials may be placed in compost receptacles including acceptable bag or containment materials shall be permanently posted. These materials include food scraps, non-recyclable paper, yard and landscaping debris, and wooden implements such as chopsticks and stir sticks. The minimum compost collection area shall be not less than 25% of that required for trash/refuse collection, be located in close proximity to other trash/refuse and recycling areas and be of comparable access and convenience as other waste streams.

901.3.4.2.1 Location of compost receptacles shall include at minimum equivalent central and localized collection areas. Equivalent central collection may be located in a basement. Additional localized collection area shall include a tripart or third chute instead of bipart if dual trash and recycling chutes are provided. If no chute(s) are provided, trash pickup shall be frequent enough to ensure food waste does not cause odor, spills, or unsafe conditions.

Recycle Chute. New buildings provided with trash chutes or existing buildings renovated that add a new trash chute shall provide an automated sorting combination trash and recycling chute or an additional equivalent chute adjacent to the trash chute for the purpose of recycling. Separate bins shall be provided in the termination room to prevent recycled items from entering the trash bin. Chutes must be appropriately labeled “Landfill/Trash/Garbage” and Recycle”.

901.3.4.3 Reserved.

901.3.4.4 Reserved.

MR06: MERCURY CONTENT LEVELS OF LAMPS

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

Exceptions:

1. Eight-foot models of straight fluorescent T8 lamps.
2. High-output and very-high-output, straight fluorescent lamps greater than 1.25 in. (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.

TABLE 901.3.5
MAXIMUM MERCURY CONTENT FOR ELECTRIC LAMPS

LAMP	MAXIMUM MERCURY CONTENT
Screw-base compact fluorescent lamps < 25 W	4 mg
Screw-base compact fluorescent lamps ³□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.

MR07: BUILDING MATERIALS (ENVIRONMENTAL IMPACTS)

901.3.6 Building Materials . 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 Prescriptive Requirements.

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

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

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

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

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

901.4.1.2 Regional Materials. A minimum of 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 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 Wood Building Components. Wood building components, including but not limited to structural framing, sheathing, flooring, subflooring, wood window sash and frames, doors, and architectural millwork, used to comply with this requirement shall contain not less than 60% certified wood content tracked through a chain of custody process, either by physical separation or percentage-based approaches, or wood that qualifies as a *salvaged material*. Certified wood content documentation shall be provided by sources certified through a forest certification system with principles, criteria and standards developed using ISO/IEC Guide

59 or the WTO Technical Barriers to Trade. Wood building components from a *vendor* shall be permitted to comply when the annual average amount of certified wood products purchased by the *vendor*, for which they have chain of custody *verification* not older than two years, is 60% or greater of their total annual wood products purchased.

901.4.1.4 Multiple-Attribute Product Declaration or Certification. A minimum of ten different products installed in the *building project* at the time of issuance of certificate of occupancy shall comply with one of the following subsections. Declarations, reports, and assessments shall be submitted to the *authority having jurisdiction* (*Agency*) 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 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.

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

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

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

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

901.5 Performance Requirements.

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

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

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

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

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

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

a. Each building alternative shall comply with Chapters 6 and 8 of this code and either Chapter 4 or 7.

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.

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

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

MR08: DESIGN FOR DECONSTRUCTION

901.6 Design for Deconstruction. Project shall be designed for adaptability and disassembly at end of life. Documentation illustrating compliance with three of the following code sections shall be provided to the Agency:

a. Section 901.6.1 Building Records

b. Section 901.6.2 Building Materials Disclosure

c. Section 901.6.3 Design for Durability, Adaptability, and Disassembly

901.6.1 Building Records: A complete copy of the building records, including as-built plans, specifications, coordinating calculations, and supporting reports shall be provided to the building project owner upon completion.

901.6.2 Building Materials Disclosure: Documentation of building materials shall be provided in a table of procured materials and components used for all structural elements, building enclosure, and interior finishes including manufacturer, name, and model of each major material installed onsite.

901.6.3 Design for Durability, Adaptability, and Disassembly: The *building project* shall use any combination of the following methodologies to provide one design element per 5,000 ft^2 of the *building project's* gross floor area, or a minimum of 10, whichever is greater.

a. modular components,

b. prefabricated elements,

c. multi-functional assemblies that limit raw materials,

d. standardized fastening systems,

e. mechanical connections in lieu of chemical adhesives,

f. demountable partitions,

g. Cradle to Cradle® Certified materials or equivalent,

h. materials made from a single raw material as to avoid composite materials with adhesive or chemical bonding

MR09: USE OF SALVAGED MATERIALS

901.6.4 Use of *Salvaged Materials*: A minimum of 5% of building materials or products installed or reused, based on cost, shall be *salvaged materials*.

MR10: DESIGN FOR DECONSTRUCTION – DWELLING UNITS AND ACCESSORY STRUCTURES

901.7 Dwelling Units and Accessory Structures for Deconstruction. Detached Single Family Dwellings, carriage houses, gazebos, pergolas, and other similar appurtenant structures built in 1970 or earlier shall be dissembled by a contractor familiar with deconstruction best practices, instead of being mechanically demolished. All structure, enclosure, appliances, and finish materials from the foundation up are included. Salvaged materials shall be sold, donated, or reused onsite. Materials not eligible for salvage shall be recycled with a certified recycling facility or another approved facility. Contractors are required to post signs on the property stating "This property is being deconstructed in accordance with the provisions of the Denver Green Code".

Exception: Unsafe structures, or materials are unsuitable for salvage due to fire damage, asbestos contamination, lead-based paint, rot, or mold. In such cases, a written explanation shall be provided to the Agency for review. Projects containing materials not complying in any way with the provision of this section shall provide written explanation to the Agency for review. Materials shall not be discarded without approval.

CHAPTER 10

CONSTRUCTION AND PLANS FOR OPERATION

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

1001.2 Compliance. *Building projects* shall comply with Chapter 10 in accordance with Section 101.4.

1001.3 Provisions.

1001.3.1 Construction.

CX01: FUNCTIONAL AND PERFORMANCE TESTING AND COMMISSIONING

1001.3.1.1 Functional and performance testing and commissioning . *Building projects* shall comply with the functional performance testing (FPT) requirements of Sections 1001.3.1.1.1.1 through 1001.3.1.1.1.3 An *FPT* process and system performance requirements shall be incorporated into *construction documents* and construction schedule of the *building project* to verify system performance.

1001.3.1.1.1 FPT Requirements. *FPT* 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. Interior 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 250 gal (946 L) per day..

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

a. Designate *FPT providers*. For systems that are required to comply with Section 1001.3.1.1.1, *FPT providers* shall be *owner's* qualified employees, independent commissioning (*Cx*) *providers*, or qualified designers experienced with *FPT* on the designated systems. *FPT providers* shall be independent of the building system design and construction function.

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

1001.3.1.1.1.2 Activities Prior to Building Occupancy for Facilities Using FPT. Before issuance of a certificate of occupancy (or Temporary 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*, but not more than nine (9) months later.

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, and transferred to any subsequent owner(s) upon sale or lease of the building.

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

CX02: ACOUSTICAL CONTROL

1001.3.1.1.2 Acoustical Control

1001.3.1.1.2.1Acoustical Field Measurement. Where required by Chapter 8 EQ09, the *FPT* specified in Sections 1001.3.1.1.2.1.1 through 1001.3.1.1.2.1.2 shall be completed.

1001.3.1.1.2.1.1 Reserved.

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

1001.3.1.1.2.1.3 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 *Agency*, noise that is not created on the source property need not be included in the reported test results.

CX03: BUILDING PROJECT COMMISSIONING PROCESS

1001.3.1.2 Building Project Commissioning (Cx) Process. The *Cx process* shall be performed in accordance with this section using the ICC G4 Guideline for Commissioning or other *generally accepted engineering standards* acceptable to the *Agency*. The *Cx provider* shall verify that a *Cx process* has been incorporated into the design phases of the project and that commissioning shall be called out on the *construction documents.* The *Cx process* documents that the building and its commissioned components, assemblies, and systems comply with the *owner's project requirements* (*OPR*). The project requirements, including *OPR*, *BoD*, design and construction record documentation, training plans and records, O&M plans, and procedures, and Cx reports shall be assembled in a systems manual that provides information for building operating and maintenance staff.

1001.3.1.2.1 Systems to be Commissioned. For buildings that exceed 10,000 ft^2 (1000 m^2) 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 CE23 and CE24.

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 250 gal (946 L) per day.

g. Renewable energy systems and energy storage systems.

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

1001.3.1.2.2Cx 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 the ICC G4 Commissioning Guideline shall be submitted for review with the building permit application.

b. An *approved Cx provider* shall be designated by the *owner* to manage *Cx process* activities prior to completion of *construction documents*. The *Cx provider* shall have the necessary training, experience, and equipment and be independent from the design team and the contractor responsible for the work being commissioned. The *Cx provider* shall disclose possible conflicts of interest so that objectivity can be confirmed. The Cx team shall include an *FPT provider* who may also be the *Cx provider*.

c. Construction phase Cx requirements shall be incorporated into project specifications and other *construction documents* developed by the design team.

1001.3.1.2.3 Cx Activities Prior to Building Occupancy. The following activities shall be completed prior to issuance of a Certificate of Occupancy (or Temporary 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*, but not more than nine (9) months later.

b. The *owner* shall be provided with a preliminary Cx report per compliance with Section 1001.3.1.3.

c. The *Cx provider* shall verify that the *owner* has been provided with a systems manual that includes the information needed to understand and operate the commissioned systems as designed, including warranty information for the commissioned systems. The systems manual with design and operational information shall be available for building operator and maintenance training.

1001.3.1.2.4 Postoccupancy Cx Activities. The *Cx plan* shall contain postoccupancy Cx requirements in accordance with the ICC G4 Commissioning Guideline. The *Cx provider* shall provide the *owner* with a complete systems manual, all record documents, and a complete final Cx report in accordance with the ICC G4 Commissioning Guideline.

1001.3.1.3 Project Cx Documents .

1001.3.1.3.1 Cx Plan. A *Cx plan* shall be developed by a *Cx provider* in accordance with the ICC G4 Commissioning Guideline for all systems to be commissioned and/or tested.

1001.3.1.3.2 Design Review Report. The *Cx provider* shall provide to the *owner* and design teams a Cx design review report in accordance with the ICC G4 Commissioning Guideline that details compliance with the *OPR*. This Cx design review shall not be considered a design peer review or a code or regulatory review.

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

a. Performance of commissioned equipment, systems, and assemblies;

b. Issue and resolution logs, including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation;

c. Deferred tests that cannot be performed at the time of report preparation;

d. Documentation of the training of operating personnel and building occupants on commissioned systems and a plan for the completion of any deferred trainings that were unable to be fully commissioned at the time of report preparation; and

e. A plan for the completion of commissioning, including climatic and other conditions required for performance of the deferred tests.

1001.3.1.3.4 Final Cx Report. The *Cx provider* shall provide to the *owner*, and Agency prior the issuance of a Certificate of Occupancy or Temporary Certificate of Occupancy, a final Cx report that complies with the ICC G4 Commissioning Guideline..

1001.3.1.3.5 Reserved.

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

CX04: EROSION AND SEDIMENTATION CONTROL

1001.3.1.4 Erosion and Sedimentation Control (ESC). The project team must develop 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.

CX05: IAQ CONSTRUCTION MANAGEMENT

1001.3.1.5 IAQ Construction Management. Develop and implement an IAQ construction management plan to include the following:

a. Air conveyance materials shall be stored and covered so that they remain clean. All filters and controls shall be in place and operational when HVAC systems are operated during building flush-out or baseline IAQ monitoring. Except for system startup, testing, balancing, and commissioning, permanent HVAC systems shall not be used during construction.

b. After construction ends, prior to occupancy and with all interior finishes installed, a postconstruction, preoccupancy building flush-out as described under Section 1001.3.1.5(b)(1), or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 1001.3.1.5(b)(2), shall be performed:

1. **Postconstruction, preoccupancy flush-out.** A total air volume of *outdoor air* in total air changes as defined by Equation 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 EQ04 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 EQ02.

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 ft^2 (1.5 L/s per m^2) of *outdoor air*, or the outdoor airflow rate determined in Section 801.3.1.1, whichever is greater. These conditions shall

be maintained until the total air changes calculated according to Equation 10-1 have been delivered to the *space*. The flush-out shall be continuous.

(Equation 10-1)

where:

TAC = total air changes.

V_{ot} = system design *outdoor air* intake flow, cfm (L/s) (according to ANSI/ASHRAE Standard 62.1).

A = floor area, ft^2 (m^2).

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 are not exceeded in the return airstreams of the HVAC systems that serve the *space* intended for occupancy. If the return airstream of the HVAC system serving the *space* intended for occupancy cannot be separated from other *spaces*, then for each portion of the building served by a separate ventilation system, the testing shall demonstrate that the *contaminant* maximum concentrations at *breathing zone* listed in Table 1001.3.1.5 are not exceeded in the larger of the following number of locations: (i) no fewer than one location per 25,000 ft^2 (2500 m^2) or (ii) in each contiguous floor area. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with *outdoor air*, and retest the specific parameters exceeded to demonstrate that the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from the same locations as in the first test.

TABLE 1001.3.1.5
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	0.070 ppm (8-h)
Particulates (PM2.5)	35 (24 h)
Particulates (PM10)	150 (24 h)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	3
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 V1.2 and shall be in conjunction with the individual VOCs listed.

CX06: MOISTURE CONTROL (DURING CONSTRUCTION)

1001.3.1.6 Moisture Control. The following items to control moisture shall be implemented during construction:

a. Materials stored on-site, or materials installed that are absorptive, shall be protected from moisture damage.

b. Building construction materials that show visual evidence of biological growth due to the presence of moisture shall not be installed on the *building project*.

CX07: CONSTRUCTION ACTIVITY POLLUTION PREVENTION (VEHICLE IDLING)

1001.3.1.7 Construction Activity Pollution Prevention: Idling of Construction Vehicles. 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. Signs shall be posted at vehicle entrances to the *building project* providing notice of this requirement.

CX08: CONSTRUCTION ACTIVITY POLLUTION PREVENTION (PROTECTION OF OCCUPIED AREAS)

1001.3.1.8 Construction Activity Pollution Prevention: Protection of Occupied Areas. The *construction documents* shall identify operable windows, doors, and air intake openings that serve occupied *spaces*, including those not associated with the *building project*, that are in the area of construction activity or within 35 ft (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.

CX09: SOIL-GAS CONTROL (TESTING)

1001.3.1.9 Soil-Gas Control. 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/m^3). Where radon testing indicates that the indoor radon concentration is 2.7 pCi/L (100 Bq/m^3) 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/m^3).

CX10: CONSTRUCTION WASTE MANAGEMENT PLAN

1001.3.1.10 Construction and Demolition Waste Management.

1001.3.1.10.1 Collection. Specific areas on the construction *site* shall be designated for collection of recyclable and reusable materials. Alternatively, off-site storage and sorting of materials shall be permitted. Diversion efforts shall be tracked throughout the construction process.

1001.3.1.10.1.2 Materials. All concrete, asphalt, masonry, wood, metals and carboard shall be recycled. For all demolitions, these materials that are free of asbestos and lead paint shall be salvaged or recycled, and where possible, all remaining materials, such as doors, windows, cabinets, fixtures, and wood shall be salvaged or recycled.

1001.3.1.10.2 Documentation. Prior to issuance of the final certificate of occupancy, a final construction waste management report documenting compliance with MR01 shall be submitted to the *owner* and *Agency*.

CX11: PLANS FOR OPERATION

1001.3.2 Plans for Operation. This section specifies the items to be included in plans for operation of a *building project* that falls under the requirements of this code.

1001.3.2.1 High-Performance Building Operation Plan. A master building plan for operation shall be developed that meets the requirements specified in Sections 1001.3.2.1.1 through 1001.3.2.2.

1001.3.2.1.1 Reserved.

1001.3.2.1.2 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 Initial M&V. Use the water measurement devices and collection/storage infrastructure specified in WE06 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 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 WE06.

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.

1001.3.2.1.2.3 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 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 Initial M&V. Use the energy measurement devices and collection/storage infrastructure specified in CE03 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 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 CE03. 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 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 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 EQ04, 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 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 EQ03 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 Reserved.

1001.3.2.4 Reserved.

CX12: TRANSPORTATION MANAGEMENT PLAN

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

Exception: *Residential building projects*.

1001.3.3.1 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 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 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.

CX13: IAQ MAINTENANCE AND MONITORING

1001.4 IAQ Maintenance and Monitoring. The plan for operation shall document procedures for maintaining and monitoring IAQ after building occupancy and shall contain the following:

a. For buildings located in nonattainment areas for PM2.5, as defined by USEPA, all outdoor air provided to occupied spaces shall pass through filters or air cleaners as specified in EQ04.
Exception: *Spaces* without mechanical ventilation.

b. For buildings located in "non-attainment" areas for ozone, as defined by the USEPA, all outdoor air provided to occupied spaces shall pass through filters or air cleaners as specified in EQ04.
Exception: *Spaces* without mechanical ventilation.

c. Biennial monitoring of IAQ by one of the following methods:
    1. Performing IAQ testing as described in CX06.
    2. Monitoring occupant perceptions of IAQ by any method, including but not limited to occupant questionnaires.
    3. Each building shall have an occupant complaint/ response program for IEQ.

d. For buildings where radon mitigation is required, operation, maintenance, and monitoring procedures shall include all of the following:
    1. Annual inspection by maintenance staff to verify operation of fans and other mechanical components.
    2. Biennial radon testing in accordance with AARST MALB to verify that radon concentrations remain 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, mitigation shall be conducted in accordance with AARST RMS-LB, and the building shall be retested to verify that the radon concentration is below 2.7 pCi/L (100 Bq/m3). Where the required effectiveness of mitigation systems is consistently demonstrated for a period of not less than eight years, and such systems are inspected quarterly to verify fan operation, radon testing shall be repeated at intervals of not less than every five years.
    3. Biennial inspection and repair as needed for mitigation system performance indicators, fans, and visible mitigation system components, including piping, fasteners, supports, labels, and soil-gas barrier closures at exposed membranes, sumps, and other openings between soil and interior *space*.
    4. Documentation and retention of inspection and repair records and testing reports.

CX14: OUTDOOR AIR OZONE AIR CLEANERS

1001.5 (10.5) Outdoor Air Ozone Air Cleaners. Ozone air cleaning devices required under EQ04 shall be operated whenever outdoor ozone concentrations are forecast to exceed applicable regulatory limits.

CX15: INDOOR ENVIRONMENTAL QUALITY ASSURANCE AND AWARENESS

1001.6. Indoor Environmental Quality Assurance and Awareness. The plan for operation shall include an indoor environmental quality occupant survey and information about air quality measurements shall be made available to occupants through in accordance with 1001.6.1 and 1001.6.2:

1001.6.1) Indoor Environmental Quality Survey. An indoor environmental quality occupant survey shall be implemented complying with all of the following:

a. The survey shall be implemented within a period of 6 to 18 months after of 80% of intended building occupancy. The survey shall be repeated not less often than once every three years. The survey questions shall include satisfaction questions and diagnostic questions for IAQ, lighting, acoustics, and thermal comfort.
b. The survey questions shall use a seven-point satisfaction scale and comply with ANSI/ASHRAE Standard 55, Section 7.3.1.1.
c. A report of the survey results shall be produced that includes the following:
    1. The survey report shall state where the response rate was less than the response rates specified in ASHRAE Standard 55, Section 7.3.1.
    2. The survey report shall indicate the percentage of satisfaction for each question in accordance with ASHRAE Standard 55, Section 7.4.1(a).
    3. The percentage satisfaction results shall be compared to a nationally recognized survey benchmarking database where the building occupancy category is represented in the databases of nationally recognized organizations.
    4. If survey results fall beneath ASHRAE Standard 55, Section 7.4.1(a), planned remediation activities shall be developed and implemented no more than 6 months after reporting results.

1001.6.2 Promote Indoor Environmental Quality Awareness. Information about the air quality measured in CX16 shall be made available to occupants as follows:

a. Data are presented through one of the following:
    1. Display screen prominently positioned at a height of 3.5 to 5.5 feet in a publicly shared space on each story or within each tenant space.
    2. Hosted on a website or phone application accessible to occupants.
b. Data presented include one of the following:
    1. Results of indoor environmental quality survey. These shall include planned remediation activities as applicable.
    2. Concentrations of the parameters measured CX16 .
    3. Qualitative results of air quality (e.g., colored-coded levels).

CX16: BENCHMARKING OPERATIONAL WATER AND WASTE

1001.7 Benchmarking Operational Water and Waste. This section specifies items to be included in plans for operation of a *building project*, to be developed and delivered prior to occupancy. The plan shall meet the requirements specified in Sections 1001.7.1 through 1001.7.2 and be provided to the *owner* prior to building occupancy, transferred to any subsequent *owner*(s) upon sale or lease of the building, and a copy provided to the *Agency.*

1001.7.1 Water Use Efficiency. The plan for operation shall specify water use *verification* activities for *building projects* to track and assess building and site (full property) *potable* and *nonpotable water* consumption. The plan shall describe the procedures needed to comply with the requirements outlined below.

1001.7.1.1 Initial Measurement &Verification (M&V). Use the water measurement devices and collection/storage infrastructure specified in WE06 to collect and store water use data for each device, starting no later than after building *FPT* has been completed and certificate of occupancy (or Temporary Certificate of Occupancy) has been issued.

1001.7.1.2 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 (or Temporary 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 WE06.

b. **Benchmark water performance.** Develop a plan to enter building operating characteristics and water use data into a program or tool such as the ENERGY STAR® Portfolio Manager. For building parameter inputs into the program (***Informative Note:*** e.g., number of occupants, hours of operation, etc.), use actual average values.

c. **Assess water use performance.** Develop a plan, a copy of which shall be maintained on-site and made available to the *Agency* upon request, to assess *building project* water use efficiency.

1001.7.1.3 Documentation of Water Use.

All documents associated with the M&V of the building project's water use shall be retained by the *owner* for a minimum of three years.

1001.7.1.4 Occupant Education and Engagement.

a. The plan shall identify how (in what form and through what means), and frequency by which, water use data and efficiency evaluations will be shared with project occupants. Frequency shall not be less than twice per year.
b. The plan shall identify strategies to be implemented by the project ownership team to engage project occupants and: increase awareness of regional water considerations; consider options and opportunities collectively together to lower total project water consumption; and pursue individual actions resulting in lowered aggregate water demands.

1001.7.2 Waste Diversion. The plan for operation shall specify waste diversion *verification* activities for *building projects* to track and assess building operational waste diversion. The plan shall describe the procedures needed to comply with the requirements outlined below.

1001.7.2.1 Waste Management Policy. Develop a policy that identifies types of waste that will be produced on site, processes to segregate wastes into separate waste streams and defines appropriate treatment, storage, or disposal facilities. Policy shall define procedures to document waste (tracked by weight or volume) with a goal to divert 50% or greater overall diversion from landfill, incineration (waste-to-energy or WTE) and the environment for solid, non-hazardous wastes. Diversion strategies shall include but are not limited to

a. **Reduction**. Discover upstream waste opportunities in daily operations.
b. **Reuse**. Reuse or repurpose items to avoid disposal.
c. **Composting**. *Organic* matter may be collected to be decomposed by micro-organisms into a soil amendment.
d. **Recycling**. Collect materials that can be converted into manufacturing feedstock material and used in creation of new products (excludes use as fuel substitute or for energy production)
e. **Anaerobic Digestion**. Organic matter may be collected to be broken down by microorganisms into a soil amendment in the absence of oxygen (byproducts must be recovered for productive use in nature)

1001.7.2.2 Initial M&V. Use the waste weight measurements defined in ENERGY STAR® Portfolio Manager, or similar equivalent program or tool based on collection/storage infrastructure capacities specified in MR05 to collect and store waste use data for each storage receptacle starting no later than six months after building *FPT* has been completed and Temporary Certificate of Occupancy has been issued. If waste weight measurements cannot be estimated per the program or tool due to mixed contents, a waste audit shall be conducted to calculate average waste weights by material type.

1001.7.2.3 Track and Assess Waste Diversion. The plan shall specify the procedures for tracking and assessing the *building project* waste diversion by weight 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 (or Temporary Certificate of Occupancy) has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Waste Diversion reports.** Develop a plan for collecting *building project* waste diversion based on weight measurements

b. **Benchmark waste diversion performance.** Develop a plan to enter building operating characteristics and waste diversion data into the ENERGY STAR® Portfolio Manager, or similar equivalent program or tool. For building parameter inputs into the program or tool (***Informative Note:*** e.g., number of occupants, hours of operation, etc.), use actual average values.

c. **Assess waste diversion performance.** Develop a plan, a copy of which shall be maintained on-site and made available to the *Agency* upon request, to assess *building project* rate of waste diversion.

1001.7.2.4 Documentation of Waste Diversion.

All documents associated with the M&V of the building's waste diversion shall be retained by the *owner* for a minimum of three years.

1001.7.2.5 Occupant Education and Engagement.

a. The plan shall identify how (in what form and through what means), and frequency by which, waste diversion data and evaluations of opportunities for improvement will be shared with project occupants. Frequency shall not be less than twice per year.
b. The plan shall identify strategies to be implemented by the project ownership team to engage project occupants and: increase awareness of waste reduction impacts and opportunities; consider specific options and opportunities collectively together to increase diversion rates from the project; and pursue individual actions resulting in lowered aggregate waste production.

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-2018

Radon Mitigation Standards for Schools and Large Buildings
1001.3.1.9

ANSI/AARST MALB-2014

Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings
1001.3.1.9

ACCA

Air Conditioning Contractors of America Association, Inc.
1330 Braddock Place, Suite 350
Alexandria, VA 22314
(703) 575-4477

Manual D

Residential Duct Systems (Third Edition Version 2.5 – 2016)

402.1.2.2.1

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 210/240-2017 (with Addenda 1 and 2)

Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
Appendix B

ANSI/AHRI 310/380-2017

Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-14)

Appendix B

AHRI 340/360-2019 (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

AHRI Standard 550/590 (2020)

Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

701.4.3.1.1

AHRI Standard 551/591 (2020)

Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

701.4.3.1.1

ANSI/AHRI 1230-2014 (with Addendum 1)

Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
Appendix B

AMERICAN BIRD CONSERVANCY

4249 Loudoun Ave.
The Plains, VA 20198-2237

American Bird Conservancy Bird Collision Deterrence Material Threat Factor Table (May 2022)
www.abcbirds.org/glass-collisions/nyc-threat-factor

501.3.10.1

ANSI

American National Standards Institute
25 West 43rd Street
New York, NY 20036

ANSI Z21.10.3-2017

Gas Water Heaters, Volume 3, Storage Water Heaters with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous
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ANSI Z21.47-2016

Gas-Fired Central Furnaces
Appendix B

ANSI Z83.8-2016

Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
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ANSI A138.1 (2012)

Green Squared American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, And Tile Installation Material

901.4.1.4.3

ANSI/RESNET/ICC 301-2019

Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index

401.4

ANSI/RESNET/ICC 380-2019

Standard for Testing Airtightness of Building, Dwelling Unit, and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems; and Airflow of Mechanical Ventilation Systems

401.5

ANSI/CTA-2045-A (2018)

Modular Communications Interface for Energy Management

401.11

ANSI/CTA-2045-B (2018)

Modular Communications Interface for Energy Management

401.11

ANSI/ASABE S640 (2017)

Plant Grow Lighting

701.4.6.1.3

ASA

Acoustical Society of America
1305 Walt Whitman Road
Suite 300
Melville, NY 11747-4300

ANSI/ASA S1.13-2005

Measurement of Sound Pressure Levels in Air

1001.3.1.1.2

ANSI/ASA S1.4-2014

Sound Level Meters

1001.3.1.1.2

ANSI/ASA S12.60-2009

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

801.3.3

ANSI/ASA S12.60-2010

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

801.3.3

ANSI/ASA 12.72-2015

Measuring the Ambient Noise Level in a Room

1001.3.1.1.2

ASABE

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

ASABE/ICC 802-2020

Landscape Irrigation Sprinkler and Emitter Standard
601.3.1.2.1

ASHE

American Society for Healthcare Engineering of the American Hospital Association
155 N. Wacker Drive, Suite 400
Chicago, IL 60606

2018 FGI Guidelines: Hospitals and Outpatient Facilities

Guidelines for Design and Construction of Hospitals and Outpatient Facilities
801.3.3

2018 FGI Guidelines: Residential Health, Care and Support Facilities

Guidelines for Design and Construction of Residential Health, Care, and Support Facilities
801.3.3

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

ANSI/ASHRAE Standard 55-2017 (with Addenda a and b)

Thermal Environmental Conditions for Human Occupancy
801.3.2

ANSI/ASHRAE Standard 62.1-2019

Ventilation for Acceptable Indoor Air Quality
301.2, 701.4.3.2, 701.4.3.8, 801.3, 1001.3.1.5, 1001.3.2.1.4

ANSI/ASHRAE Standard 62.2-2019

Ventilation and Acceptable Indoor Air Quality in Residential Buildings
801.3.1, 801.3.1.1

ANSI/ASHRAE/IES Standard 90.1-2019

Energy Standard for Buildings Except Low-Rise Residential Buildings
301.1, 301.2, 501.3.6, 701.3.1, 701.4.1, 701.4.2, 701.4.3, 701.4.4, 701.4.6 , 701.4.7, 701.4.8, Appendix A, Appendix B, Appendix C

ANSI/ASHRAE Standard 111-2008 (RA 2017)

Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
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Method of Testing and Rating Pool Heaters
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ANSI/ASHRAE Standard 154-2016

Ventilation for Commercial Cooking Operations
701.4.3.8.1

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Criteria for Moisture-Control Design Analysis in Buildings
801.3.6

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Appendix A

ANSI/ASHRAE/ASHE Standard 170-2017

Ventilation of Health Care Facilities
801.3.1

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Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
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Commissioning Process for Buildings and Systems
1001.3.1.2, 1001.3.1.3

ASHRAE Guideline 0-2013

The Commissioning Process
1001.3.1.1

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HVAC&R Technical Requirements for the Commissioning Process
1001.3.1.1

ASHRAE Guideline 4-2008 (RA 2013)

Preparation of Operating and Maintenance Documentation for Building Systems
1001.3.1.1

ASHRAE Handbook, 2021

Fundamentals
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ASHRAE Handbook, 2020

HVAC Applications
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ASHRAE Standard 62.1-2019 (Appendix C)

Ventilation for Acceptable Indoor Air Quality
Table 1001.3.1.4

ANSI/ASHRAE/ACCA Standard 180, 2018
Standard Practice for Inspection and Maintenance of. Commercial Building HVAC Systems
1001.3.2.2

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

ASME A112.18.1-2020/CSA B125.1-20

Plumbing Supply Fittings
601.3.2.1

ASME A112.19.2-2020/CSA B45.1-20

Ceramic Plumbing Fixtures

601.3.2.1

ASME A112.19.14-2013 (R2018)

Six-Liter Water Closets Equipped with a Dual Flushing Device
601.3.2.1

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Vitreous China Nonwater Urinals
601.3.2.1

ASTM

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

ASTM C33 - 18

Standard Specification for Concrete Aggregates
801.3.4.1.2

ASTM C518-21

Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
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ASTM C920-18

Standard Specification for Elastomeric Joint Sealants
801.3.4.1.1

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Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
501.3.5.4

ASTM C1549-16

Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
501.3.5.4

ASTM D1003-13

Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
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Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
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Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)
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Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings
1001.3.1.1.5.1.

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Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
501.3.5.4

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Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

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Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight

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Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

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Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

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Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door

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Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process

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Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

501.3.5.4

ASTM E2399/E2399M-19

Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems

501.3.5.5

ASTM E2921-22

Standard Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes and Rating Systems

901.5.1

BIFMA

Business and Institutional Furniture Manufacturer's Association
678 Front Avenue NW, Suite 150
Grand Rapids, MI 49504-5368

ANSI/BIFMA e3-2019

Furniture Sustainability Standard

901.4.1.4.3

ANSI/BIFMA M7.1-2011 (R2016)

Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components and Seating
801.5.2

CARB

California Air Resources Board
1001 "I" Street
P.O. Box 2815
Sacramento, CA 95812

CARB SCM for Architectural Coatings-2019

California Air Resources Board (ARB) Suggested Control Measure for Architectural Coatings
801.3.9.2.2

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
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CDPH

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

CDPH/EHLB/Standard Method V1.2 (2017)

Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers—Version 1.2
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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

CRRC

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

ANSI/CRRC S100-2020

Standard Test Methods for Determining Radiative Properties of Materials
501.3.5.4

CSA

CSA Group
8501 East Pleasant Valley Road
Independence, OH 44131-5516

CSA B55.1-2020

Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units
401.8

CSA B55.2-2020

Drain Water Heat Recovery Units

401.8

CTI

Cooling Technology Institute
PO Box 681807
Houston, TX 77268

CTI ATC-105 (19)

Acceptance Test Code for Water Cooling Towers

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CTI ATC-105S (11)

Acceptance Test Code for Closed-Circuit Cooling Towers

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CTI ATC-106 (11)

Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers

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CTI STD-201RS (19)

Standard for the Certification of Water Cooling Tower Thermal Performance

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DBC

Wellington E. Webb Municipal Office Building
201 West Colfax Ave
Denver, CO 80202

2021 DCBC

Denver Commercial Building Code®

102.4, 102.6, 104.1

2021 DEC

Denver Energy Code®

102.4

2021 DEBC

Denver Existing Building Code®

102.4, 102.6

2021 DFC

Denver Fire Code®

102.4, 102.6, 501.3.5.5

2021 DFGC

Denver Fuel Gas Code®

102.4

2021 DMC

Denver Mechanical Code®

102.4

2021 DPC

Denver Plumbing Code®
102.4

2021 IPMC

International Property Maintenance Code®
102.4, 102.6

2021 DRC

Denver Residential Code®
101.3.2, 102.4

2021 ICC PC

Performance Code for Buildings and Facilities®
102.4

ICC G4 Guideline for Commissioning (2018)

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Denver Revised Municipal Code (DRMC)

Established Tree Definition

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FGI

Facility Guidelines Institute

FGI Guidelines for Design and Construction (2022)
801.3.3

Green Buildings Ordinance

Wellington E. Webb Municipal Office Building
201 West Colfax Ave
Denver, CO 80202

Green Buildings Ordinance [GBO] **Rules and Regulations**: Article 3
501.3.5.3

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

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, 601.3.1.2.2

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

IES

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

TM-15-2011 including addendum a

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LM-83-12

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301.2, 801.5.1

ISO

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

ISO-13256-1-2017

Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps
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ISO-13256-2-2017

Water-Source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-Water and Brine-to-Water Heat Pumps
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ISO 14025-2006

Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures
901.4.1.4

ISO 14040-2006

Environmental Management—Life Cycle Assessment—Principles and Framework

901.4.1.4

ISO 14044-2006

Environmental Management—Life Cycle Assessment— Requirements and Guidelines
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ISO 21930-2007

Sustainability in Building Construction—Environmental Declaration of Building Products
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ISO/IEC-17025-2007

General Requirements for the Competence of Testing and Calibration Laboratories
801.3.9

ISO/IEC 17065-2012

Conformity Assessment—Requirements for Bodies Certifying Products, Processes, and Services
801.3.9

ISO/IEC Guide 59-2019

Code of Good Practice for Standardization
901.4.1.3.1

NEMA

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

ANSI/NEMA MG 1-2016 (with 2018 supplements)

Motors and Generators
701.4.3.1

NEMA DC 3, Annex A-2013

Energy-Efficiency Requirements for Programmable Thermostats
701.4.7.4

NFPA

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

NFPA 70-2020

National Electrical Code
501.3.6.3

NFRC

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

ANSI/NFRC 200-2020

Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence
301.2

NSC

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

NSC 373-2013

Sustainable Production of Natural Dimension Stone
901.4.1.4

NSF

NSF International
789 Dixboro Road
Ann Arbor, MI 48105

NSF/ANSI 58-2017

Reverse Osmosis Drinking Water Treatment Systems
601.3.6

NSF/ANSI 140-2019

Sustainability Assessment for Carpet
901.4.1.4

NSF/ANSI 332-2015

Sustainability Assessment for Resilient Floor Coverings
901.4.1.4

NSF/ANSI 336-2018

Sustainability Assessment for Commercial Furnishings Fabric
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NSF/ANSI 342-2019

Sustainability Assessment for Wallcovering Products
901.4.1.4

NSF/ANSI 347-2018

Sustainability Assessment for Single Ply Roofing Membranes
901.4.1.4

NSF/ANSI 350-2018

On-Site Residential and Commercial Water Reuse Systems
601.3.7

NSF 41-2018

Non-liquid Saturated Treatment Systems
601.3.9.2

PHIUS

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

PHIUS 2021 Passive Building Standard
401.6.1 and 701.7

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

UL

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL 100-2016

Standard for Sustainability for Gypsum Boards and Panels
901.4.1.4

UL 102-2012

Standard for Sustainability for Door Leafs
901.4.1.4

UL 727-2018

Standard for Oil-Fired Central Furnaces
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UL 731-2018

Standard for Oil-Fired Unit Heaters
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UL2818-2017

Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing
801.3.9

UL2821-2017

Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings
801.3.9

U.S. Congress

United States Congress
Washington, DC 20515

EPAct 2005 HR6 Public Law 109-58

The Energy Policy Act (EPAct) of 2005
701.4.7.3

EISA 2007 HR6 Public Law 110-140

The Energy Independence and Security Act of 2007
701.4.7

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

U.S.C. § 6518 (2012)
Organic Certification
501.3.12.3.2

C.F.R. § 205.601 (2022)
Synthetic substances allow for use in organic crop production
501.3.12.3.2

C.F.R. § 205.602 (2018)
Nonsynthetic substances prohibited for us in organic crop production
501.3.12.3.2

USDOE

United States Department of Energy
Energy Information Administration
Washington, DC 20585

10 CFR Part 430, App N (2022)

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

EPA 420-F-07-063, November 2007

Green Vehicle Guide: Consider a SmartWay Vehicle Program—Requirements for Certified Passenger Vehicles
501.3.7

40 C.F.R. § 152.25(f)
Exemptions for pesticides of a character not requiring FIFRA regulation
501.3.12.3.2

EPA 625/R-96/0106, January 1999

Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, Sections TO-1, TO-11, TO-17
1001.3.1.5

February 16, 2012

NPDES General Permit for Stormwater Discharges From Construction Activities

1001.3.1.4

USEPA Method TO-17 (1999)

Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes
801.3.9

Version 1.0, August 1, 2012

ENERGY STAR Program Requirements for Uninterruptible Power Supplies
701.4.7

Version 1.0, August 14, 2009

WaterSense Specification for Flushing Urinals
601.3.2.1

Version 1.1, July 26, 2018

WaterSense Specification for Showerheads
601.3.2.1

Version 1.0, October 1, 2007

WaterSense Tank-Type High-Efficiency Lavatory Faucet Specification
601.3.2.1

Version 1.0, November 3, 2011

WaterSense Specification for Weather-Based Irrigation Controllers
601.3.1.2

Version 1.2, August 1, 2003

ENERGY STAR Program Requirements for Commercial Steam Cookers
701.4.7

Version 2.0, July 7, 2020

ENERGY STAR Program Requirements for Room Air Cleaners
701.4.7

Version 1.2, June 2, 2014

WaterSense Tank-Type High-Efficiency Toilet Specification
601.3.2.1

Version 1.2, May 8, 2009

ENERGY STAR Program Requirements for Commercial Griddles
701.4.7

Version 2.0, April 22, 2011

ENERGY STAR Program Requirements for Commercial Fryers
701.4.7

Version 2.1 June 20, 2017

ENERGY STAR Program Requirements for Lamps (Light Bulbs)
701.4.7

Version 3.0, January 2, 2018

ENERGY STAR Program Requirements for Commercial Ice Makers
601.3.2.5, 701.4.7

Version 2.0, June 25, 2012

ENERGY STAR Program Requirements for Commercial Dishwashers
601.3.2.5, 701.4.7

Version 3.0, October 11, 2019

ENERGY STAR Program Requirements for Imaging Equipment
701.4.7

Version 2.0, May 9, 2013

ENERGY STAR Program Requirements for Water Coolers
701.4.7

Version 2.2, August 15, 2019

ENERGY STAR Program Requirements for Luminaires
701.4.7.3

Version 2.0, October 1, 2011

ENERGY STAR Program Requirements for Hot Food Holding Cabinets
701.4.7

USEPA—continued

Version 2.2, October 7, 2015

ENERGY STAR Program Requirements for Commercial Ovens
701.4.7

Version 3.0, April 1, 2012

ENERGY STAR Program Requirements for Residential Ceiling Fans
701.4.7

Version 3.0, December, 20, 2013

ENERGY STAR Program Requirements for Boilers
701.4.7

Version 3.2, April 16, 2015

ENERGY STAR Program Requirements for Residential Water Heaters
701.4.7

Version 3.0, May 1, 2013

ENERGY STAR Program Requirements for Audio and Video
701.4.7

Version 5.0, October 31, 2019

ENERGY STAR Program Requirements for Dehumidifiers
701.4.7

Version 4.0, March 27, 2017

ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers
701.4.7

Version 3.0, October 1, 2014

ENERGY STAR Program Requirements for Telephony
701.4.7

Version 3.2, April 16, 2015

ENERGY STAR Program Requirements for Geothermal Heat Pumps
701.4.7

Version 2.9, April 29, 2020

ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines
701.4.7

Version 4.1, February 21, 2018

ENERGY STAR Program Requirements for Residential Ventilating Fans

701.4.7

Version 4.1, October 26, 2015

ENERGY STAR Program Requirements and Criteria for Room Air Conditioners
701.4.7

Version 4.1, February 1, 2013

ENERGY STAR Program Requirements for Furnaces
701.4.7

Version 5.1, January 1, 2018

ENERGY STAR Program Requirements for Set-Top Boxes
701.4.7

Version 5.0, September 15, 2014

ENERGY STAR Program Requirements for Refrigerators and Freezers
701.4.7

Version 5.0, September, 15, 2015

ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners
701.4.7

Version 6.0, April 29, 2015

ENERGY STAR Program Requirements Product Specification for Residential Dishwashers
601.3.2.2, 701.4.7

Version 7.1, November 16, 2018

ENERGY STAR Program Requirements for Computers
701.4.7

Version 8.0, January 28, 2020

ENERGY STAR Program Requirements for Displays
701.4.7

Version 8.0, March 1, 2019

ENERGY STAR Program Requirements for Televisions
701.4.7

Version 8.0, February 5, 2018

ENERGY STAR Program Requirements for Clothes Washers
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)

USGBC

Leadership in Energy and Environmental (LEED) V4.1
101.4.2

WTO

World Trade Organization
Centre William Rappard
Rue de Lausanne 154,
CH-1211 Geneva 21, Switzerland

WTO TBT-1994

WTO Technical Barriers to Trade (TBT) Agreement Annex 3 Code of Good Practice for the Preparation, Adoption and Application of Standards

901.4.1.3.1

NORMATIVE APPENDIX A

CLIMATE ZONES AND PRESCRIPTIVE BUILDING ENVELOPE AND DUCT INSULATION TABLES

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

Tables A101.1 (A-1) through A101.3 (A-3) appear twice in this appendix. The three tables are shown first with I-P units, followed by three tables with SI units.

For *climate zones*, see ANSI/ASHRAE/IES Standard 90.1, Section 5.1.4, and ANSI/ASHRAE Standard 169.

a. For locations in the United States and its territories, use ANSI/ASHRAE Standard 169, Table B-1, "U.S. States by State and County," to determine the assigned climate zone and, where required, the assigned climate zone letter. ***Informative Note:*** Referenced Standard Reproduction Annex ASHRAE Standard 169 (included at the end of this document) contains an extraction of ANSI/ASHRAE Standard 169, Figure B-1, "Climate Zone for United States Counties," (which is informative for Standards 90.1 and 189.1). ANSI/ASHRAE/IES Standard 90.1 Referenced Standard Reproduction Annex ASHRAE Standard 169 (included at the end of ANSI/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
(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
(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
(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 $(h \cdot ft^2 \cdot °F)/Btu$, 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
(SUPERSEDES TABLE A2.4.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
SINGLE-RAFTER ROOF REQUIREMENTS (SI)

CLIMATE ZONE	MINIMUM INSULATION R-VALUE OR MAXIMUM ASSEMBLY U-FACTOR		
	NONRESIDENTIAL	RESIDENTIAL	SEMIHEATED
0, 1	R-6.7 U-0.165	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
2	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
3, 4, 5	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-5.3 U-0.204
6	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-6.7 U-0.165
7, 8	R-6.7 + R-2.6 ci U-0.111	R-6.7 + R-2.6 ci U-0.111	R-6.7 U-0.165

TABLE A101.2
(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
MINIMUM DUCT INSULATION R-VALUE[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 $m^2 \cdot k/kW$, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 701.4.2 (7.4.2). Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 23.8 C at the installed thickness.

b. Includes crawlspaces, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above.

TABLE A101.3
(SUPERSEDES TABLE 6.8.2 IN ANSI/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 $m^2 \cdot k/kW$, 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
(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	
			Single packaged	12.0 SEER	
Small duct, high velocity, air cooled	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	
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	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 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 15.3 IEER	AHRI 210/240
	≥65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 IEER	
	≥135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 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
Condensing, water or evaporatively cooled	≥135,000 Btu/h			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.

Informative Note:

TABLE B101.2
(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	
			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	
	< 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	
	< 17,000 Btu/h	All	86°F entering water	14.0 EER	ISO-13256-1

Water-to-air water loop (cooling mode)	≥17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	14.0 EER	
	> 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	14.0 EER	
Water-to-air ground water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	
Water-to-air ground loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	
Water-to-water water loop (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water-to-water groundwater (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine-to-water ground loop (cooing mode)	< 135,000 Btu/h	All	77°F entering water	12.1 EER	
Air conditioners, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	9.00 HSPF	AHRI 210/240
			Single packaged	8.50 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	9.00 HSPF	
			Single packaged	8.50 HSPF	
Through-the-*wall*, air cooled (heating mode)	< 30,000 Btu/h (cooling capacity)	All	Split systems	7.40 HSPF	AHRI 210/240
			Single packaged	7.40 HSPF	
Small-duct high velocity, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	7.20 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	7.20 HSPF	
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
(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 *outdoor air*	14.4 – (0.300 × Cap/1000)[c] EER	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	95°F db *outdoor air*	10.9 – (0.213 × Cap/1000)[c] EER	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	95°F db *outdoor air*	14.4 – (0.300 × Cap/1000)[c] EER	ARI 310/380
PTHP (cooling mode) nonstandard size[b]	< 7000 Btu/h	95°F db *outdoor air*	10.8 – (0.213 × Cap/1000)[c] EER	ARI 310/380
PTHP (heating mode) new constructions	All capacities	47°F db/43°F wb *outdoor air*	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 *outdoor air*	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
(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 *outdoor air*	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.2 EER 12.9 IEER		AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.4 IEER		
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb *outdoor air*	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.2 IEER		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb *outdoor air*	10.6 EER 11.6 IEER		
SPVHP (heating mode)	< 65,000 Btu/h	47°F db/43°F wb *outdoor air*	8.0 HSPF		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb *outdoor air*	3.3 COP_H		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb *outdoor air*	3.2 COP_H		
Room air conditioners, with louvered sides	< 6,000 Btu/h		12.1 *CEER*	11.5 *CEER*	ANSI/AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h		12.1 *CEER*	11.5 *CEER*	
	≥ 8,000 Btu/h and < 14,000 Btu/h		12.0 *CEER*	11.5 *CEER*	
	≥ 14,000 Btu/h and < 20,000 Btu/h		11.8 *CEER*	11.2 *CEER*	
	≥ 20,000 Btu/h and < 28,000 Btu/h		10.3 *CEER*	9.8 *CEER*	
	≥ 28,000 Btu/h		9.9 *CEER*	9.4 *CEER*	
Room air conditioners, without louvered sides	< 6,000 Btu/h		11.0 *CEER*	10.5 *CEER*	
	≥ 6,000 Btu/h and < 8,000 Btu/h		11.0 *CEER*	10.5 *CEER*	
	≥8,000 Btu/h and < 11,000 Btu/h		10.6 *CEER*	10.1 *CEER*	

	≥ 11,000 Btu/h and < 14,000 Btu/h		10.5 *CEER*	10.0 *CEER*	
	≥ 14,000 Btu/h and < 20,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
	≥ 20,000 Btu/h		10.3 *CEER*	9.8 *CEER*	
Room air conditioner heat pump, with louvered sides	< 20,000 Btu/h		10.8 *CEER*	10.3 *CEER*	
	≥20,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
Room air conditioner heat pump, without louvered sides	< 14,000 Btu/h		10.2 *CEER*	9.7 *CEER*	
	≥14,000 Btu/h		9.6 *CEER*	9.1 *CEER*	
Room air conditioner, casement only	All capacities		10.5 *CEER*	10.0 *CEER*	
Room air conditioner, casement-slider	All capacities		11.4 *CEER*	10.8 *CEER*	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
b. Connected room air conditioners that are connected to utility programs are allowed a lower *CEER* value but must be in compliance with and certified per EnergyStar version 4.0 requirements for connected equipment.

TABLE B101.5
(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/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
(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[h,i]	89% AFUE[f,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 ≤ 2,5000,000 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
(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[g]	PERFORMANCE REQUIRED [a,b,c,d,e,f,i]	TEST PROCEDURE[h]
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
(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 – 0.0058V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.0031V	
			Medium	UEF ≥ 0.9577 – 0.0023V	
			High	UEF ≥ 0.9844 – 0.0016V	
Electric resistance storage water heaters		≥ 20 gal and £ 55 gal	Very small	UEF ≥ 0.8808 – 0.0008V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.0003V	
			Medium	UEF ≥ 0.9307 – 0.0002V	
			High	UEF ≥ 0.9349 – 0.0001V	
		> 55 gal		Must use heat-pump water heater	
		> 75 gal	Very small	UEF ≥ 1.0136 – 0.0028V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.0014V	

Electric resistance grid-enabled water heaters			Medium	UEF ≥ 0.9853 – 0.0010*V*	
			High	UEF ≥ 0.9720 – 0.0007*V*	
Heat-pump water heaters		£ 55 gal		EF ≥ 2.00, FHR ³ 50 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 2.20, FHR ³ 50 gal	
Gas-fired storage water heaters	£□75,000 Btu/h	£ 55 gal		EF ≥ 0.67, FHR ³ 67 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 0.77, FHR ≥ 67 gal	
	> 75,000 Btu/h	£ 140 gal		E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (*Q*/800 + 110Ö*V*), Btu/h	ANSI Z21.10.3
Gas instantaneous water heaters	> 50,000 Btu/h and < 200,000 Btu/h[d]	³ 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
	³ 75,000 Btu/h[c]	£ 140 gal and ³ 4,000 (Btu/h)/gal		E_t ≥ 0.94 or EF ³ 0.93 SL = 0.84 × (*Q*/800 + 110Ö*V*), Btu/h	ANSI Z21.10.3
Oil storage water heaters	£□105,000 Btu/h	£ 50 gal	Very small	EF = 0.2509 – 0.0012*V*	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.0016*V*	
			Medium	EF = 0.6078 – 0.0016*V*	
			High	EF = 0.6815 – 0.0014*V*	
	> 105,000 Btu/h	< 4,000 (Btu/h)/gal		E_t ≥ 80% and SL £ (*Q*/800 + 110Ö*V*), Btu/h	ANSI Z21.10.3
Oil instantaneous water heaters	£ 210,000 Btu/h	£ 50 gal		EF≥0.59 – 0.0019*V*	DOE 10 CFR Part 430
	> 210,000 Btu/h	³ 4,000 (Btu/h)/gal and < 10 gal		E_t ≥ 80%	ANSI Z21.10.3
	> 210,000 Btu/h	³□4,000 (Btu/h)/gal and ³ 10 gal		E_t ≥ 78% and SL ≤ (*Q*/800 +110Ö*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	³□4,000 (Btu/h)/gal and < 10 gal		E_t ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		³□4.000 (Btu/h)/gal and ³ 10 gal		E_t ≥ 80% SL ≤ (*Q*/800 + 110Ö*V*), Btu/h	ANSI Z21.10.3
Hot-water supply boilers, oil		³□4,000 (Btu/h)/gal and ³□10 gal		E_t ≥ 78% SL ≤ (*Q*/800 + 110Ö*V*), Btu/h	
Pool heaters, gas	All sizes			E_t ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			E_t ≥ 78%	ASHRAE 146

Heat-pump pool heaters	All sizes	50°F db 44.2°F wb outdoor air 80.0°F entering water		≥4.0 COP	AHRI 1180
Unfired storage tanks	All sizes			≥R-12.5	None

a. Energy factor (EF) and thermal efficiency (E_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
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/ft^3).

TABLE B101.10
(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
(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]
	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230

VRF air cooled (cooling mode)	≥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	
VRF air cooled	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	8.5 HSPF	AHRI 1230

(heating mode)	≥65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb *outdoor air*	3.40 COP_H	
			17°F db/15°F wb *outdoor air*	2.40 COP_H	
	≥135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb *outdoor air*	3.20 COP_H	
			17°F db/15°F wb *outdoor air*	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
(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 $ICOP_C$	
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
(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	ISO-13256-2
Water-to-water groundwater (cooling mode)	< 40 kW	All	15°C entering water	4.78 COP_C	
Brine-to-water ground loop (cooing 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	
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	
	< 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
(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 *outdoor air*	4.22 – (0.300 × Cap/1000)[c] COP_C	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	35°C db *outdoor air*	3.19 – (0.213 × Cap/1000)[c] COP_C	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	35°C db *outdoor air*	4.22 – (0.300 × Cap/1000)[c] COP_C	ARI 310/380
PTHP (cooling mode) nonstandard size[b]	< 7,000 Btu/h	35°C db *outdoor air*	3.16 – (0.213 × Cap/1000)[c] COP_C	ARI 310/380
PTHP (heating mode) new constructions	All capacities	8.3°C db/6.1°C wb *outdoor air*	3.7 – (0.052 × Cap/1000)[c] COP_H	ARI 310/380
PTHP (heating mode) nonstandard size[b]	All capacities	8.3°C db/6.1°C wb *outdoor air*	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 0.45 m. high and less than 1.0 m. wide and having a cross-sectional area less than 0.43 m^2.
c. "Cap" means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 2.1 kW, use 2.1 kW in the calculation. If the unit's capacity is greater than 4.4 kW, use 4.4 kW in the calculation.

TABLE B101.4
(SUPERSEDES TABLE 6.8.1-4 IN 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 $CCOP_C$	
	≥5.9 kW		3.17 $CCOP_C$	3.02 $CCOP_C$	

Room air conditioner heat pump, with louvered sides	≥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
(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
(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
(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[g]	PERFORMANCE REQUIRED [a,b,c,d,e,f,i]	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
(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 – 0.0015V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.00082V	
			Medium	UEF ≥ 0.9577 – 0.00061V	
			High	UEF ≥ 0.9844 – 0.00042V	
Electric resistance storage water heaters		≥75.7 L and ≤208 L	Very small	UEF ≥ 0.8808 – 0.00021V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.000079V	
			Medium	UEF ≥ 0.9307 – 0.000053V	
			High	UEF ≥ 0.9349 – 0.000026V	
		> 208 L		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		≥284 L	Very small	UEF ≥ 1.0136 – 0.00074V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.00037V	
			Medium	UEF ≥ 0.9853 – 0.00026V	
			High	UEF ≥ 0.9720 – 0.00018V	
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	
	≤22.0 kW	≤208 L		EF ≥ 0.67, FHR ≥ 250 L	

Gas-fired storage water heaters		> 208 L		EF ≥ 0.77, FHR ≥ 250 L	DOE 10 CFR Part 430
	> 22.0 kWh	≤530 L		E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/234 + 56.5ÖV), W	ANSI Z21.10.3
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 ≥ 0.94 or EF ≥ 0.93 SL = 0.84 × (Q/234 + 56.5ÖV), W	ANSI Z21.10.3
Oil storage water heaters	≤30.7 kW	≤190 L	Very small	EF = 0.2509 – 0.00032V	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.00042V	
			Medium	EF = 0.6078 – 0.00042V	
			High	EF = 0.6815 – 0.0037V	
	> 30.7 kW	< 309.7 W/L		E_t ≥ 80% and SL ≤ (Q/234 + 56.5ÖV), W	ANSI Z21.10.3
Oil instantaneous water heaters	≤61.5 kW	≤190 L		EF ≥ 0.59 – 0.00050V	DOE 10 CFR Part 430
	> 61.5 kW	≥309.7 W/L and < 38 L		E_t ≥ 80%	ANSI Z21.10.3
	> 61.5 kW	≥309.7W/L and ≥30 L		E_t ≥ 78% and SL £ (Q/234 + 56.5ÖV), 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 ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥309.7 W/L and ≥30 L		E_t ≥ 80% SL ≤ (Q/234 + 56.5ÖV), W	ANSI Z21.10.3
Hot-water supply boilers, oil		≥309.7 W/L and ≥30 L		E_t ≥ 78% SL ≤ (Q/234 + 56.5ÖV), W	ANSI Z21.10.3
Pool heaters, gas	All sizes			E_t ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			E_t ≥ 78%	ASHRAE 146
Heat-pump pool heaters	All sizes	10°C db 6.8°C wb *outdoor air* 26.7°C entering water		≥4.0 COP	ASHRAE 146
Unfired storage tanks	All sizes			≥R-2.2°C • m²/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
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
(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
(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	
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		VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	

	(cooling capacity)		–8.3°C db/–9.4°C wb *outdoor air*	2.40 COP_H	
	≥40 kW (cooling capacity)		VRF multisplit system 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	
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
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 801.3.9 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} (µg/m³) of each target VOC shall be calculated using Equation 2 of CDPH/EHLB/Standard Method V1.2 (commonly referred to as California Section 01350), as shown below, or in compliance with GREENGUARD Environmental Institute GGPS.001 standard for building materials and finishes; or Green Seal® standards. 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.

$$C_Bi = (EF_{Ai} \times A_B) / Q_B = EF_{Ai} / (Q_B / A_B) = EF_{Ai} / q_P$$

where:

EF_{Ai} = area specific emission rate or emission factor at 336 hours after placing a test specimen in the chamber (14 days total exposure time), µg h^{-1} per unit.

A_B = exposed surface area of the installed material in the building, m^2.

V_B = building volume, m^3.

Q_B = flow rate of outside ventilation air.

INFORMATIVE APPENDIX E

RESERVED

INFORMATIVE APPENDIX F

INTEGRATED DESIGN

(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

SECTION F101
Integrated Design Process/Integrated Project Delivery

Integrated design, and related concepts such as *integrated project delivery* and integrative design, leverages early stakeholder collaboration, through the sharing of knowledge and expertise among project team members, to develop stronger, more balanced design solutions. This *integrated design process* stands in contrast to traditional design methods, where there is limited use of the skills and knowledge of all stakeholders. An *integrated design process* provides increased predictability of project outcomes earlier and enables the construction of *high-performance green buildings* that consume fewer resources and provide better comfort and functionality.

Integrated design introduces major issues and key participants into the project early, where more opportunities occur for creative problem solving. The complex interactions of sophisticated building systems require early coordination to maximize their effectiveness and output. Early team building and goal setting may also reduce total project costs. The collaborative process can inform *building envelope*, mechanical, electrical, plumbing, and other building system design. The later in the design process that systems are introduced, the more expensive their implementation will be. Information technology can also be a valuable asset in increasing predictability of outcomes earlier in the project and is recommended for all integrated teams.

In contrast with a linear design process, which addresses problems sequentially, an integrated process approaches each problem with input from the various viewpoints of the participants and the domains they represent, circling back after each design decision to collectively evaluate the impact on all stakeholders. This process acknowledges the complex interdependency of building systems and their relationship to resource consumption and occupant well-being.

Several existing, and currently evolving, models for collaboration should be considered, including *ASHRAE Handbook—HVAC Applications*, Chapter 60; the MTS 1.0 WSIP Guide, *Whole Systems Integrated Process Guide for Sustainable Buildings and Communities*; and *Integrated Project Delivery: A Guide* by the AIA and AIA California Council.

Project-specific integrated design and/or *integrated project delivery* processes should be determined with full participation of the stakeholder team. What works for one project may not be the best approach for the next. Additionally, the team should collectively identify the performance standards and the associated metrics by which project success will be evaluated. Design charrettes of varying duration may be an effective tool to consider, though ultimately it is the responsibility of the stakeholder team to determine the process that will best fit a specific problem or project.

F101.1 Design Charrette. The following outlines one type of design charrette process that resulted in a successful integrated design. A charrette process can be initiated at the initial stages of building design, and the members of the process should include all stakeholders.

F101.1.1 Charrette Process. Experienced personnel representing each specialty should participate in the charrette process. A discussion of all systems and all items that affect the *integrated design* should be discussed. Stakeholders should be able to decide and vote on the best integrated system.

The integrative team process should entail the following steps of design optimization:

a. The original goals and budget of the project should be revisited to see whether the overall intentions of the project are intact.

b. The project should be compared with this code or at least one existing green rating system.

c. Each of the building and *site* components should be scrutinized to help ensure that natural systems for energy conservation, lighting, ventilation, and passive heating and cooling are maximized before mechanical systems are engaged.

d. The appropriateness and integration logic of the building's primary systems should be confirmed.

e. The impact of the design on the *site* and its larger context should be evaluated, including the environmental impact on a life-cycle cost basis.

f. Building information modeling (BIM) software, design tools, and the experience of the design team should be used, where practical, to help optimize the design.

g. All members of the design team should be included when making design decisions.

h. Commissioning and consideration of future operation and maintenance (O&M) requirements should be included within the design optimization process.

F101.1.2 Design Charrette Matrix. At the end of the charrette process, a matrix for each proposed building 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.

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.

ACCA

Air Conditioning Contractors of America Association, Inc.
1330 Braddock Place, Suite 350
Alexandria, VA 22314
(703) 575-4477

Manual D (Third Edition Version 2.5 – 2016)

Residential Duct Systems

402.1.2.2.1

AHRI

Air Conditioning, Heating, and Refrigeration Institute
2311 Wilson Blvd, Suite 400
Arlington, VA 22201
(703) 524-8800

AHRI Standard 550/590 (2020)

Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

701.4.3.1.1

AHRI Standard 551/591 (2020)

Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle

701.4.3.1.1

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 (2009)
901.4.1.1

AMERICAN BIRD CONSERVANCY

4249 Loudoun Ave.
The Plains, VA 20198-2237

American Bird Conservancy Bird Collision Deterrence Material Threat Factor Table (May 2022)
www.abcbirds.org/glass-collisions/nyc-threat-factor

501.3.10.1

APBP

Association of Pedestrian and Bicycle Professionals
PO BOX 93
Cedarburg, WI 53012

Bicycle Parking Guidelines, 2nd Edition, 2010

501.3.7.2

ANSI

1899 L Street, NW
11th Floor
Washington, DC 20036

ANSI A138.1 (2012)
Green Squared American National Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, And Tile Installation Material
901.4.1.4.3

ANSI/RESNET/ICC 301-2019
Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index
401.4

ANSI/RESNET/ICC 380-2019
Standard for Testing Airtightness of Building, Dwelling Unit, and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems; and Airflow of Mechanical Ventilation Systems
401.5

CSA B55.1- 2020

Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units

401.8

CSA B55.2-2020

Drain Water Heat Recovery Units

401.8

ANSI/CTA-2045-A (2018)

Modular Communications Interface for Energy Management

401.11

ANSI/CTA-2045-B (2018)

Modular Communications Interface for Energy Management

401.11

ANSI/ASABE S640 (2017)

Plant Grow Lighting

701.4.6.1.3

ASHRAE

1791 Tullie Circle NE
Atlanta, GA 30329

ASHRAE Guideline 0-2013

The Commissioning Process

1001.3.1.1

ASHRAE Guideline 1.1-2007

HVAC&R Technical Requirements for the Commissioning Process

1001.3.1.1

ASHRAE Guideline 4-2008 (RA 2013)

Preparation of Operating and Maintenance Documentation for Building Systems

1001.3.1.1

ASHRAE Handbook, 2021

Fundamentals

Appendix C

ASHRAE Handbook, 2020

HVAC Applications

Appendix F

ASHRAE Standard 62.1-2019 (Appendix C)

Ventilation for Acceptable Indoor Air Quality

Table 1001.3.1.4

ANSI/ASHRAE/ACCA Standard 180, 2018

Standard Practice for Inspection and Maintenance of. Commercial Building HVAC Systems

1001.3.2.2

ASTM

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

ASTM C755-20 (20)

Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation, Appendix X1 Problem Analysis

801.3.6

ASTM E779 (19)

Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

401.5

ASTM E1007 (21)

Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

1001.3.1.1.2.1.2

ASTM E1331-15 (2019)

Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

801.4.1

ASTM E1477 - 98a (2017)e1

Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

801.4.1

ASTM E1827-11 (2017)

Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door

401.5

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

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, 801.5.2

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

DBC

Wellington E. Webb Municipal Office Building
201 West Colfax Ave
Denver, CO 80202

DCBC-2021

Denver Commercial Building Code®
106.1, 801.3.1.8, I201.1

DEC-2021

Denver Energy Code®

DFC-2021

Denver Fire Code®
601.3.2.6

DPC-2021

Denver Plumbing Code®
601.3.1.2.1

ICC 700–2020:

National Green Building Standard

ICC G4 Guideline for Commissioning (2018)

1001.3.1.2

DGS

State of California, Department of General Services, Procurement Division
Ziggurat Building
707 Third Street
West Sacramento, CA 95605-2811

RFP DGS-56275 (2022)

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) – (2018)
Table 1001.3.1.5

EPA

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

Portfolio Manager – live online
1001.3.2.1.3.2

40 C.F.R. § 152.25(f) – (2022)
Exemptions for pesticides of a character not requiring FIFRA regulation
501.3.12.3.2

FGI

Facility Guidelines Institute

FGI Guidelines for Design and Construction (2022)
801.3.3

FSC

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

901.4.1.3.1

GSA

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

U.S. GSA-2005

The Building Commissioning Guide
1001.3.1

IES

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

IDA/IES Model Lighting Ordinance

Model Lighting Ordinance (MLO) – (2011)

501.3.6

ITE

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

4th Edition, 2004

Parking Generation
1001.3.2.4

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

NSF

National Sanitation Foundation
789 N. Dixboro Road
Ann Arbor, MI 48105

NSF 41 (2018)
Non-liquid Saturated Treatment Systems
601.3.9.2

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 (2007)
Table 701.5.2B

PHUIS

Passive House Institute
53 W Jackson Blvd
Chicago, IL 60604

PHIUS+ 2021 Passive Building Standard
401.6.1 and 701.7

SFI

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

901.4.1.3.1

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

SRI

Steel Recycling Institute
680 Andersen Drive
Pittsburgh, PA 15220

Brochure

Steel Takes LEED® With Recycled Content (2009)
901.4.1.1

UL

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

UL2818-2017

Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing
801.3.9

UL2821-2017

Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings
801.3.9

USDA

U.S. Department of Agriculture

U.S.C. § 6518 (2012)
Organic Certification
501.3.12.3.2

C.F.R. § 205.601 (2022)
Synthetic substances allow for use in organic crop production
501.3.12.3.2

C.F.R. § 205.602 (2018)
Nonsynthetic substances prohibited for us in organic crop production
501.3.12.3.2

USGBC

Leadership in Energy and Environmental (LEED) V4.1

101.4.2

INFORMATIVE APPENDIX H

RESERVED

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.

SECTION I101
PROVIDER QUALIFICATIONS

I101.1 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 Overview of the Cx Process. Table I101.2 provides an overview of activities, documentation, and responsibilities that should be included in the *Cx process*.

SECTION I201
CX DOCUMENTATION

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

I201.1 Typical Elements Included in Owner's Project Requirements (OPR). The *OPR* is a document developed by the *owner* with assistance from the design and Cx teams that details the requirements of a project and the expectations for how it will be used and operated. The *OPR* should include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. The term "project intent" or "design intent" is used by some *owners* for their *Cx process OPR*.

The *OPR* document should address the following for the commissioned systems:

a. Facility objectives, size, location, user requirements, and *owner* directives, including *space* use and occupancy/operations schedules and special project requirements.

b. Applicable codes and standards, in addition to local building codes (**Informative note:** e.g., *International Building Code*), and environmental, sustainability, and efficiency goals and benchmarks.

c. Indoor environment requirements, including temperature, humidity, and ventilation.

d. *Cx process* scope and requirements; listing of equipment; systems and assemblies requiring commissioning, including installation, evaluation, and testing requirements; and *commissioning (Cx) plan* and report formats and distribution requirements. Sampling procedures, if permitted, for all reviews, evaluations, and testing should be detailed.

e. Equipment, systems, and assemblies requirements, expectations, and warranty provisions.

f. Maintainability, access, and operational performance requirements.

g. Project documentation requirements, including formats and delivery schedules for *Basis of Design* (*BoD*), Cx specifications, *Cx plan* and reports, equipment submittals, and the systems manual; documentation reviews, approvals, and distribution during design and construction phases.

h. Training requirements for *owner*'s operation and maintenance personnel and occupants.

TABLE I101.2
TYPICAL CX PROCESS ACTIVITIES, DELIVERABLES, AND RESPONSIBILITIES

ITEM	ACTIVITY	DELIVERABLE	NORMALLY PROVIDED BY
1	*Owner's project requirements*	*OPR* document	*Owner* with assistance from design and Cx teams
2	*Basis of Design*	*BoD* document	Design team
3	*Cx plan*	*Cx plan* document	*Cx provider* with input from *owner*, design team, and contractor
4	Contractor Cx requirements	Cx specifications	Design team and *Cx provider*
5	Design review	Cx design review report	*Cx provider*
6	Submittal review	Submittal review report	*Cx provider*

7	Commissioning designated systems inspections, *functional and performance testing*	Installation, inspection, functional test reports, performance test reports	Contractors, manufacturers, *Cx provider* and team
8	Issue and resolution log	Issue and resolution logs	*Cx provider* and team
9	Systems manual	Systems manual	Contractors with review by *Cx provider*
10	Training	Training plan and reports	Contactor and manufacturers with review by *Cx provider*
11	Preliminary Cx report	Preliminary Cx report	*Cx provider*
12	Cx activities during occupancy	Additional information and updates to reports	*Cx provider* and building operations
13	Final Cx report	Final Cx report	*Cx provider*

I201.2 Basis of Design (BoD). The *BoD* is a document developed by the design team that records the concepts, calculations, decisions, and product selections used to meet the *OPR* and to satisfy applicable regulatory requirements, standards, and guidelines. The document should include both narrative descriptions and lists of individual items that support the design process, including the following:

a. A detailed description of the design team's technical approach to, and assumptions about, the *OPR*.
b. A platform for the review of the design and for changes as the project progresses.
c. A detailed description addressing coordination of applicable technical and code requirements.

I201.3 Cx Plan. A *Cx plan* is a document developed by a *Cx provider* that should include the following:

a. An overview of the *Cx process* developed specifically for the project.
b. The roles and responsibilities of the *Cx provider* and the Cx team through final commissioning activities.
c. Documentation of communication channels and processes, including distribution of the *Cx plan*, logs, testing documents, and reports during the design and construction processes.
d. A detailed description and schedule of *Cx process* activities and the list of operations, systems, and assemblies that will be commissioned, and a description of performance criteria where not shown on the *construction documents*.
e. The project design documentation and submittal review procedures and reports.
f. Inspection checklists and testing forms, issues and resolution log, and Cx progress reports to be used during the project to communicate and track commissioning and inspection process information, including format, approvals, and distribution.
g. The procedures to follow for resolution where the Cx evaluation does not meet the *OPR*.

I201.4 Cx Specifications. For construction or renovation projects requiring contract documents, the *owner* should require by agreement that the design/construction team include Cx specifications in the project contract documents. The Cx specification should require compliance with the *OPR* and with the *Cx process* contained in the project's *Cx plan* as detailed in this code.

I201.5 Cx Design Review Report. The *Cx provider* should provide a design review (Cx Design Review Report) to the *owner* and design teams to report compliance with the *OPR* and *BoD*. This Cx design review is not intended to replace a design peer review or a code or regulatory review.

I201.6 Record Documents. Record documents should be provided to the *owner* upon project completion. The record documents should be accessible to the building operations and maintenance personnel, be included in the systems manual, and include all of the following:

a. Approved *construction documents*, including record plans and specifications.

b. Approved submittals and coordination drawings. This documentation should show the actual locations of equipment, systems, and assemblies, such as piping, ductwork, valves, controls, access panels, electrical equipment, plumbing equipment, lighting and other operating components and systems. The record documents should particularly note equipment locations that are concealed or are installed in locations other than those indicated on the approved *construction documents.*

c. Engineering and institutional control information for *sites* that have previously been a *brownfield* or that have required environmental corrective action, remediation, or restoration at the federal, state, or local level.

I201.7 Systems Manual. A systems manual should be provided by an *owner* for use in building operations training. The systems manual should be made accessible to building operations and maintenance (O&M) personnel and should be updated and maintained by an *owner* for the life of the building.

A systems manual should include the following:

a. Facility design and *construction documents*, including the following:

    1. *OPR* and *BoD.*

    2. Construction record documents, including drawings, specifications, and approved submittals.

b. Facility systems and assemblies information, including the following:

    1. Manufacturer's O&M data for installed equipment systems and assemblies.

    2. Warranties and certificate of occupancy.

    3. Contractor and supplier listing and contact information.

c. A facility operations guide, including an operating plan, building and equipment operating schedules, set points and ranges, verified sequences of operation, system and equipment limitations, and emergency procedures.

d. Where training is provided, training plans, materials, and records.

e. A final commissioning report.

I201.8 Preliminary Cx Report. A preliminary Cx report should be provided by the *Cx provider* and should include the following information:

a. Performance of commissioned equipment, systems, and assemblies.

b. Issue and resolution logs, including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation.

c. Deferred tests that cannot be performed at the time of report preparation.

d. A plan for the completion of Cx activities and training, including climatic and other conditions required for performance of the deferred tests.

I201.9 Final Cx Report. A final Cx report should be provided by the *Cx provider* and should include the following information:

a. A copy of the final *Cx plan*, including *FPT* procedures used during the *Cx process*, including measurable criteria for test acceptance.

b. A copy of the final *OPR*, *BoD*, and design and submittal reviews as required by the *Cx plan* if not included in the submitted systems manual.

c. Results of all evaluations, startup data, *FPT*, and reports by suppliers, contractors, observers, and *Cx providers.*

d. Issue logs and disposition of all deficiencies found during testing, including details of corrective measures used or proposed.

e. Equipment, systems, and assemblies repaired or replaced and adjustments to calibration.

f. Documentation of equipment and systems sequences and settings, which are typically submitted in the final sequence of operation and in the systems manual.

g. A resolution plan identifying all of the issues unresolved and incomplete at the end of the project.

INFORMATIVE APPENDIX J

RESERVED

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

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 189.1-2020 incorporates ANSI/ASHRAE/USGBC/IES Standard 189.1-2017 and Addenda ar*, bm*, ck*, a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, x, y, z, aa, ab, ac, ad, ae, af, ag, ah, ai, aj, ak, al, am, an, ao, ap, ar, as, at, au, av, aw, ay, az, ba, bb, bc, bd, be, bf, bg, bh, bk, bl, bm, bn, bp, bq, bs, bt, bu, bw, bx, by, and ck to ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017. Table M101.1 (M-1) lists each addendum and describes the way in which the standard is affected by the change. It also lists the ASHRAE, and ANSI approval dates for each addendum.

TABLE K101.1
ADDENDA TO ANSI/ASHRAE/USGBC/IES STANDARD 189.1-2017

ADDENDUM	SECTIONS	DESCRIPTION OF CHANGES*	ASHRAE STANDARD COMMITTEE APPROVAL	CO-SPONSOR APPROVAL (ICC, USGBC, IES)	ASHRAE BOD/ TECH COUNCIL APPROVAL	ANSI APPROVAL
ar*	701.5.3 (7.5.3), Appendix I	Adds to the Section 701.5 (7.5) energy performance criteria, specifically a new value called “Zero Energy Performance Index” based on the proposed building versus baseline building energy use. (*Initiated as an addendum to 189.1-2014)	1/20/2018	1/3/2018 1/31/2018 1/8/2018	1/24/2018	2/2/2018
bm*	301.2 (3.2), 701.5.1 (7.5.1), 701.5.2 (7.5.2), C101.3 (C1.3), C101.3.1 (C1.3.1), C101.3.2 (C1.3.2)	Adds the option for Section 701.5 (7.5) users to model district energy systems that are not wholly contained within the project site boundary. (*Initiated as an addendum to 189.1-2014)	6/22/2019	6/10/2019 7/9/2019 6/10/2019	6/26/2019	7/24/2019
ck*	C101.3 (C1.3)	Requires that energy consumption of thermal and electric storage systems used to charge, discharge, and store energy be modeled in the proposed building design. (*Initiated as an addendum to 189.1-2014)	6/23/2018	6/25/2018 6/5/2018 5/30/2018	6/27/2018	6/28/2018
a	501.3.5.3 (5.3.5.3)	Adds a new requirement for Climate Zones (CZ) 4A and 4B to meet the heat island mitigation criteria for roofs in Section 501.3.5.3 (5.3.5.3) and two exceptions: Exception 2 to address the potential for condensation in existing CZ 4A and 4B buildings and Exception 4 for ballasted roofs in CZs 4A and 4B.	6/26/2019	7/15/2019 8/6/2019 7/19/2019	8/1/2019	8/26/2019

b	701.4.1.1 (7.4.1.1)	Limits the use of Section 701.4.1.1.2 (7.4.1.1.2), "Alternate Renewables Approach: Reduced On-Site Renewable Energy Systems and Higher-Efficiency Equipment" to building projects less than 25,000 ft^2 (2300 m^2). Larger buildings must therefore comply with either Section 701.4.1.1.1 (7.4.1.1.1) or 701.5 (7.5)	6/26/2019	7/15/2019 8/6/2019 7/19/2019	8/1/2019	8/26/2019
c	801.4.2 (8.4.2), 801.4.2.2 (8.4.2.2), 801.4.2.2.1 (8.4.2.2.1), 801.4.2.2.2 (8.4.2.2.2), Chapter 11 (Section 11)	Updates the existing paints and coatings requirements dictating the use of volatile organic compounds (VOC) by (a) limiting the paint categories that can use the VOC content option and (b) requiring VOC paints to comply with the California Air Resources Board Suggested Control Measure for Architectural Coatings	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
d	801.3.4 (8.3.4)	Modifies the language of Section 801.3.4 (8.3.4), "Soil Gas Entry Control," to reduce the possibility of confusion regarding where such controls are required	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
e	701.5.2 (7.5.2)	Corrects an error in the wording used to describe the method for determining CO_2e design and target values.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
f	301.2 (3.2)	Replaces the current definition of "construction documents," which references ASHRAE/IES Standard 90.1, with a definition that is consistent with the 2015 *International Green Construction Code*, which addresses building sites and land development.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
g	301.2 (3.2)	Replaces the current defined term, "design professional," from ASHRAE/IES Standard 90.1, with "registered design professional," which is consistent with the terminology used in the 2015 *International Green Construction Code* and accommodates specialty design categories such as on-site wastewater system designer, irrigation system designer, landscape architect, soil scientist, and other qualified tradespeople.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
h	601.3.3 (6.3.3)	Removes redundant language referring to service from a "local water utility" that must be "acceptable to the Agency" since the latter part of the requirement is an obvious prerequisite.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
i	301.2 (3.2), 301.3 (3.3), 601.3.2.3 (6.3.2.3)	Updates cooling tower requirements by specifying different maximum concentrations of contaminants for different cooling tower materials and simplifying the calculations for meeting the requirements. This addendum also replaces the prescriptive cooling tower requirements in Section	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	7/24/2019

		601.4.2.1 (6.4.2.1) with a set of revised mandatory requirements in Section 601.3 (6.3).				
j	301.2 (3.2), 701.3.2 (7.3.2), 701.4.1.1 (7.4.1.1), 701.4.1.2 (7.4.1.2), 701.4.1.3 (7.4.1.3), 1001.3.2.1.6 (10.3.2.1.6), 1001.3.2.1.7 (10.3.2.1.7), Chapter 11 (Section 11)	Updates the renewable energy requirements of Standard. The basic prescriptive requirement has been modified: the sum of renewable energy produced on-site or procured off-site must be greater than or equal to about half of the expected building energy use. A mandatory on-site PV system requirement has been added for qualifying portions of the building roof area (i.e., unshaded and not being used for public access or by a vegetated roofing system) and has been rewritten in terms of the system capacity, as opposed to annual production. The new requirements include the option of using other forms of on-site renewable energy if those systems produce an equivalent amount of annual energy as the specified PV system.	2/5/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	3/2/2020
k	701.5.1 (7.5.1), 701.5.2 (7.5.2), 701.5.3 (7.5.3), C101.1 (C1.1)	Adds renewable energy requirements to the performance path of Chapter 7 (Section 7) to be consistent with requirements being added to the prescriptive path. The addendum includes requirements for treatment of off-site renewable energy sources.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019
l	701.3.5 (7.3.5)	Adds fault detection and diagnostics (FDD) requirements to detect existing and future malfunctioning systems and notify building operators so that actions can be taken to reduce energy consumption.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
m	601.3.3 (6.3.3), 601.3.3.1 (6.3.3.1), 601.3.3.2 (6.3.3.2)	Adds new provisions to ensure properly sized tubing for efficient delivery of water through hot-water distribution systems and create better alignment between Standard 189.1, the 2018 DEC (Section C404.5), and the 2015 IgCC (Section 702.8).	6/26/2020	6/1/2020 6/3/2020 7/1/2020	7/1/2020	7/31/2020
n	301.2 (3.2), 501.3.7.2.2 (5.3.7.2.2), 801.4.2.1 (8.4.2.1), 801.4.2.2 (8.4.2.2), 801.4.2.4 (8.4.2.4), 801.5.2 (8.5.2), Chapter 11 (Section 11)	Clarifies language in Sections 801.4.2.1 (8.4.2.1), 801.4.2.2 (8.4.2.2), and 801.5.2 (8.5.2) relating to a building's weatherproofing system. Adds new definitions to expand the list of composite wood materials used in Section 801.4.2.4 (8.4.2.4) and identifies which materials must meet CARB or USEPA guidelines for ultra-low-emitting formaldehyde resins or no-added-formaldehyde resins. Adds new language to describe lab certification of composite wood and related products more consistently with other building products described in Section 801.4.2 (8.4.2).	10/16/2019	9/9/2019 10/24/2019 10/10/2019	11/1/2019	11/4/2019

o	401.2 (4.2), 501.3.5.2 (5.3.5.2), 501.3.6 (5.3.6), 501.3.7.2.3 (5.3.7.2.3), 501.3.7.2.5 (5.3.7.2.5), 501.3.8.1 (5.3.8.1)	Identifies a number of requirements from Chapter 5 (Section 5) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
p	401.2 (4.2), 701.4.2.1 (7.4.2.1), 701.4.2.2 (7.4.2.2), 701.4.2.3 (7.4.2.3), 701.4.2.6 (7.4.2.6), 701.4.2.9 (7.4.2.9), 701.4.3.2 (7.4.3.2), 701.4.3.4 (7.4.3.4), 701.4.3.5 (7.4.3.5), 701.4.3.7 (7.4.3.7), 701.4.3.8 (7.4.3.8), 701.4.4.2 (7.4.4.2), 701.4.6.2 (7.4.6.2), 701.4.6.3 (7.4.6.3), 701.4.7.2 (7.4.7.2), 701.4.7.4 (7.4.7.4), 701.4.7.5 (7.4.7.5)	Identifies a number of requirements from Chapter 7 (Section 7) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	2/5/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	3/31/2020
q	401.2 (4.2), 801.3.3.4 (8.3.3.4), 801.4.1.3 (8.4.1.3)	Identifies requirements from Chapter 8 (Section 8) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	2/5/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	3/31/2020
r	401.2 (4.2), 801.3.1.3(b) [8.3.1.3(b)], 801.3.1.4.2 (8.3.1.4.2)	Identifies requirements from Chapter 8 (Section 8) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/15/2019	12/12/2019
s	401.2 (4.2), 601.3.1.2.1(a)(3) [6.3.1.2.1(a)(3)], 601.3.1.2.1(a)(4) [6.3.1.2.1(a)(4)], 601.3.3 (6.3.3), 601.3.4.2 (6.3.4.2), 601.3.4.3 (6.3.4.3), 601.3.8 (6.3.8)	Identifies requirements from Chapter 5 (Section 5) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
t	401.2 (4.2), 901.3.1.2 (9.3.1.2)	Identifies a requirement from Chapter 9 (Section 9) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	6/26/2020	6/1/2020 6/3/2020 7/1/2020	7/1/2020	7/31/2020
u	801.3.6.3 (8.3.6.3)	Deletes Section 801.3.6.3 (8.3.6.3) in its entirety, because flashing and sealants are addressed by the IBC and other model building codes that would be	2/5/2020	1/7/2020 1/9/2020	2/5/2020	3/2/2020

		in place as baseline requirements prior to the adoption of a green code.		1/24/2020		
v	801.4.2.5 (8.4.2.5), 801.4.2.5.1 (8.4.2.5.1), 801.4.2.5.2 (8.4.2.5.2)	Adds the word "new" to clarify that Sections 801.4.2.5 (8.4.2.5) and 801.5.2 (8.5.2) apply to new office furniture products.	6/22/2019	5/31/2019 7/9/2019 6/10/2019	6/26/2019	6/27/2019
x	701.4.7.6 (7.4.7.6)	Adds new energy efficiency requirements for traction elevators that have a rise height of 75 ft (23 m) or greater. 701.4.7.6 (a) [7.4.7.6(a)] sets a minimum standard for elevator drive motor efficiency and 701.4.7.6(b) [7.4.7.6(b)] requires regenerative drives to be installed on the elevator	6/26/2019	7/15/2019 8/6/2019 7/19/2019	8/1/2019	8/26/2019
y	701.4.2.2 (7.4.2.2), C101.1 (C1.1)	Adds a new section to provide instructions for meeting envelope requirements for cases where wall-mounted mechanical equipment account for a significant portion of the wall area.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019
z	701.5.3 (7.5.3)	Updates the source energy conversion factors in Table 701.5.3 (7.5.3) and expands the list for eGRID subregions.	6/26/2020	6/1/2020 6/3/2020 7/1/2020	7/1/2020	7/31/2020
aa	701.5.2 (7.5.2), 901.5.1 (9.5.1)	Updates the table of CO_2e emission factors to add values for eGRID subregions, to account for both direct emissions and indirect emissions, and to make other considerations such as electrical losses. This is to be used with the Source Energy Conversion column that was added in Addendum z.	6/26/2020	6/1/2020 6/3/2020 7/1/2020	7/1/2020	7/31/2020
ab	401.2 (4.2), 801.3.9 (8.3.9)	Adds a requirement to Chapter 8 (Section 8) that a view to the outdoors or an indoor atrium must be provided from at least 50% of the floor area	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
ac	701.3.4 (7.3.4)	Limits automated demand response requirements to regions where a demand response program is available and adds exceptions for buildings less than 5000 ft^2 and those with thermal or electrical energy storage systems that meet the specified capacity.	2/1/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	2/6/2020
ad	301.2 (3.2), 701.4.2.7 (7.4.2.7), 701.4.3.9 (7.4.3.9)	Deletes existing requirements for SHGC multipliers and duct insulation, reverting to the related sections in Standard 90.1, which were updated in 2016. Subsequently deletes the definition for "north-oriented," which does not appear elsewhere in the standard.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019

ae	901.3.1 (9.3.1), 901.3.1.1 (9.3.1.1), 901.3.1.2 (9.3.1.2), 901.3.1.3 (9.3.1.3), 1001.3.1.10.1 (10.3.1.10.1), 1001.3.1.10.2 (10.3.1.10.2)	Clarifies that the total waste provision is for new construction only and increases the total waste threshold to a value that can be achieved by most buildings. Provides an exception for projects diverting a large percentage of total waste. Introduces the concept of "deconstruction" to the waste diversion provisions, which is relevant to historic preservation and voluntary green and sustainable projects.	2/1/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	2/6/2020
af	401.2 (4.2), 1001.3.1.5(b) [10.3.1.5(b)], 1001.3.1.8 (10.3.1.8), 1001.3.2.3 (10.3.2.3), 1001.3.2.4.2 (10.3.2.4.2), 1001.3.2.4.3 (10.3.2.4.3)	Identifies requirements from Chapter 10 (Section 10) as being appropriate for local jurisdictions to consider excluding from their adopted ordinances.	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
ag	301.2 (3.2), 701.4.3.6.2 (7.4.3.6.2), Chapter 11 (Section 11)	Adds a new definition, Fan Efficiency Index (FEI), for rating fan performance and establishes the minimum FEI value for compliance with Standard 189.1.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019
ah	701.4.6.2 (7.4.6.2), 701.4.7.3.1 (7.4.7.3.1)	Creates a new section for dwelling unit lighting efficacy provisions that go above existing EnergyStar-based requirements.	6/26/2020	6/1/2020 6/3/2020 7/1/2020	7/1/2020	7/31/2020
ai	701.4.4.2 (7.4.4.2)	Creates a new section to specify requirements for gas and electric high-capacity service water heating systems, which are expected to be more efficient than comparable systems under Standard 90.1.	2/1/2020	1/17/2020 2/4/2020 1/24/2020	2/5/2020	2/6/2020
aj	301.2 (3.2), 701.4.3.6.3 (7.4.3.6.3)	Adds a new section for low-power ventilation systems to align requirements for exhaust fans commonly used in multifamily and small commercial buildings with those specified in the DEC.	2/1/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	2/6/2020
ak	Appendix J	Adds an informative appendix that documents how the source energy conversion factors and the CO_2e emission factors in Table 701.5.2 (7.5.2) were developed so that these values can be adapted by other countries whose energy usage may differ.	N/A	N/A	N/A	N/A
al	701.4.2.6 (7.4.2.6), 801.3.3.2.4 (8.3.3.2.4), 801.3.3.3 (8.3.3.3), 801.3.3.5.2 (8.3.3.5.2), 1001.3.2.1.2.1 (10.3.2.1.2.1),	Changes "acceptance testing" to read "functional and performance testing" wherever this conversion (initiated by a different addendum) had previously been omitted.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019

	1001.3.2.1.3.1 (10.3.2.1.3.1)					
am	301.2 (3.2)	Modifies the definition "on-site renewable energy system" to clarify its scope and to remove confusing cross-references to other definitions.	10/16/2019	10/10/2019 11/5/2019 11/5/2019	11/1/2019	11/4/2019
an	301.2 (3.2), 701.4.6.6 (7.4.6.6)	Adds lighting control requirements for dwelling units to increase energy savings through the use of automatic shut-off controls and dimmers.	2/5/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	3/2/2020
ao	301.2 (3.2), 701.3.1 (7.3.1), 701.3.1.1 (7.3.1.1), 701.4 (7.4), 701.4.6.2 (7.4.6.2), Appendix A	Provides Chapter 7 (Section 7) clarifications as follows: revises the general statement used to introduce Section 701.3 (7.3) mandatory requirements; moves the climate zone requirements from Appendix A to a new Section 701.3.1.1 (7.3.1.1), also removing the term "climate zone" from Chapter 3 (Section 3) where it had merely contained a reference to former the appendix; includes more specific language regarding compliance with Section 701.4 (7.4); replaces the term "occupant sensor" with "occupancy sensor" for consistency with Standard 90.1.	2/1/2020	1/7/2020 1/9/2020 1/24/2020	2/5/2020	2/6/2020
ap	501.3.6 (5.3.6)	Updates the outdoor light pollution requirements in Chapter 5 and removes the reference to lighting requirements in ANSI/ASHRAE/IES Standard 90.1, which is already covered by Section 701.4.6 (7.4.6) of this code.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
ar	301.1 (3.1), 301.2 (3.2), 501.3.7.2.1 (5.3.7.2.1), 501.3.7.3 (5.3.7.3), 601.3.2.4 (6.3.2.4), 701.4.6.1.1 (7.4.6.1.1), 801.3.3.2.3.4 (8.3.3.2.3.4), 801.3.3.3.2.1 (8.3.3.3.2.1), 801.4.1.1.3 (8.4.1.1.3), 801.4.1.3 (8.4.1.3), 901.5.1.2 (9.5.1.2), 901.5.1.3 (9.5.1.3), 1001.3.1.1 (10.3.1.1), 1001.3.1.1.2.1.3 (10.3.1.1.2.1.3), 1001.3.1.2 (10.3.1.2),	Adds core definitions used to administer the International Codes (I-Codes.) A modified version of the I-code definitions for "approved," "approved Agency," and "approved source" have been included; the difference being that the "code official" in the I-Codes definition is now the Authority Having Jurisdiction (Agency) in Standard 189.1. The inclusion of "approved" as a definition enables prior instances of "approved by the Agency" to now be shortened. Also adds the terms "listed" and "labeled" and identifies these in context throughout the standard.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020

	I201.6 (I2.6), I201.7 (I2.7)					
as	701.4.6.1 (7.4.6.1)	Updates Lighting Power Densities (LPDs) that were adjusted from Standard 90.1 values to reflect changes made to the latter in 90.1-2019.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
at	301.2 (3.2), 701.4.6.2 (7.4.6.2), 701.4.6.2.1 (7.4.6.2.1), 701.4.6.2.2 (7.4.6.2.2), 701.4.6.2.3 (7.4.6.2.3), 701.4.6.3 (7.4.6.3), 701.4.6.3.1 (7.4.6.3.1), 701.4.6.3.2 (7.4.6.3.2)	Organizes the interior and exterior lighting control requirements into separate subsections of Section 701.4.6 (7.4.6) and adds subzone occupancy sensing control requirements for large offices per the 2018 DEC.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
au	301.2 (3.2), 701.4.1.1.2 (7.4.1.1.2), 701.4.3.1 (7.4.3.1), 701.4.7.1 (7.4.7.1), 701.4.7.6 (7.4.7.6)	Adds a new definition, Pump Energy Index (PEI), for rating pump efficiency and introduces a maximum PEI requirement for achieving compliance with the Section 701.4 (7.4) Alternate Renewables Approach.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
av	701.5.1 (7.5.1)	Updates Table 701.5.1 (7.5.1), "Energy Cost and CO_2e Building Performance Factors (BPF)," to reflect increases in the energy efficiency requirements throughout the standard.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
aw	901.3.3 (9.3.3)	Removes refrigerant requirements from Section 901.3.3 (9.3.3) that are widely considered to be outdated and reserves this section for future use.	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
ay	401.1 (4.1), Chapter 10 (Section 10)	Renumbers and rearranges Chapter 10 (Section 10) to simplify and clarify the requirements.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
az	301.2 (3.2), 501.3.7.3 (5.3.7.3)	Revises and clarifies the requirements for electric vehicle charging infrastructure in Chapter 5 (Section 5), introducing two new definitions "electric vehicle supply equipment (EVSE)" and "EV ready space."	7/6/2020	6/1/2020 6/3/2020	7/6/2020	7/6/2020

				7/1/2020		
ba	701.4.7.4 (7.4.7.4)	Revises the Section 701.4 (7.4) thermostat provisions to include an option to use ENERGY STAR requirements.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
bb	701.5.1 (7.5.1), 701.5.1.1 (7.5.1.1)	Clarifies that the proposed building performance cost index (PCI) is subject to compliance with Standard 90.1-2019 before factoring in cost credits for on-site renewable energy production.	7/31/2020	7/24/2020 7/23/2020 7/23/2020	8/10/2020	9/1/2020
bc	401.2 (4.2), 701.5.4 (7.5.4), Chapter 11 (Section 11)	Adds a new option for Section 701.5 (7.5) users to perform building energy modeling in accordance with ASHRAE Standard 209.		9/5/2020		
bd	Chapter 11 (Section 11)	Updates normative references in Chapter 11 (Section 11) to their most recent and/or relevant versions.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
be	301.2 (3.2), 801.3.5 (8.3.5), 801.3.5.1 (8.3.5.1), 801.3.5.2 (8.3.5.2), 801.3.5.3 (8.3.5.3), 801.3.5.4 (8.3.5.4), 801.3.5.4.1 (8.3.5.4.1), 801.3.5.4.2 (8.3.5.4.2)	Updates the lighting quality section to include new requirements for dimming controls, color rendition, and flicker; also clarifies applicability of the requirements and adds relevant normative references.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bf	801.3.1.10 (8.3.1.10)	Provides clarifications to Chapter 8 (Section 8) Preoccupancy Ventilation Control requirements.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bg	401.2 (4.2), 701.4.3.2 (7.4.3.2), 801.3.1 (8.3.1), 801.3.1.3 (8.3.1.3), 801.3.1.4 (8.3.1.4), 801.3.1.5 (8.3.1.5), 1001.9.4.5 (10.9.4.5), Chapter 11 (Section 11)	Updates Chapters 7 and 8 (Sections 7 and 8) in accordance with the 2019 publication of Standard 62.1: adds ISO filter standards; clarifies outdoor ozone air-cleaning requirements; and specifies the applicability of Standard 62.1 versus 170.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bh	501.3.6 (5.3.6), 501.3.6.1 (5.3.6.1), 501.3.6.3 (5.3.6.3)	Performs the same revisions as addendum ap; also combines Tables 501.3.6.2A (5.3.6.2A) and 501.3.6B (5.3.6B) into one Table 501.3.6.1 (5.3.6.1) to simplify how requirements are identified and removes one of the existing options for uplight compliance that had appeared in Section 501.3.6.3(b) [5.3.6.3(b)] and Table	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020

		501.3.6.3 (5.3.6.3) because it does not align with the IDA/IES Model Lighting Ordinance (MLO).				
bk	Appendix E	Updates the envelope criteria in Informative Appendix E based on changes to fenestration requirements in ANSI/ASHRAE/IES Standard 90.1-2019, which are subject to additional reductions to U-factor and SHGC for compliance with Standard 189.1.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
bl	701.5 (7.5), 701.5.1 (7.5.1), C101.5 (C1.5)	Clarifies the relationship between Standard 90.1, Appendix G, and Standard 189.1, Appendix C, and verifies that these modeling rules apply to Sections 701.5.1 (7.5.1), 701.5.2 (7.5.2), and 701.5.3 (7.5.3). The addendum also adds language to Normative Appendix C to better explain performance calculations.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
bn	801.3.1.3 (8.3.1.3)	Adds new requirements to Chapter 8 (Section 8) for preventing ozone emissions from air-cleaning devices.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bp	401.2 (4.2)	Modifies Section 401.2 (4.2) to improve language associated with the jurisdictional option framework.	7/6/2020	6/1/2020 6/3/2020 7/1/2020	7/6/2020	7/6/2020
bq	401.1 (4.1), Chapter 11 (Section 11)	Adds an alternate compliance path such that health care facilities meeting the requirements of Standard 189.3 can now be considered in compliance with Standard 189.1 and the IgCC.		9/5/2020		
bs	Chapters 3, 5–10 (Sections 3, 5–10)	Corrects italicization throughout the standard based on defined terms and the context in which they appear.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bt	701.4.3.9 (7.4.3.9), 701.4.3.9.1 (7.4.3.9.1), 701.4.3.9.2 (7.4.3.9.2), 701.4.3.9.3 (7.4.3.9.3), 701.4.3.9.4 (7.4.3.9.4), 701.4.3.9.5 (7.4.3.9.5)	Revises Section 701.4 (7.4) hotel/motel guestroom requirements, specifically the maximum occupancy sensor time delay for HVAC and lighting controls, to be aligned with Standard 90.1.	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020
bu	301.2 (3.2), 701.4.3.7 (7.4.3.7), 701.4.3.8.2 (7.4.3.8.2)	Aligns Standard 189.1 with recent changes to ASHRAE Standard 90.1, in which the terms “energy recovery effectiveness” and “sensible heat recovery effectiveness” were replaced with “enthalpy recovery ratio” and “sensible energy recovery ratio,” respectively. Section number	9/18/2020	7/24/2020 7/23/2020 7/23/2020	9/18/2020	9/18/2020

		changes introduced in 90.1-2019 are also reflected here.				
bw	701.4.3.9.3 (7.4.3.9.3)	Replaces HVAC set-point control requirements for hotel guest rooms with a simpler reference to Standard 90.1, Section 6.4.3.3.5.1.		9/5/2020		
bx	401.4.3.3 (4.3.3), Appendix G	Updates informative references in Appendix G to their most recent versions and adds new informative references relevant to Section 801.4.2.1.2 (8.4.2.1.2) and Section 901.4.1.4.4 (9.4.1.4.4), "Product Life Cycle."	N/A	N/A	N/A	N/A
by	Appendix L	Adds a new informative appendix to coordinate Standard 189.1 with select prerequisites and credits in the US Green Building Council's LEED Green Building Rating System.	N/A	N/A	N/A	N/A

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

NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE website at http://www.ashrae.org/technology.

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.

SECTION ANNEX 101
ASHRAE STANDARD 169-2013, SECTION A3: CLIMATE ZONE DEFINITIONS

SECTION A301
CLIMATE ZONE DEFINITIONS

To determine the climate zones for locations not listed in this code, use the following information to determine climate zone numbers and letters.

Determine the thermal climate zone, 0–8, from Table Annex 101.1 (1-1), using the heating and cooling degree-days for the location.

Determine the moisture zone (Marine, Dry or Humid):

a. If monthly average temperature and precipitation data are available, use the Marine, Dry, and Humid definitions below to determine the moisture zone (C, B, or A).

b. If annual average temperature information (including degree-days) and annual precipitation (i.e. annual mean) are available, use the following to determine the moisture zone:

   1. If thermal climate zone is 3 and CDD50°F≤4500 (CDD10°C £ 2500), climate zone is Marine (3C).
   2. If thermal climate zone is 4 and CDD50°F ≤ 2700 (CDD10°C £ 1500), climate zone is Marine (4C).
   3. If thermal climate zone is 5 and CDD50°F ≤ 1800 (CDD10°C £ 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 CDD50°F ≤ 4500 (CDD10°C £ 2500), climate zone is Marine (3C).

2. If thermal climate zone is 4 and CDD50°F ≤ 2700 (CDD10°C £ 1500), climate zone is Marine (4C).
3. If thermal climate zone is 5 and CDD50°F ≤ 1800 (CDD10°C £ 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:

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

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

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

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

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

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

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

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

where:

P	=	annual precipitation, in. (mm).
T	=	annual mean temperature, °F (°C).
Summer or high sun period	=	April through September in the Northern Hemisphere and October through March in the Southern Hemisphere.
Winter or cold season	=	October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

Humid (A) Definition—Locations that are not Marine (C) and not Dry (B).

TABLE ANNEX 101.1
ASHRAE STANDARD 169-2013, TABLE A-3: THERMAL CLIMATE ZONE DEFINITIONS

THERMAL ZONE	NAME	I-P UNITS	SI UNITS
0	Extremely hot	10,800 < CDD50°F	6000 < CDD10°C
1	Very hot	9000 < CDD50°F ≤ 10,800	5000 < CDD10°C ≤ 6000
2	Hot	6300 < CDD50°F ≤ 9000	3500 < CDD10°C ≤ 5000
3	Warm	CDD50°F ≤ 6300 and HDD65°F ≤ 3600	CDD10°C < 3500 and HDD18°C ≤ 2000
4	Mixed	CDD50°F ≤ 6300 and 3600 < HDD65°F ≤ 5400	CDD10°C < 3500 and 2000 < HDD18°C ≤ 3000
5	Cool	CDD50°F ≤ 6300 and 5400 < HDD65°F ≤ 7200	CDD10°C £ 3500 and 3000 < HDD18°C ≤ 4000
6	Cold	7200 < HDD65°F ≤ 9000	4000 < HDD18°C ≤ 5000
7	Very cold	9000 < HDD65°F ≤ 12600	5000 < HDD18°C ≤ 7000
8	Subarctic/arctic	12600 < HDD65°F	7000 < HDD18°C

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