Code Amendment Proposal Application

Proposal 2

Department of Consumer & Business Services
Building Codes Division
1535 Edgewater NW, Salem, Oregon
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Oregon.gov/bcd

Read the entire code amendment proposal application before completing this form. Please complete all parts before submitting your proposal and refer to the provided checklist.

APPLICANT INFORMATION

Name: Gary Heikkinen, Kevin Duell, Ian Casey		Date:
Representing (if applicable): NW Natural		Work phone:
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City: Portland	State: OR	Zip: 97204
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PROPOSAL INFORMATION

Specialty code: 2022 Oregon Commercial Reach Code

Code section(s): All

Briefly explain the subject of your proposal: This is a new proposal for the Oregon Commercial Reach Code.

INSTRUCTIONS AND CHECKLIST

Fill in all the information above and submit this page, signed and dated, with the required supplementary information for Parts I, II, and III listed in the following checklist. This application may be submitted by mail to the mailing address above, or by email to BCD.PTSPtech@oregon.gov.

Checklist:

- ■ **Part I** Code amendment language is attached in the proper format.
- ■ **Part II** Amendment proposal requirements for amending the code have been reviewed.
- ■ **Part III** Amendment proposal criteria questions have been answered and are attached.

Note: One application is required for each code section you are proposing to amend. If this proposal requires changes in other sections of the code for alignment, include those changes as part of this application.

APPLICANT SIGNATURE

Signature: Gary Heikkinen Date: 02/25/2022

Proposal for Oregon Commercial Reach Code

1. Describe the concept and purpose of this proposal. This is a proposal to use the energy provisions of the 2021 IgCC, which is based on ASHRAE Std. 189.1, as the Commercial Reach Code in Oregon.

2. What problem in the existing Oregon code or national model code is this proposal solving? How does this amendment address the issue? If you have evidence demonstrating the problem, submit that information. Oregon does not have an updated Commercial Reach Code. This is a possible solution to that problem.

a) If this proposal corrects any unforeseen or probable outcomes resulting from the application of a code section, explain how.

b) If this proposal corrects inadequate application by a code section to a method, material or design, explain how.

c) If this proposal eliminates conflicting, obsolete, or duplicative code provisions or standards between Oregon-adopted codes, statutes or regulations, explain why.

d) If this proposal is for a fire or life safety matter, or is it otherwise needed to protect the health, safety, welfare, comfort and security of occupants and the public, explain why.

e) If this proposal is necessary to address unique geographic or climatic conditions within Oregon, explain why.

f) If there are alternatives to this proposal that solve the problem, explain why this proposal is the best or a necessary solution. Oregon's OEESC for commercial buildings is based on ASHRAE Std. 90.1. ASHRAE Std. 189.1 is meant to use ASHRAE Std. 90.1 as a basis with additional requirements to increase energy efficiency.

g) If this proposal provides for the use of unique or emerging technologies, or promotes advances in construction methods, devices, materials and techniques, explain how. Using the IgCC/ASHRAE Std. 189.1 energy efficiency requirements will encourage emerging technologies and other advances.

h) If this proposal meets any energy conservation or indoor air quality requirements, explain how. This proposal will fulfill the requirement for a Commercial Reach Code in Oregon.

i) If this proposal involves the adoption of an electrical or plumbing building product, note if the appropriate advisory board approved the product. Additional electrical requirements may be necessary.

3. Has this been proposed at the national model code level. If so, explain when it was proposed, what happened, and why it was not adopted. Provide all associated national model code hearing information and background. The IgCC is written so that it could be adopted by a jurisdiction as their baseline code if desired and allowed.

Implementation and fiscal impact

1. Explain how the proposed provisions would be enforced? Are additional inspections or permits required? Expect that the requirements to enforce this proposed code would be the same or similar as the current OEESC based on ASHRAE Std. 90.1.

Describe any necessary equipment, training, tests or special certifications. Basically the same as requirements in ASHRAE Std. 90.1.

2. What is the fiscal impact of this proposal? Provide a cost benefit analysis and include the resources or methods you used to determine the fiscal impact.

a) If this proposal adds to the cost of construction, explain how the added cost contributes to the health and safety of occupants, or is necessary to conserve scarce resources. This proposed Reach Code will add cost to construction.

b) If there are any other adverse fiscal impacts or cost savings passed on to the general public, the construction industry, local and state governments, and small businesses, an interested person must describe the added or reduced cost of a proposed code amendment, and describe the adverse fiscal impact or cost savings in relation to the current Oregon specialty code. The added cost of construction will have an impact on these entities if they choose to use this Reach Code.

c) If this proposal will affect the cost of development of a detached single-family dwelling, please indicate the cost. For the purposes of illustrating the change on the cost, please use a 6,000-squarefoot parcel and the construction of a 1,200-square-foot detached single-family dwelling on that parcel. The information on the cost must be sufficient to assist the division in preparing a housing cost impact statement. This proposal will not impact the cost of development of detached single-family dwellings.

Impacted stakeholders and other specialty codes

1. It is important that proposals be shared with stakeholders that will be impacted by them. Was this proposal developed with people or organizations likely to be affected by it? Has it been reviewed or shared with people or organizations likely to be affected by it? If so, who, and if not, why not? We have reached out to the local ASHRAE chapter and local BOMA chapter, but have not received specific feedback.

2. Does this proposal impact other specialty codes or statewide programs? It could have some impact on OSSC, OMC, OPC and OEC.

2021 IGCC

CHAPTER7

ENERGY EFFICIENCY

701.1 (7.1) Scope.

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

701.2 (7.2) Compliance.

The energy systems shall comply with Section 701.3 (7.3), "Mandatory Provisions," and either:

a. Section 701.4 (7.4), "Prescriptive Option," or

b. Section 701.5 (7.5), "Performance Option."

701.3 (7.3) Mandatory provisions.

701.3.1 (7.3.1) General.

Building projects shall be designed to comply with Sections 5.2.1, 6.2.1, 7.2.1, 8.2.1, 9.2.1, and 10.2.1 of ANSI/ASHRAE/IES Standard 90.1.

701.3.1.1 (7.3.1.1) Climate zones.

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, "US States by State and County," to determine the assigned climate zone and, where required, the assigned climate zone letter. (***Informative Note:*** Reference 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 Reference 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, "US States by State and County.")

701.3.1.2 (7.3.1.2) Continuous air barrier.

The exceptions to the requirement for a *continuous air barrier* in ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1, for specific climate zones and constructions shall not apply. The testing criteria of Section 1001.6(a) [10.6(a)] shall supersede ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1.1.

701.3.2 (7.3.2) On-site renewable energy systems.

Building projects shall contain on-site photovoltaic systems with a rated capacity of not less than 2 W/ft^2(22 W/m^2) multiplied by the horizontal projection of the *gross roof area* over *conditioned spaces* and *semiheated spaces*. Documentation shall be provided to the *AHJ* that indicates an exclusive chain of custody and ownership of the *RECs* from the *on-site renewable energy system* to the building *owner*. *RECs* supplied from the *on-site renewable energy system* shall be conveyed to and

retired on behalf of the entity who has financial or operational control over the building's electricity consumption. *RECs* shall be tracked per Section 1001.9.8 (10.9.8). Where the building *owner* cannot provide documentation on the chain of custody or ownership of the *RECs* from the *on-site renewable energy system*, the building *owner* may provide documentation to the *AHJ* of an alternate supply contract for an equal or greater quantity of replacement *RECs* from an alternate renewable energy source.

The building *gross roof area* used for calculation in Section 701.3.2 (7.3.2) excludes the following:

a. Shaded areas that are defined as *roof* area where direct-beam sunlight is blocked by structures or natural objects for more than 1500 annual hours between 8 a.m. and 4 p.m.

b. Areas of vegetated terrace and roofing systems compliant with Section 501.3.5.5 (5.3.5.5).

c. Areas designated for public occupancy. Parking areas shall not qualify for this exclusion.

d. Areas designated for helipads.

Exceptions:

1.*Building projects* that have an annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 1.2 kBtu/ft^2• day (4.0 kWh/m^2• day).

2.Renewable energy systems, other than photovoltaic systems, that result in an equal or greater annual energy production.

3.Capacity shall be permitted to be reduced to that required to provide at least 50% of the simulated annual *site* energy consumption of the proposed *building project* in accordance with Normative Appendix C.

TABLE 701.3.3.1A (TABLE 7.3.3.1A)

ENERGY SOURCE THRESHOLDS

ENERGY SOURCE	**THRESHOLD**
Electrical service	> 200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	> 1,000,000 Btu/h (300 kW)
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 (TABLE 7.3.3.1B)

SYSTEM ENERGY USE THRESHOLDS

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

701.3.3 (7.3.3) Energy consumption management.

701.3.3.1 (7.3.3.1) Consumption management.

Measurement devices with remote communication capability shall be provided to collect energy consumption data for each energy supply source to the building (including gas, electricity, and district energy) that exceeds the thresholds listed in Table 701.3.3.1A (7.3.3.1A). The measurement devices shall have the capability to automatically communicate the energy consumption data to a data acquisition system.

For all buildings that exceed the threshold in Table 701.3.3.1A (7.3.3.1A), subsystem measurement devices with remote capability (including current sensors or flowmeters) shall be provided to measure energy consumption data of each subsystem for each use category that exceeds the thresholds listed in Table 701.3.3.1B (7.3.3.1B).

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

701.3.3.2 (7.3.3.2) Energy consumption data collection and display.

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

701.3.3.3 (7.3.3.3) Data storage and retrieval.

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

Exception: Portions of buildings used as *residential.*

701.3.4 (7.3.4) Automated demand response.

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

Exceptions:

1.Buildings with a *gross conditioned floor area* less than 5000 ft^2(500 m^2).

2.Buildings that employ a thermal or electrical energy storage system with a total storage capacity that complies with one of the following:

a. For thermal energy storage, the system shall be capable of displacing the HVAC design cooling coil capacity for not less than the equivalent of three hours.

b. For electrical energy storage, the capacity shall be not less than the requirements of the following formula:

Minimum kWh capacity=Gross conditioned floor area(ft2)×5.0 W/ft2×1.0 h×(1 kW/1000 W)

$$\text{Minimum kWh capacity} = \textit{Gross conditioned floor area}\ (\text{ft}^2) \times 5.0\ \text{W/ft}^2 \times 1.0\ \text{h} \times (1\ \text{kW}/1000\ \text{W})$$

(I-P)

Minimum kWh capacity=Gross conditioned floor area(m2)×50 W/m2×1.0 h×(1 kW/1000 W)

$$\text{Minimum kWh capacity} = \textit{Gross conditioned floor area}\ (\text{m}^2) \times 50\ \text{W/m}^2 \times 1.0\ \text{h} \times (1\ \text{kW}/1000\ \text{W})$$

(SI)

701.3.4.1 (7.3.4.1) HVAC systems zone set points.

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

a. The controls shall be programmed to automatically adjust upward the zone operating cooling set points by a minimum of 3°F (1.7°C).

b. The controls shall programmed to automatically adjust downward the zone operating heating set points by a minimum of 3°F (1.7°C).

c. The controls shall be programmed to automatically adjust downward the zone operating cooling set points by a minimum of 2°F (1.1°C).

d. The automated DR strategy shall include both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DR implementation.

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

701.3.4.2 (7.3.4.2) Variable-speed equipment.

For HVAC equipment with variable-speed control, the controls shall be programmed to allow *automatic* adjustment of the maximum speed of the equipment to 90% of design speed during automated DR events. Airflow adjustments shall not decrease the supply airflow rate below the level that would result in outdoor airflow being below the *minimum outdoor airflow rates* specified in Section 801.3.1.1 (8.3.1.1), or that would cause adverse building pressurization problems.

701.3.4.3 (7.3.4.3) Lighting.

For *building projects* with interior lighting control systems controlled at a central point, such systems shall be programmed to allow automated DR. The programming shall reduce the total connected lighting power demand during a DR event by not less than 15% but no more than 50% of the baseline power level. The baseline lighting power shall be determined in accordance with Section 701.4.6.1.1 (7.4.6.1.1). For *building projects* without central lighting controls, DR capabilities for lighting systems shall not be required.

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

Exceptions:

1.Luminaires or signage on emergency circuits.

2.Luminaires located within a *daylight area* that are dimmable and connected to automated daylighting control systems.

3.Lighting systems, including dimming systems, claiming a *lighting power allowance* for *institutional tuning* in accordance with to Section 701.4.6.1.1(f) [7.4.6.1.1(f)].

701.3.5 (7.3.5) Fault detection and diagnostics (FDD).

A fault detection and diagnostics (FDD) system shall be installed in new buildings to monitor the performance of the building's HVAC system and detect faults in the system. The FDD system shall:

a. Include *permanently installed* devices to monitor HVAC system operation;

b. Sample the HVAC system performance not less than once per hour;

c. Automatically identify, display, and report system faults;

d. Automatically notify service personnel of identified fault conditions;

e. Automatically provide prioritized recommendations for fault repair based on analysis of collected data; and

f. Be capable of tracking and recording a history of identified faults, from identification through repair completion.

Exceptions:

1.Buildings with gross floor area less than 25,000 ft^2(2500 m^2).

2.Individual tenant *spaces* with gross floor area less than 10,000 ft^2(1000 m^2).

3.*Dwelling units* and hotel/motel guest rooms.

4.*Residential* buildings with less than 10,000 ft^2(1000 m^2) of common area.

5.Emergency smoke control systems.

701.4 (7.4) Prescriptive option.

Where a requirement is provided in this section, it supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ANSI/ASHRAE/IES Standard 90.1, Sections 5 through 10.

701.4.1 (7.4.1) On-site renewable energy systems.

Building projects shall comply with either the Standard Renewables Approach or the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1).

701.4.1.1 (7.4.1.1) Renewable energy systems.

The adjusted renewable energy provided to the project shall be equal to or greater than the gross conditioned and semiheated floor areas of the *building project* multiplied by the renewable energy requirement from Table 701.4.1.1 (7.4.1.1). For allocations to multiple tenants within a *building project*, the requirements shall be assigned to each tenant based on the total of *gross conditioned* and *semiheated floor area* of each tenant space.

Building projects complying with the Alternate Renewables Approach shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the water-heating efficiency requirements in Section 701.4.4.1 (7.4.4.1), equipment efficiency requirements in Section 701.4.7.1 (7.4.7.1), and the applicable ENERGY STAR requirements in Section 701.4.7.3.2 (7.4.7.3.2). For equipment listed in Section 701.4.7.3.2 (7.4.7.3.2) that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both requirements. The Alternate Renewables Approach shall apply only to *building projects* where the sum of the *gross conditioned* and *semiheated floor areas* of the *building project* are less than 25,000 ft^2(2300 m^2).

Documentation shall be provided to the *AHJ* that substantiates procurement of renewable energy systems, of *renewable energy contracts*, or of a quantity of *RECs* required to meet the Exception to Section 701.4.1.1 (7.4.1.1). *RECs* shall be tracked in accordance with Section 1001.9.8 (10.9.8).

Qualifying renewable energy systems are as follows:

a. *On-site renewable energy system*.

b. Off-site renewable energy system.

1.Self-generation (an off-site renewable energy system owned by the *building project owner*); the system shall comply with Section 701.4.1.3 (7.4.1.3).

2.*Community renewable energy facility*; the system shall comply with Section 701.4.1.3 (7.4.1.3).

3.Purchase contract; the system shall comply with Section 701.4.1.3 (7.4.1.3).

Exception: *Building projects* that demonstrate to the *AHJ* that they cannot comply with Section 7.4.1.1 shall contract for renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity products of not less than 1.2 MWh/ft^2(12.6 MWh/m^2) of *gross floor area* of *conditioned spaces* and *semiheated spaces*, or an amount equal to 100% of the modeled annual energy use multiplied by 20 years, whichever is less. A combination of renewable electricity products and renewable energy systems shall be permitted to demonstrate compliance. *RECs* shall be tracked per Section 1001.9.8 (10.9.8).

TABLE 701.4.1.1 (TABLE 7.4.1.1)

RENEWABLE ENERGY REQUIREMENT

BUILDING TYPE	STANDARD RENEWABLES APPROACH		ALTERNATE RENEWABLES APPROACH	
	kBtu/ft^2 • y	kWh/m^2 • y	kBtu/ft^2 • y	kWh/m^2 • y
Office	14	44	13	40
Retail	24	74	21	67
School	19	61	17	55
Health care	40	126	36	113
Restaurant	40	126	36	113
Hotel	34	108	31	98
Apartment	22	68	20	62
Warehouse	8	26	7	23
All others	25	80	23	72

701.4.1.2 (7.4.1.2) Adjustable renewable energy.

Each source of renewable energy delivered to or credited to the *building project* shall be multiplied by the factors in Table 701.4.1.2 (7.4.1.2) when determining compliance with Section 701.4.1.1 (7.4.1.1).

TABLE 701.4.1.2 (TABLE 7.4.1.2)

MULTIPLIERS FOR RENEWABLE ENERGY PROCUREMENT METHODS

LOCATION	RENEWABLE ENERGY SOURCE	RENEWABLE ENERGY FACTOR
On-site	On-site renewable energy system	1.00
Off-site	Directly owned off-site renewable energy system	0.75
	Community renewable energy facility	0.75
	Virtual PPA	0.75

701.4.1.3 (7.4.1.3) Off-site renewable energy requirements.

Off-site renewable energy delivered or credited to the *building project* to comply with Section 701.4.1.1 (7.4.1.1) shall be subject to a legally binding contract to procure qualifying off-site renewable energy. Qualifying off-site renewable energy shall meet the following requirements:

a. Documentation of off-site renewable energy procurement shall be submitted to the *AHJ.*

b. The purchase contract shall have a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

c. *RECs* associated with the purchase contract from an off-site renewable energy system shall be assigned exclusively to the building *owner* for a period of not less than 15 years and tracked in accordance with Section 1001.9.8 (10.9.8).

d. The energy source shall produce electricity from solar, wind, or *geothermal energy*.

Exceptions:

1.Captured methane from feed lots and landfills are permitted to be used to generate electricity for the purposes of this section.

2.Hydropower from new generation capacity on a nonimpoundment or new generation capacity on an existing impoundment that meets one of the following conditions:

a. The hydropower facility complies with the *Low Impact Hydropower Certification Handbook* and is certified by a nationally recognized accreditation organization.

b. The hydropower facility complies with UL 2854 and is certified by an organization that has the standard in its ISO 17065 scope of accreditation.

c. The hydropower facility consists of a turbine in a pipeline or a turbine in an irrigation canal.

For facilities falling under Exception 2(a) or 2(b), only output generated during the period of certification is eligible for *RECs* sale in accordance with the provisions of this section. Renewables from new impoundments of water are not eligible.

1. e. The generation source shall be located where the energy can be delivered to the building *site* by any of the following:

   1.Direct connection to the off-site renewable energy facility.

   2.The local utility or distribution entity.

   3.An interconnected electrical network where energy delivery capacity between the generator and the building *site* is available. (***Informative Note:*** Examples of interconnected electrical networks include regional power pools and regions served by Independent System Operators or Regional Transmission Organizations.)

2. f. Records on renewable power purchased by the building *owner* from the off-site renewable energy generator that specifically assign the *RECs* to the building *owner* shall be retained or retired by the building *owner* on behalf of the entity demonstrating financial or operational control over the building seeking compliance to this code and made available for inspection by the *AHJ* upon request. [***Informative Note:*** Refer to Sections 1001.9.8 (10.9.8) and 1001.9.9 (10.9.9) for tracking and allocation requirements.]

3. g. Where multiple buildings in a *building project* are allocated energy procured by a contract subject to this section, the *owner* shall allocate for not less than 15 years the energy procured by the contract to the buildings in the *building project*. [***Informative Note*** : Refer to Section 1001.9.9 (10.9.9) for allocation requirements.]

701.4.2 (7.4.2) Building envelope.

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

701.4.2.1 (7.4.2.1) [JO] Building envelope requirements.

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

Exceptions:

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

2.The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8.

3.*Spaces* that meet the requirements of Section 801.4.1 (8.4.1), regardless of *space* area, are exempt from the *SHGC* criteria for *skylights*.

Informative Notes:

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

2.Section 501.3.5.3 (5.3.5.3) of this code includes additional provisions related to *roofs*.

701.4.2.2 (7.4.2.2) Mechanical equipment penetration requirements.

Where the total area of penetrations from mechanical equipment listed in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-4, exceeds 2% of the opaque above-grade *wall* area, the mechanical equipment penetration area shall be calculated as a separate assembly with a published U-factor value for that equipment or a default U-factor of 0.5 Btu/h • ft^2• °F (3 W/m^2• K) in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3(b). Where Exception 2 to ANSI/ASHRAE/IES Standard 90.1 Section 5.5.3 is used for compliance, the penetration shall be considered to be the same class of construction as an adjacent *wall*.

701.4.2.3 (7.4.2.3) [JO] 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 ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4. ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4 and Table A2.4.2, shall not apply.

701.4.2.4 (7.4.2.4) [JO] 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. ANSI/ASHRAE/IES Standard 90.1, Sections 5.5.3.6 and 5.5.4.3, shall not apply for *high-speed doors* complying with all criteria in this section.

701.4.2.5 (7.4.2.5) Air curtains.

Where air curtains are provided at *building entrances* or *building entrance* vestibules, for the distance from the air-curtain discharge nozzle to the floor, the air-curtain unit shall produce a minimum velocity of 6.6 ft/s (2.0 m/s) in accordance with ANSI/AMCA 220 and be installed in accordance with

manufacturer's instructions. *Automatic* controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section 1001.3.2.1 (10.3.2.1).

701.4.2.6 (7.4.2.6) Vertical fenestration area.

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

701.4.2.7 (7.4.2.7) [JO] Permanent projections.

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

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

1. Where *vertical fenestration* is located within 18 in. (450 mm) of the lot line.

2. Where equivalent shading of the *vertical fenestration* is provided by buildings, structures, geological formations, or permanent exterior projections that are not horizontal, as determined by sun-angle studies at the peak solar altitude on the summer solstice and three hours before and after the peak solar altitude on the summer solstice.

3. *Vertical fenestration* with automatically controlled shading devices capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:

    a. Exterior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position.

    b. Interior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position and have a minimum solar reflectance of 0.50 for the surface facing the *fenestration.*

    c. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than four hours.

    d. *Functional and performance testing (FPT)* and commissioning shall be conducted as required by Chapter 10 to verify that *automatic* controls for shading devices respond to changes in illumination or radiation intensity.

4.*Vertical fenestration* with automatically controlled *dynamic glazing* capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:

a. *Dynamic glazing* shall have a lower labeled *SHGC* equal to or less than 0.12, lowest labeled visible transmittance (VT) no greater than 0.05, and highest labeled VT no less than 0.40.

b. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than 4 hours.

c. *FPT* and commissioning shall be conducted as required by Chapter 10 to verify that *automatic* controls for *dynamic glazing* respond to changes in illumination or radiation intensity

5.Existing buildings undergoing alteration, repair, relocation, or a change of occupancy.

701.4.2.8 (7.4.2.8) SHGC of north-facing vertical fenestration.

In Climate Zone 5, *vertical fenestration* that is oriented within 22.5 degrees of true north in the Northern Hemisphere, or is oriented within 22.5 degrees of true south in the Southern Hemisphere, shall be allowed to have a maximum *SHGC of* 0.10 greater than that specified in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8. When this provision is used, separate calculations shall be performed for these sections of the *building envelope,* and these values shall not be averaged with any others for compliance purposes.

701.4.2.9 (7.4.2.9) Building envelope trade-off option.

The *building envelope* trade-off option in ANSI/ASHRAE/IES Standard 90.1, Section 5 6, shall not apply unless the procedure incorporates the modifications and additions to ANSI/ASHRAE/IES Standard 90.1 noted in Section 701.4.2 (7.4.2).

701.4.2.10 (7.4.2.10) Orientation.

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

a.$A_W \le (A_N + A_S)/4$ and $A_E \le (A_N + A_S)/4$

b.$A_W \times SHGC_W \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$ and $A_E \times SHGC_E \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$

where:

SHGC$_x$ **=** The *SHGC* for orientation *x* that complies with Section 701.4.2.8 (7.4.2.1).

A **=** *Fenestration area* for orientation *x.*

N **=** North (oriented less than 45 degrees

S **=** South (oriented less than 45 degrees of true south).

E **=** East (oriented less than or equal to 45 degrees of true east).

W **=** West (oriented less than or equal to 45 degrees of true west).

Exceptions:

1.*Vertical fenestration* that complies with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception 3.

2.Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).

3.Alterations and additions with no increase in *vertical fenestration area.*

4.Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section 701.4.2.1 (7.4.2.1).

701.4.3 (7.4.3) Heating, ventilating, and air conditioning.

The heating, ventilating, and air conditioning shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 6, with the following modifications and additions.

701.4.3.1 (7.4.3.1) Minimum equipment efficiencies for the alternate renewables approach.

All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701 4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 701.4.7.3.2 (7.4.7.3.2). Where equipment efficiency is not defined/listed in Normative Appendix B or in Section 701.4.7.3.2 (7.4.7.3.2) or 701 4.7.6 (7.4.7.6), 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 6.8.1-10, “Floor-Mounted Air Conditioners and Condensing Units Serving Computer Rooms—Minimum Efficiency Requirements.”

c. Table 6.8.1-11, “Commercial Refrigerators, Commercial Freezers, and Refrigeration—Minimum Efficiency Requirements.”

d. Table 6.8.1-12, “Vapor-Compression-Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements.”

e. Table 6.8.1-13, “Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements.”

f. Table 6.8.1-14, “Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements.”

g. 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).

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

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

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

k. Table 10.8-5, “Minimum Nominal Full-Load Efficiency for Fire Pump Electric Motors.”

701.4.3.1.1 (7.4.3.1.1) Water-cooled centrifugal chiller packages efficiency adjustment.

a. **For water-cooled centrifugal units rated per AHRI Standard 550/590 (I-P).** Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44.00°F leaving and 54.00°F entering chilled-fluid temperatures, and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures, shall have maximum full-load (FL) kW/ton and part-load rating requirements adjusted using the following equations:

FLadj=FL/KadjPLVadj=IPLV/KadjKadj=A×B

$$\mathrm{FL}_{adj} = \mathrm{FL}/K_{adj}$$
$$\mathrm{PLV}_{adj} = \mathrm{IPLV}/K_{adj}$$
$$K_{adj} = A \times B$$

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_{adf} = Maximum *NPLV* rating, adjusted for nonstandard conditions

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

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

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 equations:

FLadj=FL×KadjPLVadj=IPLV×KadjKadj=A×B

$$\mathrm{FL}_{adj} = \mathrm{FL} \times K_{adj}$$
$$\mathrm{PLV}_{adj} = \mathrm{IPLV} \times K_{adj}$$
$$K_{adj} = A \times B$$

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 × $(LIFT)^4$-0.000202076 × $(LIFT)^3$+ 0.0101800 × $(LIFT)^2$- 0.264958 × LIFT + 3.93073.

B = 0.0027 × 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.

701.4.3.2 (7.4.3.2) [JO] Ventilation controls for densely occupied spaces.

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

a. An air-side economizer.

b. *Automatic* modulating control of the *outdoor air* dampers.

c. A design outdoor airflow greater than 1000 cfm (500 L/s).

Exceptions:

1.Systems with exhaust air energy recovery complying with Section 701.4.3.7 (7.4.3.7).

2.Systems with a design outdoor airflow less than 750 cfm (375 L/s).

3.*Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces.*

4.*Spaces* with one of the following occupancy categories as listed in ANSI/ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

The *DCV* system shall be designed to comply with ASHRAE Standard 62.1, Section 6.2.6.1. 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.

701.4.3.3 (7.4.3.3) Duct leakage tests.

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

701.4.3.4 (7.4.3.4) [JO] Economizers.

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

a. The minimum size requirements for economizers for comfort cooling and for computer rooms are defined in Table 701.4.3.4 (7.4.3.4) and supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.5.1-1 and 6.5.1-2.

b. Rooftop units with a capacity of less than 54,000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h (16 kW) shall comply with the staging requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.

c. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume* [*VAV*] systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

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

a. Where the alternate renewables approach defined in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) is used, ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, Exception 10, shall be permitted to eliminate the economizer requirement, provided the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-2, are applied to the efficiency requirements required by Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1). If the standard renewable approach is chosen, as defined in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1), then the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-2, shall be applied to the efficiency requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.8.1-1 through 6.8.1-11.

b. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat-pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

TABLE 701.4.3.4 (TABLE 7.4.3.4)

MINIMUM SYSTEM SIZE FOR WHICH AN ECONOMIZER IS REQUIRED

CLIMATE ZONES	**COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED[a]**
4C, 5B,	≥ 33,000 Btu/h (9.7 kW)[a]

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

701.4.3.5 (7.4.3.5) [JO] Zone controls.

The exceptions to ANSI/ASHRAE/IES Standard 90.1, Section 6.5.2.1, shall be modified as follows:

a. Exception 1 shall not be used.

b. Exception 2(a)(2) shall be replaced by the following text: “the design outdoor airflow rate for the zone.”

701.4.3.6 (7.4.3.6) Fan system power and efficiency.

701.4.3.6.1 (7.4.3.6.1) Fan system power limitation.

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

701.4.3.6.2 (7.4.3.6.2) Fan efficiency.

The fan efficiency requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall be used, except that the *fan energy index (FEI*) at the design point of operation shall be 1.10 or greater. All exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall apply.

701.4.3.6.3 (7.4.3.6.3) Low-power ventilation systems.

Ventilation systems shall meet the fan efficacy requirements of Table 701.4.3.6.3 (7.4.3.6.3).

Exceptions:

1. Fans in fan coils and terminal units that operate only when providing heating to the *space* served.
2. Fans in *space* conditioning equipment certified under ASHRAE/IES Standard 90.1, Section 6.4.1.
3. Intermittently operating dryer exhaust duct power ventilators, domestic range hoods, or domestic range booster fans.
4. Ventilation systems with fan motor nameplate power ≥ $^{1}/_{12}$ hp (62.1 W).
5. Ventilation fans with fan nameplate electrical input power ≥ 180 W.

701.4.3.7 (7.4.3.7) [JO] Exhaust air energy recovery.

The exhaust air energy recovery requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1.2, including the requirements in Tables 6.5.6.1.2-1 and 6.5.6.1.2-2, shall be used except that the *enthalpy recovery ratio* shall not be less than 60%, superseding the 50% effectiveness requirement in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1.

701.4.3.8 (7.4.3.8) [JO] Kitchen exhaust systems.

The requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.7.2 shall apply, except as follows: Sections 701.4.3.8.1 (7.4.3.8.1) and 701.4.3.8.2 (7.4.3.8.2) supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Sections 6.5.7.2.2 and 6.5.7.2.3.

701.4.3.8.1 (7.4.3.8.1)

For kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm (950 L/s), the maximum exhaust flow rate for each hood shall be determined in accordance with Table 701.4.3.8.1 (7.4.3.8.1). For single hoods, or hood sections installed over appliances with different duty ratings, the maximum allowable exhaust flow rate for the hood or hood section shall be determined in accordance

with Table 701.4.3.8.1 (7.4.3.8.1) for the highest appliance duty rating under the hood or hood section. Refer to ANSI/ASHRAE Standard 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

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

TABLE 701.4.3.6.3 (TABLE 7.4.3.6.3)

MINIMUM VENTILATION FAN EFFICACY REQUIREMENTS

FAN TYPE	MINIMUM EFFICACY NAMEPLATE RATING	TEST METHOD AND RATING CONDITIONS
Fan system with exhaust air energy recovery	1.2 cfm/W (0.6 L/s/W)	CAN/CSA 439-18 • •Efficacy for a fan system providing exhaust air energy recovery is that associated with the average of the system's supply and exhaust flow rate
Bathroom, utility room ≥ 90 cfm (40 L/s)	6.0 cfm/W (2.8 L/s/W)	ENERGY STAR Specification for Residential Ventilating Fans • •Eligibility Criteria Version 4.1

TABLE 701.4.3.8.1 (TABLE 7.4.3.8.1)

MAXIMUM NET EXHAUST FLOW RATE PER LENGTH OF HOOD

TYPE OF HOOD	LIGHT-DUTY EQUIPMENT		MEDIUM-DUTY EQUIPMENT		HEAVY-DUTY EQUIPMENT		EXTRA-HEAVY-DUTY EQUIPMENT	
	cfm per linear foot	L/s per linear meter	cfm per linear foot	L/s per linear meter	cfm per linear foot	L/s per linear meter	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	NA[b]	NA[b]	NA[b]	NA[b]
Backshelf/Passover	210	325	210	325	280	433	NA[b]	NA[b]

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).

b.NA = Not Allowed.

701.4.3.8.2 (7.4.3.8.2)

Kitchen/dining facilities with 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 ASHRAE Standard 62.1, Sections 6.2 and 6.5, 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 energy recovery ratio* of not less than 40% shall be applied on at least 50% of the total exhaust airflow. A 40% *sensible energy recovery ratio* shall mean a change in the dry-bulb temperature of the *outdoor air* supply equal to 40% of the difference between the *outdoor air* and entering exhaust air dry-bulb temperatures at *design conditions*.

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

701.4.3.9 (7.4.3.9) Automatic control of HVAC and lights in hotel/motel guest rooms.

Where hotels and motels have 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. Captive keycard systems shall not be used to comply with this section.

701.4.3.9.1 (7.4.3.9.1) Lighting and switched outlet control.

Within 20 minutes of all occupants leaving the guest room, power for lighting and switched outlets shall be automatically turned off.

701.4.3.9.2 (7.4.3.9.2) Television control.

Within 20 minutes of all occupants leaving the guest room, televisions shall be automatically turned off or placed in sleep or standby mode.

701.4.3.9.3 (7.4.3.9.3) HVAC set-point control.

HVAC system controls shall be in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3.3.5.1.

701.4.3.9.4 (7.4.3.9.4) Ventilation control.

Within 20 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall be automatically turned off, or *isolation devices* serving each guest room shall automatically shut off the supply of *outdoor air* to the room and shut off exhaust air from the guest room. In conjunction with the *automatic* ventilation shutoff, an *automatic* preoccupancy purge cycle shall provide *outdoor air* ventilation as specified in Section 801.3.1.9 (8.3.1.9).

701.4.4 (7.4.4) Service water heating.

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

701.4.4.1 (7.4.4.1) Equipment efficiency for the alternate renewables approach.

All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.8 (B-8), and with the applicable ENERGY STAR requirements in Section 701.4.7.3.2 (7.4.7.3.2). These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 7.8.

701.4.4.2 (7.4.4.2) Buildings with high-capacity service water heating systems.

This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 7.5.3. New buildings with *service water heating* systems with a total installed water heating input capacity of 1,000,000 Btu/h (300 kW) or greater shall meet the following:

a. Fuel-burning water heating equipment shall have a minimum rated efficiency of 0.92 E_t or 0.92 UEF.

b. Electric water heating equipment shall have a minimum rated efficiency of 2.4 UEF or 2.0 COP.

Multiple units of water heating equipment of the same type, fuel-burning or electric, shall be allowed to meet this requirement based on an input-capacity-weighted average of rated efficiency.

Exceptions:

1.Buildings provided with any combination of *on-site renewable energy systems* or waste heat recovery systems capable of providing not less than 25% of the total water heating load, not including *on- site renewable energy system* capacity used for compliance with any other section of this code.

2.Water heaters installed in individual *dwelling units*.

701.4.4.3 (7.4.4.3) [JO] Insulation for spa pools.

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

701.4.5 (7.4.5) Power.

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

701.4.6 (7.4.6) Lighting.

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

701.4.6.1 (7.4.6.1) Lighting power allowance.

701.4.6.1.1 (7.4.6.1.1) Interior lighting power densities (LPDs).

The interior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, either Section 9.5 or 9.6, with the following modifications:

a. For those areas where the Building Area Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.5.1, shall be replaced with the corresponding LPD in Table 701.4.6.1A (7.4.6.1A).

b. For those areas where the Space-by-Space Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.1, shall be replaced with the corresponding LPD in Table 701.4.6.1B (7.4.6.1B).

c. Room geometry adjustment when using the Space-by-Space Method: ANSI/ASHRAE/IES Standard 90.1, Section 9.6.4, shall be replaced with the following. For corridor/transition *spaces* less than 8 ft (2.4 m) wide, or individual *spaces* where room cavity ratio (RCR) calculated for the empty room is documented to be greater than the RCR threshold for that *space* type shown in Table 7.4.6.1B, the allowed LPD shall be 1.2 times the LPD in Table 701.4.6.1B (7.4.6.1B). RCR shall be calculated as described in ANSI/ASHRAE/IES Standard 90.1, Section 9.6.4.

d. Additional lighting power when using the Space-by-Space Method: For those areas where the Space-by-Space Method is used, the additional increase in the interior lighting power allowed by ANSI/ASHRAE/IES Standard 90.1, Section 9.6.2, for specific lighting functions shall be replaced by the requirements and allowances of this section. Additional power shall be allowed only if the specified

lighting is installed and automatically controlled separately from the *general lighting* and is designed and installed to be turned off during nonbusiness hours. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior *lighting power allowance* is permitted in the following cases:

1.For *spaces* in which lighting is specified to be installed in addition to the *general lighting* for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 0.5W/ft^2(5.4 W/m^2) of such *spaces*.

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

Additional interior lighting power allowance=750 W+[Retail Area 1×0.40 W/ft2(4.3 W/m2)]+[Retail Area 2×0.40 W/ft2(4.3 W/m2)]+[Retail Area 3×1.00 W/ft2(10.8 W/m2)]+[Retail Area 4×1.50 W/ft2(16.1 W/m2)]

Additional interior *lighting power allowance* =
750 W + [Retail Area 1 × 0.40 W/ft^2 (4.3 W/m^2)]
+ [Retail Area 2 × 0.40 W/ft^2 (4.3 W/m^2)]
+ [Retail Area 3 × 1.00 W/ft^2 (10.8 W/m^2)]
+ [Retail Area 4 × 1.50 W/ft^2 (16.1 W/m^2)]

where:

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

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

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

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

Exception: Other merchandise categories included in Retail Areas 2 through 4 where the documented need for additional lighting power based on visual inspection, contrast, or other critical display has been *approved*.

e. Any of the control factors from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.3, shall be permitted to be applied, provided that the corresponding control method is not required by ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1.

f. An additional *lighting power allowance* shall be credited for *institutional tuning* of dimmable lighting systems that meet all of the following requirements:

1.*Institutional tuning* controls shall be accessible only to authorized personnel.

2.*Construction documents* shall state that maximum light output or power of controlled lighting shall be reduced by at least 15% from full output.

3.The maximum light output or power of the controlled lighting shall be measured without *institutional tuning* and with *institutional tuning* to verify reduction of light output or power by at least 15% when tuned. In daylighted areas these measurements shall be conducted at night.

TABLE 701.4.6.1A (TABLE 7.4.6.1A)

LIGHTING POWER DENSITIES USING THE BUILDING AREA METHOD

BUILDING AREA TYPE[a]	**LPD, W/ft^2**	**LPD, W/m^2**
Automotive facility	0.64	6.9
Convention center	0.51	5.5
Courthouse	0.74	8.0
Dining: Bar lounge/leisure	0.69	7.4
Dining: Cafeteria/fast food	0.66	7.1
Dining: Family	0.61	6.6
Dormitory	0.52	5.6
Exercise center	0.61	6.6
Fire station	0.50	5.4
Gymnasium	0.67	7.2
Health care clinic	0.68	7.3
Hospital	0.86	9.3
Hotel/Motel	0.70	7.5
Library	0.72	7.8
Manufacturing facility	0.60	6.5
Motion picture theater	0.62	6.7
Multifamily	0.49	5.3
Museum	0.68	7.3

Office	0.69	7.4
Parking garage	0.12	1.3
Penitentiary	0.67	7.2
Performing arts theater	0.85	9.1
Police station	0.68	7.3
Post office	0.62	6.7
Religious facility	0.70	7.5
Retail	0.91	9.8
School/university	0.67	7.2
Sports arena	0.76	8.2
Town hall	0.72	7.8
Transportation	0.51	5.5
Warehouse	0.41	4.4
Workshop	0.83	8.9

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

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

TABLE 701.4.6.1B (TABLE 7.4.6.1B)

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

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

COMMON SPACE TYPES[a]	LPD, W/ft^2	LPD, W/m^2	RCR THRESHOLD
Atrium			
< 20 ft (6.1 m) in height	0.39	4.2	NA
≥ 20 ft (6.1m) and ≤ 40 ft (12.2 m) in height	0.48	5.2	NA
> 40 ft (12.2 m) in height	0.60	6.5	NA
Audience Seating Area			
Auditorium	0.44	4.7	6
Convention center	0.23	2.5	4
Gymnasium	0.23	2.5	6
Motion picture theater	0.30	3.2	4
Penitentiary	0.44	4.7	4
Performing arts theater	0.75	8.1	8
Religious building	0.65	7.0	4
Sports arena	0.30	3.2	4
All other audience seating areas	0.23	2.5	4
Banking Activity Area	0.55	6.0	6
Breakroom (See Lounge/Breakroom)			
Classroom/Lecture Hall/Training Room			
Penitentiary	0.81	8.7	4
All other *classrooms*/lecture halls/training rooms	0.65	6.9	4
Conference/Meeting/Multipurpose Room	0.88	9.5	6
Confinement Cells	0.52	5.6	6

Copy/Print Room	0.31	3.3	6
Corridor[b]			
Facility for the visually impaired (and not used primarily by the staff) [c]	0.71	7.6	width < 8 ft (2.4 m)
Hospital	0.65	6.9	width < 8 ft (2.4 m)
Manufacturing facility	0.28	3.0	width < 8 ft (2.4 m)
All other corridors	0.37	4.0	width < 8 ft (2.4 m)
Courtroom	0.98	10.5	6
Computer Room	0.85	9.2	4
Dining Area			
Penitentiary	0.42	4.5	6
Facility for the visually impaired (and not used primarily by staff) [c]	1.27	13.7	4
Bar/lounge or leisure dining	0.62	6.7	4
Cafeteria or fast food dining	0.36	3.9	4
Family dining	0.54	5.8	4
All other dining areas	0.39	4.2	4
Electrical/Mechanical Room[g]	0.39	4.2	6
Emergency Vehicle Garage	0.47	5.1	4
Food Preparation Area	0.92	9.9	6
Guest Room	0.41	4.4	6
Laboratory			
In or as a *classroom*	1.04	11.2	6
All other laboratories	1.24	13.3	6

Laundry/Washing Area	0.43	4.6	4
Loading Dock, Interior	0.51	5.5	6
Lobby			
Facility for the visually impaired (and not used primarily by the staff) [c]	1.30	14.0	4
Elevator	0.52	5.6	6
Hotel	0.46	5.0	4
Motion picture theater	0.30	3.2	4
Performing arts theater	0.82	8.8	6
All other lobbies	0.76	8.2	4
Locker Room	0.45	4.8	6
Lounge/Breakroom			
Health care facility	0.38	4.1	6
All other lounges/breakrooms	0.44	4.7	4
Office			
Enclosed and ≤ 250 ft^2 (23 m^2)	0.67	7.2	8
Enclosed and > 250 ft^2 (23 m^2)	0.60	6.5	8
Open plan	0.55	6.0	4
Parking Area, Interior	0.11	1.2	4
Pharmacy Area	1.23	13.2	6
Restroom			
Facility for the visually impaired (and not used primarily by the staff) [c]	0.81	8.7	8
All other restrooms	0.57	6.2	8

Sales Area[d]	0.95	10.3	6
Seating Area, General	0.23	2.5	4
Stairway	The *space* containing the stairway shall determine the LPD requirements for the stairway.		
Stairwell	0.45	4.8	10
Storage Room			
< 50 ft^2 (4.6m^2)	0.51	5.5	6
≥ 50 ft^2 (4.6m^2) and ≤ 1000 ft^2 (93 m^2)	0.35	3.7	6
All other storage rooms	0.35	3.7	6
Vehicular Maintenance Area	0.53	5.7	4
Workshop	1.09	11.7	6
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD, W/ft^2**	**LPD, W/m^2**	**RCR THRESHOLD**
Facility for the Visually Impaired[c]			
Chapel (used primarily by residents)	0.70	7.5	4
Recreation room/common living room (and not used primarily by staff)	1.53	15.3	6
Automotive (See "Vehicular Maintenance Area")			
Convention Center—Exhibit Space	0.55	6.0	4
Dormitory—Living Quarters	0.46	4.95	8
Fire Station—Sleeping Quarters	0.19	2.05	6
Gymnasium/Fitness Center			
Exercise area	0.50	5.4	4
Playing area	0.75	8.1	4
Health Care Facility			

Exam/treatment room	1.16	12.5	8
Imaging room	0.85	9.2	6
Medical supply room	0.54	5.8	6
Nursery	0.94	10.1	6
Nurse's station	0.75	8.1	6
Operating room	1.87	20.1	6
Patient room	0.45	4.8	6
Physical therapy room	0.85	9.1	6
Recovery room	0.89	9.6	6
Library			
Reading area	0.77	8.3	4
Stacks	1.08	11.6	4
Manufacturing Facility			
Detailed manufacturing area	0.80	8.6	4
Equipment room	0.61	6.6	6
Extra high bay area (> 50 ft [15.2 m] floor-to-ceiling height)	0.73	7.9	4
High bay area (25 ft [7.6 m] to 50 ft [15.2 m] floor-to-ceiling height)	0.58	6.2	4
Low bay area (< 25 ft [7.6 m] floor-to-ceiling height)	0.61	6.6	4
Museum			
General exhibition area	0.31	3.3	6
Restoration room	0.77	8.3	6

Performing Arts Theater—Dressing Room	0.35	3.8	6
Post Office—Sorting Area	0.66	7.1	4
Religious Buildings			
Fellowship hall	0.42	4.5	4
Worship/pulpit/choir area	0.77	8.3	4
Retail Facilities			
Dressing/fitting room	0.49	5.3	8
Mall concourse	0.53	5.7	4
Sports Arena—Playing Area [h]			
Class I facility	2.26	24.3	4
Class II facility	1.45	15.6	4
Class III facility	1.08	11.6	4
Class IV facility	0.72	7.8	4
Transportation Facility			
Baggage/carousel area	0.35	3.8	4
Airport concourse	0.22	2.4	4
Terminal ticket counter	0.48	5.2	4
Warehouse—Storage Area			
Medium-to-bulky, palletized items	0.27	2.9	4
Smaller, hand-carried items [e]	0.60	6.5	6

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

b. In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c) [7.4.6.1.1(c)].

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

d. For accent lighting, see Section 701.4.6.1.1(d) [7.4.6.1.1(d)].

e. Sometimes referred to as a “picking area.”

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

g. Electrical/mechanical rooms. An additional 0.50 W/ft^2(5.4 W/m^2) shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft^2(4.2 W/m^2). The additional 0.50 W/ft^2(5.4 W/m^2) allowance shall not be used for any other purpose.

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

701.4.6.1.2 (7.4.6.1.2) Exterior LPDs.

The exterior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, Section 9.4.3, with the following modification. The LPDs from ANSI/ASHRAE/IES Standard 90.1, Table 9.4.2-2, shall be multiplied by the appropriate LPD factor from Table 701.4.6.1.2 (7.4.6.1.2).

701.4.6.2 (7.4.6.2) Dwelling units.

This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.3. Not less than 90% of the *permanently installed* lighting serving *dwelling units* shall be provided by *lamps* with an *efficacy* of not less than 75 lm/W or *luminaires* with an efficacy of not less than 55 lm/W.

Exception: Lighting attached to, or integral to, appliances.

701.4.6.3 (7.4.6.3) Interior lighting controls.

The interior lighting control requirements in this section are in addition to the control requirements in ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.1.

701.4.6.3.1 (7.4.6.3.1) [JO] Occupancy sensor controls in commercial and industrial storage stacks.

The lighting in commercial and industrial storage stack areas shall be controlled by an occupancy 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.

701.4.6.3.2 (7.4.6.3.2) [JO] 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.

TABLE 701.4.6.1.2 (TABLE 7.4.6.1.2)

LIGHTING POWER ALLOWANCE FACTORS

	LIGHTING ZONE				
	LZ0	**LZ1**	**LZ2**	**LZ3**	**LZ4**
For tradable areas, uncovered parking areas: parking areas and drives with measured *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* ≥ 29	Not allowed	1	1	1	1
For tradable areas, other	1.00	0.90	0.90	0.95	0.95
For nontradable areas	1.00	0.95	0.95	0.95	0.95

701.4.6.3.3 (7.4.6.3.3) Occupancy sensing control in large office spaces.

General lighting in office *spaces* greater than 250 ft^2(23 m^2) shall be controlled by occupancy sensing controls that comply with all of the following:

a. The occupancy sensing controls shall be configured so that *general lighting* shall be controlled separately in control zones with floor areas not greater than 600 ft^2(56 m^2).

b. Within 20 minutes of the control zone being unoccupied, the occupancy sensing controls shall turn off or uniformly reduce lighting power to no more than 20% of full power.

c. Within 20 minutes of the entire office *space* being unoccupied, the occupancy sensing controls shall automatically turn off *general lighting* in all control zones in the *space*.

d. *General lighting* in each control zone shall be allowed to automatically turn on to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the *space*, the *general lighting* in other control zones that are unoccupied shall operate at no more than 20% of full power.

701.4.6.4 (7.4.6.4) Exterior lighting controls.

This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.4, for all exterior sign lighting and lighting serving uncovered parking areas and open areas in outdoor sales lots.

701.4.6.4.1 (7.4.6.4.1) 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 Section 701.4.6.4.1.1 (7.4.6.4.1.1) or 701.4.6.4.1.2 (7.4.6.4.1.2).

Exceptions:

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

2.Signs in tunnels.

701.4.6.4.1.1 (7.4.6.4.1.1)

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.

701.4.6.4.1.2 (7.4.6.4.1.2)

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.*

701.4.6.4.2 (7.4.6.4.2) Parking and outdoor sales lighting.

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.

701.4.6.5 (7.4.6.5) Dwelling unit lighting controls.

Permanently installed luminaires in laundry rooms, utility rooms, closets, and storage rooms in *dwelling units* shall be controlled with *automatic shut-off controls*.

For all other spaces and exterior applications that are controlled from within a *dwelling unit*, where three or more *permanently installed* luminaires are controlled together, the control shall be either a *dimmer* or an *automatic shut-off control*.

Dwelling units with greater than 5000 ft^2(460 m^2) of conditioned floor area shall have a lighting *control* system that has the capability to turn off all *permanently installed* interior lighting from a control located at an exit door or have a lighting *control* system that has the capability to turn off all *permanently installed* interior lighting from remote locations.

Exceptions:

1.Spaces using less than 10 W of total lighting power.

2.Lighting designed for safety or security.

3.*Permanently installed* night lighting that does not exceed 2 W per luminaire.

701.4.7 (7.4.7) Other equipment.

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

701.4.7.1 (7.4.7.1) Equipment efficiency for the alternate renewables approach.

All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the applicable ENERGY STAR requirements in Section 701.4.7.3.2 (7.4.7.3.2), and the pump efficiency requirements in Section 701.4.7.6 (7.4.7.6).

701.4.7.2 (7.4.7.2) [JO] 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.

701.4.7.3 (7.4.7.3) ENERGY STAR equipment.

All *building projects* shall comply with the requirements in Section 701.4.7.3.1 (7.4.7.3.1) and all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) shall also comply with Section 701.4.7.3.2 (7.4.7.3.2).

701.4.7.3.1 (7.4.7.3.1) ENERGY STAR requirements for equipment not covered by federal appliance efficiency regulations (all building projects).

The following equipment within the scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy:

a. Appliances:

1.Room air cleaners: ENERGY STAR Program Requirements for Room Air Cleaners.

2.Water coolers: ENERGY STAR Program Requirements for Water Coolers.

b. Heating and Cooling:

1.Programmable thermostats: ENERGY STAR Program Requirements for Programmable Thermostats.

2.Ventilating fans: ENERGY STAR Program Requirements for *Residential* Ventilating Fans.

c. Electronics:

1.Cordless phones: ENERGY STAR Program Requirements for Telephony.

2.Audio and video: ENERGY STAR Program Requirements for Audio and Video.

3.Televisions: ENERGY STAR Program Requirements for Televisions.

4.Set-top boxes: ENERGY STAR Program Requirements for Set-Top Boxes.

d. Office Equipment:

1.Computers: ENERGY STAR Program Requirements for Computers.

2.Copiers: ENERGY STAR Program Requirements for Imaging Equipment.

3.Fax machines: ENERGY STAR Program Requirements for Imaging Equipment.

4.Laptops: ENERGY STAR Program Requirements for Computers.

5.Mailing machines: ENERGY STAR Program Requirements for Imaging Equipment.

6.Monitors: ENERGY STAR Program Requirements for Displays.

7.Multifunction devices (printer/fax/scanner): Program Requirements for Imaging Equipment.

8.Printers: ENERGY STAR Program Requirements for Imaging Equipment.

9.Scanners: ENERGY STAR Program Requirements for Imaging Equipment.

10.Computer servers: ENERGY Star Program Requirements for Computer Servers.

e. Lighting:

1.Integral LED lamps not subject to Section 701.4.6.2 (7.4.6.2): ENERGY STAR Program Requirements for Integral LED Lamps.

f. Commercial Food Service:

1.Commercial fryers: ENERGY STAR Program Requirements for Commercial Fryers.

2.Commercial hot food holding cabinets: ENERGY STAR Program Requirements for Hot Food Holding Cabinets.

3.Commercial steam cookers: ENERGY STAR Program Requirements for Commercial Steam Cookers [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].

4.Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers.

5.Commercial griddles: ENERGY STAR Program Requirements for Commercial Griddles.

6.Commercial ovens: ENERGY STAR Program Requirements for Commercial Ovens [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].

Exception: Products with minimum efficiencies addressed in the Energy Policy Act (EPAct) and the Energy Independence and Security Act (EISA) when complying with Section 701.4.1.1 (7.4.1.1).

701.4.7.3.2 (7.4.7.3.2) ENERGY STAR requirements for equipment covered by federal appliance efficiency regulations (alternate renewables approach).

For all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1), the following equipment within the scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy. For those products listed below that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both the requirements in this section and in Normative Appendix B.

a. Appliances:

1.Clothes washers: ENERGY STAR Program Requirements for Clothes Washers [see also the water efficiency requirements in Section 601.3.2.2 (6.3.2.2)].

2.Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.

3.Dishwashers: ENERGY STAR Program Requirements Product Specifications for Residential Dishwashers [see also the water efficiency requirements in Section 601.3.2.2 (6.3.2.2)].

4.Refrigerators and freezers: ENERGY STAR Program Requirements for Refrigerators and Freezers.

5.Room air conditioners: ENERGY STAR Program Requirements and Criteria for Room Air Conditioners.

b. Heating and Cooling:

1.*Residential* air-source heat pumps: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].

2.*Residential* boilers: ENERGY STAR Program Requirements for Boilers [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].

3.*Residential* central air conditioners: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].

4.*Residential* ceiling fans: ENERGY STAR Program Requirements for *Residential* Ceiling Fans.

5.Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.

6.*Residential* warm air furnaces: ENERGY STAR Program Requirements for Furnaces.

7.*Residential* geothermal heat pumps: ENERGY STAR Program Requirements for Geothermal Heat Pumps.

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

d. Lighting:

1.Lamps: ENERGY STAR Program Requirements for Lamps (Light Bulbs).

2.Luminaires: ENERGY STAR Program Requirements for Luminaires.

3.*Residential* light fixtures: ENERGY STAR Program Requirements for *Residential* Light Fixtures.

e. Commercial Food Service:

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

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

f. Other Products:

1.Battery charging systems: ENERGY STAR Program Requirements for Products with Battery Charger Systems (BCSs).

2.External power adapters: ENERGY STAR Program Requirements for Single-Voltage AC-DC and AC-AC Power Supplies.

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

701.4.7.4 (7.4.7.4) [JO] Programmable thermostats.

Residential programmable thermostats shall meet the requirements of NEMA Standards Publication DC 3, Annex A, "Energy-Efficiency Requirements for Programmable Thermostats," or the requirements of the ENERGY STAR program for connected thermostats.

701.4.7.5 (7.4.7.5) [JO] Refrigerated display cases.

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

701.4.7.6 (7.4.7.6) Elevator power conversion System.

In new buildings, traction elevators with a rise of 75 ft (23 m) or more shall be provided with a power conversion system that includes all of the following:

a. A drive motor with a minimum Class IE2 efficiency rating, as defined by IEC EN 60034-30.

b. A regenerative drive that recovers potential energy released during motion, converts it to electrical energy, and supplies it to the building electrical system.

701.4.7.7 (7.4.7.7) Pump efficiency.

All pumps in buildings complying with the Alternate Renewables Approach in Section 701.4.1.1 (7.4.1.1) and Table 701.4.1.1 (7.4.1.1) that are subject to the requirements of ASHRAE/IES Standard 90.1, Section 10.4.7, shall have a Pump Energy Index no greater than 0.97.

701.4.8 (7.4.8) Energy cost budget.

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

701.5 (7.5) Performance option.

Buildings shall comply with Sections 701.5.1 (7.5.1), using the baseline definition and modeling procedures as defined in Standard 90.1, Appendix G, and modified by Normative Appendix C of this code.

701.5.1 (7.5.1) Annual energy cost.

The proposed building performance cost index shall be calculated in accordance with ANSI/ASHRAE/IES Standard 90.1, Normative Appendix G, and be equal to or less than the target Performance Cost Index (PCI), as determined from the following equation:

PCIt=[BBUEC+(BBREC×BPF)]×(1−RF)BBUEC+BBREC

$$PCI_t = \frac{[BBUEC + (BBREC \times BPF)] \times (1 - RF)}{BBUEC + BBREC}$$

where:

PCI_t = Target PCI required for achieving compliance with the standard, unitless.

BBUEC = The component of *baseline building performance* that is due to *unregulated energy use,* $.

BBREC = The component of *baseline building performance* that is due to *regulated energy use,* or *baseline building performance* minus BBUEC, $.

BPF = Building performance factor taken from Table 701.5.1 (7.5.1), unitless.

RF = Renewable energy production fraction from Table 701.5.1 (7.5.1) unitless.

On-site renewable energy systems in the *proposed design* shall be calculated using the procedures in Normative Appendix C. For mixed-use buildings, the building performance factor (BPF) shall be determined by weighting each building type by floor area. A *building project* served in whole or in part by a *district energy plant* shall follow the modeling requirements contained in Normative Appendix C, Section C1.4, in order to comply with this section.

701.5.1.1 (7.5.1.1) Compliance with ANSI/ASHRAE/IES Standard 90.1 without renewables.

The proposed building PCI shall comply with the requirements of ANSI/ASHRAE/IES Standard 90.1, Section 4.2.1.1. The energy cost credits from on-site renewable energy production shall not be subtracted *from the proposed design* energy costs for the purposes of this section.

701.5.4 (7.5.4) [JO] Energy simulation aided design.

For *building projects* that exceed 25,000 ft^2(2300 m^2) of gross floor area, the *building project* shall comply with the requirements of ASHRAE Standard 209, Section 4.2.1.

Exception: ASHRAE Standard 209, Section 5.2 shall not apply.

TABLE 701.5.1 (TABLE 7.5.1)

ENERGY COST BUILDING PERFORMANCE FACTORS (BPF)

BUILDING TYPE			**RENEWABLE FRACTION (RF)**
	4C	**5B**	
Multifamily	0.67	0.65	0.50
Health care/hospital	0.50	0.47	0.35
Hotel/motel	0.47	0.47	0.50
Office	0.45	0.47	0.50
Restaurant	0.60	0.59	0.10
Retail	0.51	0.50	0.50
School	0.38	0.39	0.50
Warehouse	0.44	0.44	0.50
All others	0.50	0.47	0.50

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CHAPTER 7, ENERGY EFFICIENCY

Referenced Sections

Chapter 3

301.2 (3.2)Definitions.

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

Chapter 5

501.3.5.3 (5.3.5.3) Roofs.

This section applies to the building and covered parking roof surfaces for building projects in Climate Zones 0, 1, 2, 3, 4A, and 4B. A minimum of 75% of the roof surface area shall be covered with products that have:

a. A minimum three-year-aged SRI of 64 in accordance with Section 501.3.5.4 (5.3.5.4) for roofs with a slope of less than or equal to 2:12.

b. A minimum three-year-aged SRI of 25 in accordance with Section 501.3.5.4 (5.3.5.4) for roofs with a slope of more than 2:12.

The area occupied by one or more of the following shall be excluded from the calculation to determine the roof surface area required to comply with this section:

a. Roof penetrations and associated equipment.

b. On-site renewable energy systems, including photovoltaics, solar thermal energy collectors, and required access around the panels or collectors.

c. Portions of the roof used to capture heat for building energy technologies.

d. Roof decks and rooftop walkways.

e. Vegetated terrace and roofing systems complying with Section 501.3.5.5 (5.3.5.5).

Exceptions:

1. Building projects where an annual energy analysis simulation demonstrates that the total annual building energy cost and total annual CO2e, as calculated in accordance with Section 701.5.2 (7.5.2), are both a minimum of 2% less for the proposed roof than for a roof material complying with the SRI requirements of Section 501.3.5.3 (5.3.5.3).

2. Existing buildings in Climate Zones 4A and 4B undergoing alteration, repair, relocation, or a change in occupancy.

3. Roofs used to shade or cover parking, and roofs over semiheated spaces, provided that they have a minimum initial SRI of 29. A default SRI value of 35 for new concrete without added color pigment is allowed to be used instead of measurements.

4. Ballasted roofs in Climate Zones 4A and 4B having a stone ballast of not less than 17 lb/ft2(83 kg/m2) or a paver ballast of not less than 23 lb/ft2 (112 kg/m2).

501.3.5.5 (5.3.5.5) Vegetated terrace and roofing systems.

Vegetated terrace and roofing systems, where provided in accordance with Section 501.3.5.3 (5.3.5.3), shall comply with the following:

a. All plantings shall be capable of withstanding the microclimate conditions of the vegetated area, including but not limited to wind, precipitation, and temperature. *Plants* shall be selected and placed to provide foliage coverage of not less than 50% of designed area of vegetation based on the anticipated *plant* growth within two years of the issuance of the final certificate of occupancy. *Construction documents* shall be submitted that show the planting location and anticipated two-year foliage coverage of the plantings. Duplicate coverage shall not be credited where multiple *plants* cover the same area. *Invasive plants* shall not be planted.

b. The growing medium shall be designed for the physical conditions and local climate to support the *plants* selected. The planting design shall include measures to protect the growing medium until the *plants* are established. The maximum wet weight and water-holding capacity of a growing medium shall be determined in accordance with ASTM E2399.

c. Nonvegetated clearances and borders shall be provided in accordance with the *International Fire Code*, Section 317.

d. Plantings shall be capable of maintaining the function of the vegetated *roof* or terrace as required by Section 1001.9.1 (10.9.1).

e. Irrigation of the vegetated *roofs* and terraces shall comply with Section 601.3.2.4 (6.3.2.4).

f. Installation of plantings shall be in accordance with the *roof*-covering manufacturer's installation instructions.

Chapter 6

601.3.2.2 (6.3.2.2) Appliances.

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

1. Clothes washers (residential)— Maximum *water factor* (*WF*) of 5.4 gal/ft^3 of drum capacity (0.72 L/L of drum capacity).

2. Dishwashers—Standard-size dishwashers shall have a maximum *WF* of 3.8 gal/full operating cycle (14.3 L/full operating cycle). Compact sizes shall have a maximum *WF* of 3.5 gal/full operating cycle (13.2 L/full operating cycle). Standard and compact size shall be defined by ENERGY STAR criteria.

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

b. Clothes washers installed in publicly accessible *spaces* (***Informative Note:*** e.g., multifamily and hotel common areas), and coin- and card-operated clothes washers of any size used in laundromats, shall have a maximum *WF* of 4.0 gal/ft^3 of drum capacity normal cycle (0.53 L/L of drum capacity normal cycle). [See also the energy efficiency requirements in Section 701.4.7.3 (7.4.7.3).]

c. Commercial dishwashers in commercial foodservice facilities shall meet all ENERGY STAR requirements as listed in the ENERGY STAR Program Requirements for Commercial Dishwashers, Version 2.0.

601.3.2.4 (6.3.2.4) Roofs.

a. The use of *potable water* or *reclaimed water* for *roof* spray systems to thermally condition the *roof* shall be prohibited.
Exception: Where *approved*, on-site treated *reclaimed water* may be used for *roof* spray systems.
b. In-ground irrigation systems on vegetated *roofs* using *potable water* or off-site treated *reclaimed water* shall be prohibited.
c. The use of *potable water* or *reclaimed water* for irrigation of vegetated (green) *roofs* is prohibited after the vegetation establishment period or 18 month after the initial installation, whichever is less. After the landscape *plants* are established, the irrigation system using *potable water* or *reclaimed water* shall be removed from *site*.

Exception: Where *approved*, on-site treated *reclaimed water* may be used for vegetated *roof* irrigation systems during and after the vegetation establishment period.

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

a. Shall use high-efficiency prerinse spray valves (i.e., valves that function at 1.3 gpm [4.9 L/min] or less and comply with a 26 second performance requirement when tested in accordance with ASTM F2324),
b. Shall use dishwashers that comply with the requirements of the ENERGY STAR Program for Commercial Dishwashers,
c. Shall use boilerless/connectionless food steamers that consume no more than 2.0 gal/h (7.5 L/h) in the full operational mode,
d. Shall use combination ovens that consume not more than 10 gal/h (38 L/h) in the full operational mode,
e. Shall use air-cooled ice machines that comply with the requirements of the ENERGY STAR Program for Commercial Ice Machines, and
f. Shall be equipped with hands-free faucet controllers (foot controllers, sensor activated, or other) for all faucet fittings within the food preparation area of the kitchen and the dish room, including pot sinks and washing sinks.

601.3.5.1 (6.3.5.1)Consumption management.

Measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building. 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*, rainwater) to the *building project* that exceeds the thresholds listed in Table 601.3.5.1A (6.3.5.1A). 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 601.3.5.1B (6.3.5.1B).

601.3.5.2 (6.3.5.2)[JO] Consumption data collection.

All building measurement devices, monitoring systems, and submeters installed to comply with the threshold limits in Section 601.3.5.1 (6.3.5.1) 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.

601.3.5.3 (6.3.5.3)[JO] Data storage and retrieval.

The meter data management system shall be capable of electronically storing water meter, monitoring systems, and submeter data and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device and submeter and provide alarm notification capabilities as needed to support the requirements of the water user efficiency plan for operation in Section 1001.9.2 (10.9.2).

TABLE 601.3.5.1A (TABLE 6.3.5.1A)

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	500 gal/day (1900 L/day)

TABLE 601.3.5.1B (TABLE 6.3.5.1B)

SUBSYSTEM WATER MEASUREMENT THRESHOLDS

SUBSYSTEM	SUBMETERING THRESHOLD
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)

Steam and hot-water boilers	> 500,000 Btu/h (150 kW) input
Total irrigated landscape area with controllers	> 25,000 ft^2 (2500 m^2)
Separate campus or project buildings	Consumption > 1000 gal/day (3800 L/day)
Separately leased or rental *space*	Consumption > 1000 gal/day (3800 L/day)
Any large water-using process	Consumption > 1000 gal/day (3800 L/day)

Chapter 8

801.3.1.1 (8.3.1.1) Minimum ventilation rates.
In health care facilities, the ventilation requirements of ASHRAE/ASHE Standard 170 shall apply. In *residential dwelling units*, the *dwelling unit* ventilation rates and local exhaust airflow rates as required by ASHRAE Standard 62.2 shall apply. ASHRAE Standard 62.2, Section 4.1.2, shall not apply. In all other cases, ASHRAE Standard 62.1, Sections 6.1.1 and 6.2, shall be used to determine minimum zone and intake outdoor airflow rates. ASHRAE Standard 62.1, Sections 6.1.2 and 6.1.3, shall not apply.
Informative Note: ASHRAE Standard 62.1, Sections 6.1.1 and 6.2, define the Ventilation Rate Procedure for determining ventilation rates.

801.3.1.9 (8.3.1.9) Guest room preoccupancy outdoor air purge cycle.
Guest room ventilation systems controlled according to Section 701.4.3.9.4 (7.4.3.9.4) shall have an *automatic* preoccupancy purge cycle that shall provide *outdoor air* ventilation at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change. In guest rooms with a *networked guest room control system*, the purge cycle shall be completed within 60 minutes prior to the time the room is scheduled to be occupied. Where guest rooms are not connected to a *networked guest room control system*, the preoccupancy purge cycle shall occur daily.

801.3.1.2 (8.3.1.2) Outdoor air delivery monitoring.

801.3.1.2.1 (8.3.1.2.1) System design for outdoor air intake measurement.
Each mechanical ventilation system shall be configured to allow for the measurement of the *outdoor air* intake for use in testing and balancing, recommissioning, and *outdoor air* monitoring as required in Section 801.3.1.2.2 (8.3.1.2.2).

801.3.1.2.2 (8.3.1.2.2) Monitoring requirements.
Each mechanical ventilation system shall have a *permanently installed* device to measure the *minimum outdoor airflow* that meets the following requirements:

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

b. The device shall have an accuracy of ±10% of the *minimum outdoor airflow.* Where the *minimum outdoor airflow* varies, as in *demand control ventilation* (*DCV*) systems, the device shall maintain this accuracy over the entire range of occupancy and system operation.

c. The device shall be capable of notifying the building operator, either by activating a local indicator or sending a signal to a building monitoring system, whenever an *outdoor air fault condition* exists. This notification shall require manual reset.

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

801.3.1.3 (8.3.1.3) Filtration and air cleaner requirements.

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

1. **Wetted surfaces.** Particulate matter filters or air cleaners having a minimum efficiency reporting value (MERV) of not less than 8 where rated in accordance with ANSI/ASHRAE Standard 52.2, or not less than Coarse 90% where rated in accordance with ISO 16890,

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 5.9.

2. **Particulate matter smaller than 10 micrometers (PM10).** Particulate matter filters or air cleaners shall be provided in accordance with Standard 62.1, Section 6.1.4.1, with the following modification. Such filters or air cleaners shall have a MERV of not less than 11 where rated in accordance with ASHRAE Standard 52.2, or not less than ePM2.5-50% where rated in accordance with ISO 16890.

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 6.1.4.2, with the following modification. Such filters or air cleaners shall have a MERV of not less than 13 where rated in accordance with ASHRAE Standard 52.2, or not less than ePM1-50% where rated in accordance with ISO 16890.

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

b. **[JO] Outdoor air ozone removal.** Air cleaning devices for ozone shall be provided for buildings located in an area that is designated "non-attainment" for ozone by USEPA, or located in an area that does not comply with applicable ambient air quality standards for ozone as determined by the *authority having jurisdiction* (*AHJ*). Such air cleaning devices shall have an ozone removal efficiency of no less than 40% where installed, operated, and maintained in accordance with the manufacturer's recommendations, and shall treat all *outdoor air* intake flow. Such air cleaning devices shall be operated whenever the outdoor ozone level is expected to exceed the National Ambient Air Quality Standards (NAAQS). This requirement supersedes the requirements of ASHRAE Standard 62.1, Section 6.1.4.3. This requirement applies to all buildings, including health care facilities covered by ASHRAE/ASHE Standard 170.

Exceptions:

1.Systems designed with an *outdoor air* intake flow of 1.5 ach or less.

2.Where controls are provided that sense outdoor ozone level and reduce intake airflow to 1.5 ach or less while complying with the outdoor airflow requirements of Section 801.3.1.1 (8.3.1.1).

3.*Outdoor air* brought into the building and heated by direct-fired *makeup-air* units.

c. **Sealing.** Where particulate matter filters or air cleaners are required by Section 801.3.1.3 (8.3.1.3), filter tracks, filter supports, filters, and access doors shall be sealed in accordance with the following:

1. Where filter track and filter support systems incorporate multiple filters, the gap between each filter shall be sealed with a gasket, and the gap between the filter and its track or support shall be sealed using gaskets that expand when the filter is removed. Filter support systems shall include a filter-to-support gasket *permanently installed* on the filter support, except for filter track and filter support systems that seal around the filter by means of a friction fit.

2. Filter tracks and filter supports shall be sealed to the HVAC equipment housing and ducts by a sealant or other sealing method.

3. Filter access doors shall be sealed to minimize filter bypass and air leakage into or out of the system.

4. Gaskets and seals used to comply with the requirements of this section shall be capable of effecting a seal for the anticipated life of the equipment, and the system shall be designed such that the seals are readily accessible.

5. Field- or shop-fabricated *spacers* shall not be installed for the purpose of replacing the intended-size filter with a smaller-size filter.

d. **Ozone emissions.** The requirements in this section supersede the requirements in ASHRAE Standard 62.1, Sections 5.7.1 and 5.7.2. Air cleaning devices with electronic filter elements that rely on ionization or corona discharge shall be *listed* and *labeled* in accordance with UL 2998. Ultraviolet-generating devices in supply air devices, ducts, and plenums shall not emit 185 nm wavelengths.

801.3.1.4 (8.3.1.4) Building pressure.

The requirements in Section 801.3.1.4 (8.3.1.4) supersede the requirements in ASHRAE Standard 62.1, Section 5.11. *Building projects* shall be designed in accordance with the following subsections.

801.3.1.4.1 (8.3.1.4.1) Mechanical exhaust.

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

801.3.1.4.2 (8.3.1.4.2)[JO] Exfiltration.

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

Exceptions:

1. Where excess exhaust is required by process considerations, such as certain industrial or health care facilities.
2. Warehouse facilities.
3. Buildings in Climate Zones 0B, 1B, 2B, 3B, 3C, 4B, 4C, 5, 6, 7, and 8.

801.4.1 (8.4.1) Daylighting.

801.4.1.1 (8.4.1.1) Daylighting in large spaces directly under a roof and having high ceilings.

Enclosed spaces, including conditioned and unconditioned *spaces*, meeting all of the following criteria, shall comply with Sections 801.4.1.1.1 (8.4.1.1.1), 801.4.1.1.2 (8.4.1.1.2) and 801.4.1.1.3 (8.4.1.1.3):

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

b. The *space* area is greater than 2500 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. *Spaces* in buildings located in Climate Zones 7 or 8.
2. Auditoria, motion picture theaters, performing arts theaters, museums, places of worship, and refrigerated warehouses.
3. *Enclosed spaces* where documentation shows that existing structures or natural objects block direct sunlight on at least 50% of the *roof* over the *enclosed space* at all three of the following times on the date of the spring equinox: three hours before solar noon (peak solar altitude), at solar noon, and three hours after solar noon.

801.4.1.1.1 (8.4.1.1.1) Minimum daylight area.

Not less than 50% of the floor area shall be in the *daylight area* as defined in Section 3. For the purposes of Section 801.4.1.1.1 (8.4.1.1.1), the definition of *daylight area* shall be modified such that partitions and other obstructions that are less than the ceiling height are disregarded. *Daylight areas* shall be

under *skylights*, under *roof monitors*, 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.

801.4.1.1.2 (8.4.1.1.2) Visible transmittance (VT) of skylights and roof monitors.

The visible transmittance of *skylights* and *roof monitors* for *daylight areas* used to comply with Section 801.4.1.1.1 (8.4.1.1.1) shall not be less than 0.40. For *dynamic glazing,* the highest-labeled VT shall be used for compliance with this section.

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

801.4.1.1.3 (8.4.1.1.3) Skylight optical diffusion characteristics.

Skylights used to comply with Section 801.4.1.1.1 (8.4.1.1.1) shall have a glazing material or diffuser that has a measured haze value greater than 90% when tested according to ASTM D1003 or other *approved* test method.

Exceptions:

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

801.4.1.2 (8.4.1.2) Minimum sidelighting effective aperture.

The *spaces* listed in Table 801.4.1.2A (8.4.1.2A) shall comply with items (a), (b) and (c).

a. The north-, south-, and east-facing façades shall have a minimum *sidelighting effective aperture* as prescribed in Table 801.4.1.2B (8.4.1.2B).

b. For all façades, the combined width of the *primary sidelighted areas* shall not be less than 75% of the length of the façade *wall*.

c. Opaque interior surfaces in *daylight areas* shall have average visible light reflectances greater than or equal to 80% for ceilings, 40% for partitions higher than 60 in. (1.5 m), and 60% for walls.

Exceptions:

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

TABLE 801.4.1.2A (TABLE 8.4.1.2A)
DAYLIT SPACES

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

TABLE 801.4.1.2B (TABLE 8.4.1.2B)
MINIMUM SIDELIGHTING EFFECTIVE APERTURE

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

801.4.1.3 (8.4.1.3)[JO] Shading for offices.
For office *spaces* 250 ft^2(23 m^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 or internal using the *interior PF*. Shading devices shall be limited to the following:

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

b. Building self-shading through *roof* overhangs or recessed windows.

Exceptions:

1. Facades facing within 45 degrees of true north in the northern hemisphere or facades facing 45 degrees from true south in the southern hemisphere.
2. Translucent panels and glazing systems with a measured haze value greater than 90% when tested according to ASTM D1003 or other *approved* test method, 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 Section 701.4.2.6 (7.4.2.6), Exception 2.
5. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Section 701.4.2.6 (7.4.2.6), Exception 3.
6. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

CHAPTER10

CONSTRUCTION AND PLANS FOR OPERATION

1001.1 (10.1) Scope.
This section specifies requirements covering: the construction process, system start-up and commissioning, tests of completed systems and corrective actions, plans for high performance operation and maintenance of the building and site, energy and water performance verification, service life plans, and transportation management.

1001.2 (10.2) Compliance.
All of the provisions of Chapter 10 (Section 10) are mandatory provisions.

1001.3 (10.3) Functional and performance testing and commissioning.
Building projects with not greater than 10,000 ft^2(1000 m^2) of gross floor area shall comply with Section 10.3.1. *Building projects* with greater than 10,000 ft^2(1000 m^2) of gross floor area, shall comply with Section 1001.3.2 (10.3.2).

1001.3.1 (10.3.1) Building systems functional and performance testing (FPT).
Functional and performance testing shall be performed on all building systems specifically referenced in this section using *generally accepted engineering standards* where such standards are *approved*.

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 (10.3.1.1) FPT requirements.
An *FPT* process shall be performed for the following:

a. Heating, ventilating, air conditioning, and refrigeration systems (mechanical and passive) and associated controls that exceed total system capacities of 180,000 Btu/h (53,000 W) for cooling, 300,000 Btu/h (88,000 W) for heating, or 10,000 cfm (5000 L/s) for ventilation.

b. Lighting systems over 5 kW in total capacity, including *automatic* and daylighting controls, manual daylighting controls, occupancy-sensing devices, time switching, and *automatic shut-off controls*.

c. Domestic water-heating systems rated at over 50,000 Btu/h (15,000 W).

d. Water pumping and mixing systems over 5 hp (4 kW).

e. Irrigation systems that use more than 1000 gal (4000 L) per day.

1001.3.1.2 (10.3.1.2) Activities prior to building permit for facilities using the FPT process.
The following activities shall be completed before a permit is issued for any system requiring *FPT*:

a. Designate *FPT providers*. For systems that are required to comply with Section 1001.3.1 (10.3.1), *FPT providers* shall be *owner's* qualified employees, independent *commissioning (Cx) providers*, or qualified designers experienced with *FPT* on the designated systems. *FPT providers* shall be independent of the building system design and construction function and shall possesses the necessary experience and testing equipment.

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

1001.3.1.3 (10.3.1.3) Activities prior to building occupancy for facilities using the FPT process.
Before issuance of a certificate of occupancy, the *FPT providers* shall complete the following activities:

a. Installation and startup of the specified systems shall be verified.

b. *FPT* of systems shall be verified.

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

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

1001.3.1.4 (10.3.1.4) Documentation.
The completed project design and *FPT* documentation shall be provided to the *owner* and shall be retained with the project records.

1001.3.2 (10.3.2) Building project commissioning (Cx) Process.
The *Cx process* shall be performed in accordance with this section using ANSI/ASHRAE/IES Standard 202 or other *generally accepted engineering standards* where such standards are *approved*. The *Cx provider* shall verify that a *Cx process* has been incorporated into the design phases of the project and that commissioning shall be incorporated into the *construction documents.* The *Cx process* documents that the building and its commissioned components, assemblies, and systems comply with the *owner's project requirements* (*OPR*). The project requirements, including *OPR*, *BoD*, design and construction record documentation, training plans and records, O&M plans and procedures, and Cx reports shall be assembled in a systems manual that provides information for building operation and maintenance staff.

1001.3.2.1 (10.3.2.1) Systems to be commissioned.
The *Cx process* shall be included in the design and construction of the *building project*. The following systems and associated controls, where included in the *building project*, shall be commissioned:

a. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.

b. Air-curtain systems.

c. Lighting systems: *automatic* and manual daylighting controls, occupancy sensing devices, *automatic shut-off controls*, time switching, and other lighting control devices, and dimming systems claiming a *lighting power allowance* for *institutional tuning* according to Section 701.4.6.1.1(f) [7.4.6.1.1(f)].

d. Domestic hot-water systems and controls.

e. Water pumping and mixing systems over 5 hp (4kW) and purification systems.

f. Irrigation system performance that uses more than 1000 gal (4000 L) per day.

g. Renewable energy systems and energy storage systems.

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

1001.3.2.2 (10.3.2.2) Cx activities prior to building permit.
The following activities shall be completed prior to issuance of a building permit:

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

1001.3.2.3 (10.3.2.3) Cx activities prior to building occupancy.
The following activities shall be completed prior to issuance of a certificate of occupancy:

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

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

b. The *owner* shall be provided with a preliminary Cx report per compliance with Section 10.3.2.3. A copy of the Cx preliminary report shall be submitted to the *AHJ* upon request.
c. The *Cx provider* shall verify that the *owner* has been provided with a systems manual that includes the information needed to understand and operate the commissioned systems as designed, including warranty information for the commissioned systems. The systems manual with design and operational information shall be available for building operator and maintenance training.

1001.3.2.4 (10.3.2.4) Postoccupancy Cx activities.
The *Cx plan* shall contain postoccupancy Cx requirements in accordance with ANSI/ASHRAE/IES Standard 202. The *Cx provider* shall provide the *owner* with a complete systems manual, all record documents, and a complete final Cx report in accordance with Standard 202.

1001.3.2.5 (10.3.2.5) Project Cx documents.

1001.3.2.5.1 (10.3.2.5.1) Cx plan.
A *Cx plan* shall be developed by a *Cx provider* in accordance with ANSI/ASHRAE/IES Standard 202 for all systems to be commissioned and/or tested.

1001.3.2.5.2 (10.3.2.5.2) Design review report.

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

1001.3.2.5.3 (10.3.2.5.3) 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.

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

1001.3.2.5.4 (10.3.2.5.4) Final Cx report.

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

1001.3.2.5.5 (10.3.2.5.5) Documentation.

Owner shall retain the systems manual and final Cx report.

1001.4 (10.4) Construction operations and start-up requirements.

1001.4.1 (10.4.1) Erosion and sedimentation control (ESC).

Develop and implement an ESC plan for all construction activities. The ESC plan shall conform to the erosion and sedimentation control requirements of the most current version of the USEPA NPDES General Permit for Stormwater Discharges from Construction Activities, or local erosion and sedimentation control standards and codes, whichever is more stringent, and regardless of size of project.

1001.4.2 (10.4.2) 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. Materials stored on-site, or materials installed that are absorptive, shall be protected from moisture damage.

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

1001.4.3 (10.4.3) 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. Signage shall be posted at vehicle entrances to the *building project* providing notice of this requirement.

1001.4.4 (10.4.4)[JO] 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.

1001.4.5 (10.4.5) Construction and demolition waste management.

1001.4.5.1 (10.4.5.1) Collection.
Specific areas on the construction *site* shall be designated for the 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.

1001.6 (10.6) Building envelope airtightness.
Building envelope airtightness shall comply with ANSI/ASHRAE/IES Standard 90.1, with the following modifications and additions. Air leakage *verification* shall be determined in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 5.9.1:

a. When implementing the testing option in ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1.1, whole-building pressurization testing shall meet the following requirements:

1. It shall be conducted in accordance with ASTM E779, ASTM E1827, CAN/CGSB-149.10, CAN/CGSB-149.15, ISO 9972, or equivalent standard by an independent third party.
2. The measured air leakage rate of the *building envelope* shall not exceed 0.25 cfm/ft^2(1.25 $L/s \cdot m^2$) under a pressure differential of 0.3 in. of water (75 Pa), with this air leakage rate normalized by the sum of the above- and below-grade *building envelope* areas of the *conditioned* and *semiheated space.*
3. Section 501.4.3.1.1 (5.4.3.1.1), Exception 1, is not allowed.
4. Section 501.4.3.1.1 (5.4.3.1.1), Exception 2, is allowed where the measured air leakage rate exceeds 0.25 cfm/ft^2(1.25 $L/s \times m^2$) but does not exceed 0.40 cfm/ft^2(2.0 $L/s \times m^2$).

b. When implementing the *verification* program option in ANSI/ASHRAE/IES Standard 90.1, Section 5.9.1, the air barrier design review shall be performed by an independent third party.

1001.7 (10.7)[JO] Postconstruction building flush-out and air monitoring.
After construction ends, prior to occupancy and with all interior finishes installed, a postconstruction, preoccupancy building flush-out as described under Section 1001.7.1 (10.7.1), or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 1001.7.2 (10.7.2), shall be performed.

1001.7.1 (10.7.1) Postconstruction, preoccupancy flush-out.
A total air volume of *outdoor air* in total air changes as defined by Equation 10-1 shall be supplied while maintaining an internal temperature of a minimum of 60°F (15°C) and relative humidity no higher than 60%. For buildings located in nonattainment areas, filtration and/or air cleaning as described in Section 801.3.1.3 (8.3.1.3) shall be supplied when the Air Quality Index forecast exceeds 100 (category orange, red, purple, or maroon). One of the following options shall be followed:

a. **Continuous postconstruction, preoccupancy flush-out.** The flush-out shall be continuous and supplied at an outdoor airflow rate no less than that determined in Section 801.3.1.1 (8.3.1.1).

b. **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 (8.3.1.1), whichever is greater. These conditions shall be maintained until the total air changes calculated according to Equation 10-1 have been delivered to the *space.* The flush-out shall be continuous.

TAC=Vot×1A×1H×60 min/h×24 h/ day ×14 days (I-P) TAC=Vot×1 m31000L×1A×1H×3600 s/h×24 h/ day ×14 days (SI)

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

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

(Equation 10-1)

where:

TAC = Total air changes.

$\boldsymbol{V_{ot}}$ **=** 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).

1001.7.2 (10.7.2) 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 D5197. The testing shall demonstrate that the *contaminant* maximum concentrations listed in Table 1001.7.2 (10.7.2) 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 1001.7.2 (10.7.2) are not exceeded in the larger of:

a. No fewer than one location per 25,000 ft^2(2500 m^2) or
b. 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 1001.7.2 (TABLE 10.7.2)
MAXIMUM CONCENTRATION OF AIR POLLUTANTS RELEVANT TO IAQ

CONTAMINANT	**MAXIMUM CONCENTRATION, µg/m^3 (UNLESS OTHERWISE NOTED)**
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-h)
Particulates (PM2.5)	35 (24 h)
Particulates (PM10)	150 (24 h)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-butadiene	20
t-butyl methyl ether (methyl-t-butyl ether)	8000

Carbon disulfide	800
Caprolactam [a]	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1,4-dichlorobenzene	800
Dichloromethane (methylene chloride)	400
1,4-Dioxane	3000
Ethylbenzene	2000
Ethylene glycol	400
Formaldehyde	33
2-Ethylhexanoic acid[a]	25
n-Hexane	7000
1-methyl-2-pyrrolidinone[a]	160

Naphthalene	9
Nonanal [a]	13
Octanal[a]	7.2
Phenol	200
4-phenylcyclohexene (4-PCH)[a]	2.5
2-propanol (isopropanol)	7000
Styrene	900
Tetrachloroethene (tetra-chloroethylene, 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 and shall be in conjunction with the individual VOCs listed.

1001.8 (10.8) 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).

1001.9 (10.9) Plans for high-performance building operation.
This section specifies the items to be included in plans for operation of a *building project*. A plan for operation starting immediately prior to occupancy shall be developed that meets the requirements specified in Sections 1001.9.1 through 1001.9.8 (10.9.1 through 10.9.8). The plan shall be turned over to the *owner.*

1001.9.1 (10.9.1) Site sustainability.
A *site* sustainability portion of the plan for operation shall be developed and shall contain the following provisions:

a. Where trees and vegetation are used to comply with the shade requirements of Section 501.3.5 (5.3.5), the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5 (Section 5).
b. For *roof* surface materials selected to comply with the requirements of Section 501.3.5.3 (5.3.5.3), the plan for operation shall include the maintenance procedures for keeping the *roof* surfaces cleaned in accordance with manufacturer's recommendations.
c. For vegetated terrace and roofing systems selected to comply with Section 501.3.5.5 (5.3.5.5), the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth and *roof* membrane system. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5 (Section 5).

1001.9.2 (10.9.2) 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.

1001.9.2.1 (10.9.2.1) Initial M&V.
Use the water measurement devices and collection/storage infrastructure specified in Section 601.3.5 (6.3.5) to collect and store water use data for each device, starting no later than after building *FPT* has been completed and certificate of occupancy has been issued.

1001.9.2.2 (10.9.2.2) Track and assess water use.
The plan shall specify the procedures for tracking and assessing the *building project* water use and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Water use reports.** Develop a plan for collecting *building project* water use data for water sources and subsystems measured in Section 601.3.5 (6.3.5).
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.

1001.9.2.3 (10.9.2.3) 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.

1001.9.3 (10.9.3) 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.

1001.9.3.1 (10.9.3.1) Initial M&V.
Use the energy measurement devices and collection/storage infrastructure specified in Section 701.3.3 (7.3.3) to collect and store energy data for each device, starting no later than after FPT has been completed and certificate of occupancy has been issued.

1001.9.3.2 (10.9.3.2) Track and assess energy consumption.
The plan for operation shall specify the procedures for tracking and assessing the *building project* energy performance and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Energy use reports.** Develop a plan for collecting *building project* energy data for energy sources and system energy loads measured in Section 701.3.3 (7.3.3). The reports shall include the following, as a minimum:

1. Hourly load profile for each day.
2. Monthly average daily load profile.
3. Monthly and annual energy use.
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.

1001.9.3.3 (10.9.3.3) Documentation of energy efficiency.
All documents associated with the M&V of the building's energy efficiency shall be retained by the *owner*.

1001.9.4 (10.9.4) IAQ.
The plan for operation shall include the requirements of ASHRAE Standard 62.1, Section 8, and shall describe additional procedures for implementing a regular indoor environmental quality M&V program after building occupancy.

1001.9.4.1 (10.9.4.1) Outdoor airflow measurement.
The plan for operation shall document procedures for implementing a regular outdoor airflow monitoring program after building occupancy and shall meet the following requirements:

a. For each mechanical ventilation system where direct outdoor airflow measurement is required according to Section 801.3.1.2 (8.3.1.2), a procedure shall be in place to respond when there is notification that the *minimum outdoor airflow* is in an *outdoor air fault condition*. For systems that use a damper indicator instead of a direct measurement, per the exception to Section 801.3.1.2 (8.3.1.2), a procedure shall be in place to respond when there is notification that the indicator identifies that the damper is out of position.
b. For each mechanical ventilation system where direct *minimum outdoor airflow* measurement is required according to Section 801.3.1.2 (8.3.1.2), the *minimum outdoor airflow* shall be recorded every three months in either electronic or written form.
c. For systems that use a damper indicator per the exception to Section 801.3.1.2 (8.3.1.2), the *minimum outdoor airflow* shall be measured and recorded in either electronic or written form every two years for air-handling systems with a design supply airflow rate of more than 2000 cfm (1000 L/s). The *minimum outdoor airflow* shall be measured using methods as described in ANSI/ASHRAE Standard 111 and with an accuracy of ±10% or better.

1001.9.4.2 (10.9.4.2) Outdoor airflow scheduling.
Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.

1001.9.4.3 (10.9.4.3) Outdoor airflow documentation.
The following documentation shall be maintained concerning outdoor airflow M&V:

a. A list of each air system requiring direct outdoor airflow measurement.
b. Monitoring procedures and monitoring frequencies for each monitored sensing device, including a description of the specific response measures to be taken if needed.
c. Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.
d. Operation and calibration check procedures and the records associated with operation checks and recalibration.

1001.9.4.4 (10.9.4.4) 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 nonattainments areas for PM2.5, as defined by USEPA, air filtration and/or air cleaning equipment, as defined in Section 801.3.1.3(a) [8.3.1.3(a)], shall be operated

continuously during occupied hours or when the USEPA Air Quality Index exceeds 100 or equivalent designation by the local authorities for PM2.5.

Exception: *Spaces* without mechanical ventilation.

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

Exception: *Spaces* without mechanical ventilation.

c. Biennial monitoring of IAQ by one of the following methods:

1. Performing IAQ testing as described in Section 1001.7.1.2 (10.7.1.2).
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 under Section 1001.8 (10.8), operation, maintenance, and monitoring procedures shall include all of the following:

1. Quarterly inspection 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/m^3). Where radon testing indicates that the indoor radon concentration is 2.7 pCi/L (100 Bq/m^3) 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/m^3).

    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.

1001.9.4.5 (10.9.4.5) Outdoor air ozone air cleaners.

Ozone air cleaning devices required under Section 801.3.1.3 (8.3.1.3) shall be operated whenever outdoor ozone concentrations are forecast to exceed applicable regulatory limits.

1001.9.5 (10.9.5) Building green cleaning plan.

A green cleaning plan shall be developed for the *building project* in compliance with Green Seal Standard GS-42.

Exception: *Dwelling units* of a *building project.*

1001.9.6 (10.9.6) Moisture measurement.

The plan for operation shall document procedures for implementing a regular humidity sensor monitoring program after building occupancy. Such procedures shall include provisions for the following:

a. For systems complying with Section 801.3.1.4 (8.3.1.4), using relative humidity sensors to determine *HVAC zone* relative humidity directly, or using dew-point and zone temperature sensors to determine *HVAC zone* relative humidity indirectly, the relative humidity determined shall be checked annually and compared to the relative humidity established using methods described in ASHRAE Standard 111.
b. Sensors shall be cleaned or repaired and recalibrated as necessary to ensure that sensor measurements are within 10% of actual relative humidity measurements.

1001.9.7 (10.9.7) Indoor environmental quality survey.
The plan for operation shall include an indoor environmental quality occupant survey complying with all of the following:

a. The survey shall be implemented within a period of 6 to 18 months after issuance of the certificate of occupancy. The survey shall be repeated not less often than once every three years.
b. The survey questions shall include satisfaction questions and diagnostic questions for IAQ, lighting, acoustics, and thermal comfort. The survey questions shall use a seven-point satisfaction scale and comply with ANSI/ASHRAE Standard 55, Section 7.3.1.1.
c. A plan for reporting 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.

1001.9.8 (10.9.8) Renewable energy certificate tracking.
For multitenant buildings where *RECs* are transferred to tenants, the plan for operation shall include procedures for tracking the quantity and vintage of *RECs* that are required to be retained and retired in compliance with Sections 701.3.2 (7.3.2) and 701.4.1.1 (7.4.1.1) of this code. The plan shall include provisions to transfer the *RECs* to building tenants, or to retire *RECs* on their behalf in proportion to the *gross conditioned* and *semiheated floor area* leased or rented. The plan shall include provisions to use a *REC* tracking system that meets the requirements of Section V.B of the Green-e Framework for Renewable Energy Certification. The plan shall describe how the building *owner* will procure alternative qualifying renewable energy in the case that the renewable energy producer ceases operation.

1001.9.9 (10.9.9) Renewable energy allocation to multiple buildings.
Where renewable energy is allocated to multiple buildings in compliance with Section 701.4.1.3(g) [7.4.1.3(g)], the plan shall indicate how renewable energy produced from on-site or off-site systems that is not allocated before issuance of the certificate of occupancy will be allocated to new or existing buildings included in the *building project*. The plan shall indicate who will be responsible for retaining the documentation for allocations and where it will be stored so that it can be made available for inspection by the *AHJ* upon request.

Where multiple buildings in a *building project* share a common utility interconnection and are served by the same *on-site renewable energy system*, the building *owner* shall allocate for not less than 15 years the annual *REC* generation of the on-site renewable energy system to the *buildings* served by

the system. The annual generation vintage date of delivered *RECs* shall be allocated to the same 12 month reporting year, up to six months prior, or up to three months after the calendar year in which the electricity is used in the building. The annual allocation of *RECs* shall be documented as part of the plan. The plan shall indicate who will be responsible for retaining the documentation and where it will be stored so that it can be made available for inspection by the *AHJ* upon request.

1001.9.10 (10.9.10) 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 ASHRAE/ACCA Standard 180 for HVAC systems in buildings that meet the definition of commercial buildings in Standard 180.

b. The plan shall address all elements of ASHRAE/ACCA Standard 180, Section 4, and shall develop required inspection and maintenance tasks similar to ASHRAE/ACCA Standard 180, Section 5, for electrical and plumbing systems in buildings that meet the definition of commercial buildings in ASHRAE/ACCA Standard 180.

c. *Outdoor air* delivery monitors required by Section 801.3.1.2 (8.3.1.2) shall be visually inspected at least once each quarter and cleaned or repaired, as necessary, and calibrated at the manufacturer's recommended interval or not less than once per year, whichever is more frequent.

d. For systems with a damper indicator and with less than 2000 cfm (1000 L/s) of supply air, the system components that control the *minimum outdoor airflow* shall be visually inspected every two years. Records of this inspection shall be maintained on-site either in electronic or written form.

e. Documentation of the plan and of completed maintenance procedures shall be maintained on the building *site* at all times in:

1. Electronic format for storage on the building energy management system (EMS), building management system (BMS), computerized maintenance management system (CMMS), or other computer storage means, or
2. Maintenance manuals specifically developed and maintained for documenting completed maintenance activities.

1001.10 (10.10)[JO] Service life plan.

A service life plan that is consistent with the *OPR* shall be developed to estimate to what extent structural, *building envelope* (not mechanical and electrical), and *hardscape* materials will need to be repaired or replaced during the service life of the building. The design service life of the building shall be no less than that determined using Table 1001.10 (10.10). The estimated service life shall be documented for building assemblies, products, and materials that will need to be inspected, repaired, and/or replaced during the service life of the building. *Site* improvements and *hardscape* shall also be included. Documentation in the service life plan shall include the *building project* design service life and basis for determination, and the following for each assembly or component:

a. Building assembly description.

b. Materials or products.

c. Design or estimated service life in years.

d. Maintenance frequency.

e. Maintenance access for components with an estimated service life less than the service life of the building.

Provide a service life plan at the completion of design development. The *owner* shall retain a copy of the service life plan for use during the life of building.

TABLE 1001.10 (TABLE 10.10)
MINIMUM DESIGN SERVICE LIFE FOR BUILDINGS

CATEGORY	MINIMUM SERVICE LIFE	BUILDING TYPES
Temporary	Up to 10 years	Nonpermanent construction buildings (sales offices, bunkhouses); temporary exhibition buildings
Medium life	25 years	Industrial buildings; stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

1001.11 (10.11) Transportation management plan.
A transportation management plan shall be developed compliant with the following requirements. The *owner* shall retain a copy of the transportation management plan.

1001.11.1 (10.11.1) All building projects.
The plan shall include the following:

a. Preferred parking for carpools and vanpools with parking facilities.
b. A plan for bicycle transportation.

1001.11.2 (10.11.2)[JO] Owner-occupied building projects or portions of building projects.
For *owner*-occupied buildings, or for the employees in the *owner*-occupied portions of a building, the building *owner* shall offer at least one of the following primary benefits to the *owner*'s employees:

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.

Exception: Multifamily *residential building project.*

In addition, the *owner* shall provide all of the following to the *owner*'s employees:

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.

1001.11.3 (10.11.3)[JO] Building tenant.

The building *owner*:

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

CHAPTER11

NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

AARST

American Association of Radon Scientists and Technologists 527 N. Justice Street Hendersonville, NC 28739

ANSI/AARST RMS-LB-2018:
Radon Mitigation Standards for Schools and Large Buildings
1001.3.9 (10.3.9), 1001.9.4.4 (10.9.4.4)

ANSI/AARST MALB-2014:
Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings
1001.3.9 (10.3.9), 1001.9.4.4 (10.9.4.4)

AHAM

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

ANSI/AHAM RAC-1—2015:
Room Air Conditioners
Appendix B

AHRI

Air-Conditioning, Heating, and Refrigeration Institute 2111 Wilson Blvd, Suite 500 Arlington, VA22201

ANSI/AHRI 210/240—2017:
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-C744-17)
Appendix B

AHRI 340/360—2019:
Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
Appendix B

ANSI/AHRI 365—2009:
Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units
Appendix B

ANSI/AHRI 460—2005:
Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
Appendix B

ANSI/AHRI 1230—2014 (with Addendum 1):
Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
Appendix B

AMCA

Air Movement and Control Association International, Inc. 30 West University Drive Arlington Heights, IL 60004-1893

AMCA 208—18:
Calculation of the Fan Energy Index
701.4.3.6.2 (7.4.3.6.2)

ANSI/AMCA 220—19:
Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating
701.4.2.5 (7.4.2.5)

ANSI

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

ANSI C78.377—2017:
American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products
801.3.5.3 (8.3.5.3)

ANSI Z21.10.3—2017:
Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous
Appendix B

ANSI Z21.11.2—2016:
Gas-fired Room Heaters, Volume II, Unvented Room Heaters
801.3.1.5 (8.3.1.5)

ANSI Z21.47—2016:
Gas-Fired Central Furnaces
Appendix B

ANSI Z83.4—2017/CSA 3.7—2017:
Non-recirculating Direct Gas-fired Industrial Air Heaters
801.3.1.5 (8.3.1.5)

ANSI Z83.8—2016:
Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
Appendix B

ANSI Z83.19—2009/CSA 2.35—2009:
Gas-fired High-intensity Infrared Heaters
801.3.1.5 (8.3.1.5)

APA

The Engineered Wood Association 7011 S. 19th Street, Tacoma, WA 98466-5333

ANSI A190.1—2017:
Standard for Wood Products-Structural Glued Laminated Timber
801.4.2.4 (8.4.2.4)

ANSI/APA PRG 320—2019
Standard for Performance-Rated Cross-Laminated Timber
801.4.2.4 (8.4.2.4)

ASA

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

ANSI/ASA S1.13—2005 (R2010):
Measurement of Sound Pressure Levels in Air
1001.5 (10.5)

ANSI/ASA S1.4—2014:
Sound Level Meters
1001.5 (10.5)

ANSI/ASA S12.60—2009/Part 2 (R2014):
Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors
801.3.3 (8.3.3), 801.3.3.4 (8.3.3.4)

ANSI/ASA S12.60—2010/Part 1 (R2015):
Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools
801.3.3 (8.3.3)

ANSI/ASA 12.72—2015:
Measuring the Ambient Noise Level in a Room
1001.5 (10.5)

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 (6.3.1.2.1)

ASHE

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

2018 FGI Guidelines:
Hospitals and Outpatient Facilities: Guidelines for Design and Construction of Hospitals
801.3.3 (8.3.3)

2018 FGI Guidelines:
Hospitals and Outpatient Facilities: Guidelines for Design and Construction of Outpatient Facilities
801.3.3 (8.3.3)

2018 FGI Guidelines:
Residential Health, Care and Support Facilities: Guidelines for Design and Construction of Residential Health, Care, and Support Facilities
801.3.3 (8.3.3)

ASHRAE

ASHRAE 180 Technology Parkway NW, Peachtree Corners, GA 30092

ANSI/ASHRAE Standard 52.2—2017:
Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
801.3.1.3 (8.3.1.3)

ANSI/ASHRAE Standard 55—2017 (with Addenda a and b)
Thermal Environmental Conditions for Human Occupancy
801.3.2 (8.3.2), 1001.9.7 (10.9.7)

ANSI/ASHRAE Standard 62.1—2019
Ventilation for Acceptable Indoor Air Quality
301.2 (3.2), 701.4.3.2 (7.4.3.2), 701.4.3.8 (7.4.3.8), 801.3 (8.3), 1001.4.2 (10.4.2), 1001.3.2.4 (10.3.2.4)

ANSI/ASHRAE Standard 62.2—2019:
Ventilation and Acceptable Indoor Air Quality in Residential Buildings
801.3.1 (8.3.1), 801.3.1.1 (8.3.1.1), 801.3.1.5 (8.3.1.5)

ANSI/ASHRAE/IES Standard 90.1—2019
Energy Standard for Buildings Except Low-Rise Residential Buildings
301.1 (3.1), 301.2 (3.2), 501.3.6 (5.3.6), 701.3.1 (7.3.1), 701.4.1 (7.4.1), 701.4.2 (7.4.2), 701.4.3 (7.4.3), 701.4.4 (7.4.4), 701.4.5 (7.4.5), 701.4.6 (7.4.6), 701.4.7 (7.4.7), 701.4.8 (7.4.8), 801.3.1.10 (8.3.1.10), 1001.6 (10.6), Appendix A, Appendix B, Appendix C

ANSI/ASHRAE Standard 111—2008 (RA 2017):
Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
801.3.1.2.2 (8.3.1.2.2), 1001.9.4 (10.9.4), 1001.9.6 (10.9.6)

ANSI/ASHRAE Standard 146—2011
Method of Testing and Rating Pool Heaters
Appendix B

ANSI/ASHRAE Standard 154—2016:
Ventilation for Commercial Cooking Operations
701.4.3.8.1 (7.4.3.8.1)

ANSI/ASHRAE Standard 160—2016:
Criteria for Moisture-Control Design Analysis in Buildings
801.3.6 (8.3.6)

ANSI/ASHRAE Standard 169—2013:
Climatic Data for Building Design Standards
701.3.1.1 (7.3.1.1)

ANSI/ASHRAE/ASHE Standard 170—2017
Ventilation of Health Care Facilities
801.3.1 (8.3.1)

ANSI/ASHRAE/ACCA Standard 180—2018
Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
301.2 (3.2), 1001.9.10 (10.9.10)

ANSI/ASHRAE/ASHE Standard 189.3—2017:
Design, Construction, and Operation of Sustainable High-Performance Health Care Facilities
401.1 (4.1)

ANSI/ASHRAE/IES Standard 202—2018:
Commissioning Process for Buildings and Systems
1001.3.2 (10.3.2), 1001.3.2.5 (10.3.2.5)

ANSI/ASHRAE Standard 209—2018:
Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

701.5.4 (7.5.4)

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 (6.3.2.1)

ASME A112.19.2—2020/CSA B45.1—20:
Ceramic Plumbing Fixtures
601.3.2.1 (6.3.2.1)

ASME A112.19.14—2013 (R2018):
Six-Liter Water Closets Equipped with a Dual Flushing Device
601.3.2.1 (6.3.2.1)

ASME A112.19.19—2021:
Vitreous China Nonwater Urinals
601.3.2.1 (6.3.2.1)

ASTM

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

C33/C33M—18:
Standard Specification for Concrete Aggregates
801.3.4.1.2 (8.3.4.1.2)

C518-15:
Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
Appendix A

C919—19:
Standard Practice for Use of Sealants in Acoustical Applications.
801.3.3.1.1 (8.3.3.1.1), 801.3.3.2.3.3 (8.3.3.2.3.3), 801.3.3.3.2 (8.3.3.3.2)

C920—18:
Standard Specification for Elastomeric Joint Sealants
801.3.4.1.1 (8.3.4.1.1)

C1371—15:
Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
501.3.5.4 (5.3.5.4)

C1549—16:
Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
501.3.5.4 (5.3.5.4)

D1003—13:
Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
301.2 (3.2), 801.4 (8.4), 801.4.1.1.3 (8.4.1.1.3), 801.4.1.3 (8.4.1.3)

D1785—15e1:
Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

801.3.4.1.3 (8.3.4.1.3)

D2559—12a (2018):
Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions

801.4.2.4 (8.4.2.4)

D5197—16:
Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)

801.4.2 (8.4.2), 1001.7 (10.7)

D5456—18:
Standard Specification for Evaluation of Structural Composite Lumber Products

801.4.2.4 (8.4.2.4)

D5055—16:
Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists

801.4.2.4 (8.4.2.4)

E90—09 (2016):
Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

801.3.3.1.1 (8.3.3.1.1)

E336—17a:
Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings

801.3.3.1.1 (8.3.3.1.1), 1001.5.2 (10.5.2)

E408—13 (2019):
Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques

501.3.5.4 (5.3.5.4)

E492—09 (2016) e1:
Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine

801.3.3.1.1 (8.3.3.1.1)

E779—10 (2018):
Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

1001.6 (10.6)

E972—96 (2013):
Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight

301.2 (3.2)

E1007—16:
Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures

801.3.3.1.1 (8.3.3.1.1)

E1643—18a:
Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

801.3.4.1.1 (8.3.4.1.1)

E1745—17:
Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

801.3.4.1.1 (8.3.4.1.1)

E1827—11 (2017):
Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door
1001.6 (10.6)
E1903—11:
Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process
301.2 (3.2)
E1918—16:
Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-sloped Surfaces in the Field
501.3.5.4 (5.3.5.4)
E1980—11
Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces
501.3.5.4 (5.3.5.4)
E2399/E2399M—19:
Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems
501.3.5.5 (5.3.5.5)
E2843—17:
Standard Specification for Demonstrating that a Building is in Walkable Proximity to Neighborhood Assets
501.3.1.1 (5.3.1.1)
E2844—15e1:
Standard Specification for Demonstrating That a Building's Location Provides Access to Public Transit
501.3.1.1 (5.3.1.1)
E2921—16:
Standard Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes and Rating Systems
901.5.1 (9.5.1)

BIFMA

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

ANSI/BIFMA e3—2019:
Furniture Sustainability Standard
801.4.2.5 (8.4.2.5), 901.4.1.4.3 (9.4.1.4.3)
ANSI/BIFMA M7.1—2011 (R2016):
Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components and Seating
801.4.2.5 (8.4.2.5), 801.5.2 (8.5.2)
ANSI/BIFMA X7.1—2011 (R2016):
Standard for Formaldehyde and TVOC Emissions of Low-Emitting Office Furniture Seating
801.4.2.5 (8.4.2.5)

BSI

BSI Customer Service 389 Chiswick High Road, London, W4 4AL, UK

BS EN 636:2012+A1:2015:
Plywood—Specifications
801.4.2.4 (8.4.2.4)

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
801.4.2.2 (8.4.2.2)
California Code of Regulations, Title 17, Sections 93120-93120.12:
Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products
801.4.2.4 (8.4.2.4)

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

CDPH/EHLB/Standard Method V1.2 (2017):
Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers—Version 1.2
801.4.2 (8.4.2), 801.5.2 (8.5.2), Table 1001.7.2 (Table 10.7.2), Appendix D

CEC
California Energy Commission 1516 Ninth Street, Sacramento, CA 95814

2019 Title 24 Part 6, JA 10:
Reference Appendices for the 2019 Building Energy Efficiency Standards. Joint Appendix JA10, Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements
801.3.5.4 (8.3.5.4)

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

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

CGSB
Canadian General Standards Board Place du Portage III, 6B1 11 Laurier Street, Gatineau, Quebec, K1A 1G6 Canada

CAN/CGSB 149.2019:
Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method
1001.6 (10.6)
CAN/CGSB 149.15-96:

Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems

1001.6 (10.6)

CITES

Convention on International Trade in Endangered Species of Wild Fauna and Flora International Environment House 11 Chemin des Anémones, CH-1219 Châtelaine, Geneva, Switzerland

CITES-1973, amended 1979 and 1983:
Convention on International Trade in Endangered Species of Wild Fauna and Flora

901.3.2 (9.3.2)

CPA

Composite Panel Association 19465 Deerfield Avenue, Suite 306, Leesburg, VA 20176

ANSI A208.1—2016
Particleboard

801.4.2.4 (8.4.2.4)

ANSI A208.2—2016
Medium Density Fiberboard (MDF) for Interior Applications

801.4.2.4 (8.4.2.4)

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 (5.3.5.4)

CSA

Canadian Standards Association 178 Rexdale Blvd. Toronto, ON, M9W 1R3, Canada

CAN/CSA 439—18:
Standard Laboratory Methods of Test for Rating the Performance of Heat/Energy-Recovery Ventilators

701.4.3.6.3 (7.4.3.6.3)

CSA O121—17:
Douglas Fir Plywood

801.4.2.4 (8.4.2.4)

CSA O151—17:
Canadian Softwood Plywood

801.4.2.4 (8.4.2.4)

CSA O153—13 (R2017):
Poplar Plywood

801.4.2.4 (8.4.2.4)

CSA O325—16:
Construction Sheathing

801.4.2.4 (8.4.2.4)

CTI

Cooling Technology Institute PO Box 681807, Houston, TX 77268

CTI ATC-105 (19):
Acceptance Test Code for Water Cooling Towers
Appendix B
CTI ATC-105S (11):
Acceptance Test Code for Closed-Circuit Cooling Towers
Appendix B
CTI ATC-106 (11):
Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers
Appendix B
CTI STD-201RS (19):
Standard for the Certification of Water Cooling Tower Thermal Performance
Appendix B

DHA

Decorative Hardwoods Association 42777 Trade West Dr., Sterling, VA 20166

ANSI/HPVA HP-1—2016:
American National Standard for Hardwood and Decorative Plywood
801.4.2.4 (8.4.2.4)

Green-e

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

Version 1.0, July 7, 2017:
Green-e Framework for Renewable Energy Certification
1001.9.8 (10.9.8)
Version 2.8, April 1, 2016:
Green-e Energy National Standard for Renewable Electricity Products
701.4.1.1 (7.4.1.1)

GS

Green Seal 1001 Connecticut Avenue, NW, Suite 827, Washington DC, 20036-5525

GS-36, 2.1, July 12, 2013:
Standard for Adhesives for Commercial Use
801.4.2.1.2 (8.4.2.1.2)
GS-42, July 7, 2015:
Standard for Commercial and Institutional Cleaning Services
1001.9.5 (10.9.5)

IA

Irrigation Association 8280 Willow Oaks Corporate Drive, Suite 400, Fairfax, VA 22031

Smart Water Application Technologies (SWAT) Climatologically Based Controllers, 8th Testing Protocol—September 2008:
Smart Water Application Technologies (SWAT), Turf and Landscape Irrigation System Smart Controllers, Climatologically Based Controllers

301.2 (3.2), 601.3.1.2.2 (6.3.1.2.2)

IAPMO

International Association of Plumbing and Mechanical Officials 5001 East Philadelphia Street, Ontario, CA 91761

Z124.9—2004:
Plastic Urinal Fixtures

601.3.2.1 (6.3.2.1)

ICC

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

2021 IBC:
International Building Code®

101.3, 102.4, 102.6, 107.1

2021 IEBC:
International Existing Building Code®

102.4, 102.6

2021 IECC:
International Energy Conservation Code®

101.5.2, 102.4

2021 IFC:
International Fire Code®

102.4, 102.6, 501.3.5.5 (5.3.5.5)

2021 IFGC:
International Fuel Gas Code®

102.4

2021 IMC:
International Mechanical Code®

102.4

2021 IPC:
International Plumbing Code®

102.4, 601.3.5.3 (6.3.5.3)

2021 IPMC:
International Property Maintenance Code®

102.4, 102.6

2021 IRC:
International Residential Code®

102.4

2021 ICC PC:

International Code Council Performance Code for Buildings and Facilities®

102.4

IEC

International Electrotechnical Commission IEC Regional Centre for North America (IEC-ReCNA), 446 Main Street, 16th Floor, Worcester, MA 01608

IEC EN 60034-30:
Rotating Electrical Machines—Part 30-1: Efficiency Classes of Line Operated AC Motors (IE code)

701.4.7.6 (7.4.7.6)

IES

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

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

501.3.6 (5.3.6)

LM-83—12:
Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)

301.2 (3.2), 801.5.1 (8.5.1)

TM-15—2011 including addendum "a":
Luminaire Classification System for Outdoor Luminaires

501.3.6.2 (5.3.6.2)

TM-30—2018:
IES Method for Evaluating Light Source Color Rendition

801.3.5.3 (8.3.5.3)

ISO

International Organization for Standardization ISO Central Secretariat Chemin de Blandonnet 8 CP 401 – 1214 Vernier Geneva, Switzerland

ISO-9972:2015:
Thermal Performance of Buildings—Determination of Air Permeability of Buildings—Fan Pressurization Method

1001.6 (10.6)

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

Appendix B

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

Appendix B

ISO 14025:2006:
Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures

901.4.1.4 (9.4.1.4)

ISO 14040:2006:
Environmental Management—Life Cycle Assessment—Principles and Framework
901.4.1.4 (9.4.1.4)

ISO 14044:2006:
Environmental Management—Life Cycle Assessment— Requirements and Guidelines
901.5.1 (9.5.1), 901.5.1.2 (9.5.1.2)

ISO-16890:2016:
Air Filters for General Ventilation
801.3.1.3 (8.3.1.3)

ISO 21930:2017:
Sustainability in Building and Civil Engineering Works—Core Rules for Environmental Product Declarations of Construction Products and Services
901.4.1.4 (9.4.1.4)

ISO/IEC-17025:2007:
General Requirements for the Competence of Testing and Calibration Laboratories
801.4.2 (8.4.2)

ISO/IEC 17065:2012:
Conformity Assessment—Requirements for Bodies Certifying Products, Processes, and Services
801.4.2 (8.4.2)

ISO/IEC Guide 59:2019:
ISO and IEC Recommended Practices for Standardization by National Bodies
901.4.1.3.1 (9.4.1.3.1)

LIHI

Low Impact Hydropower Institute 329 Massachusetts Avenue, Suite 6, Lexington, MA 02420

Version 2.03, December 20, 2018:
Low Impact Hydropower Certification Handbook
701.4.3.1 (7.4.3.1)

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 (7.4.3.1)

NEMA 77—2017:
Standard for Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
801.3.5.4 (8.3.5.4)

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

NEMA SSL7A—2015:
Phase-Cut Dimming for Solid State Lighting—Basic Compatibility
801.3.5.1 (8.3.5.1)

NFPA

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

NFPA 70—2020:
National Electrical Code

501.3.6.3 (5.3.6.3)

NFRC

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

ANSI/NFRC 200—2020:
Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence

301.2 (3.2)

NIST

National Institute of Standards and Technology 100 Bureau Drive, Gaithersburg, MD 20899

PS 1—19:
Voluntary Product Standard—Structural Plywood

801.4.2.4 (8.4.2.4)

PS 2—18:
Voluntary Product Standard—Performance Standard for Wood-Based Structural-Use Panels

801.4.2.4 (8.4.2.4)

PS 20—15:
American Softwood Lumber Standard

801.4.2.4 (8.4.2.4)

NSC

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

NSC 373—2013:
Sustainable Production of Natural Dimension Stone

901.4.1.4 (9.4.1.4)

NSF

NSF International 789 Dixboro Road, Ann Arbor, MI 48105

NSF/ANSI 44—2018:
Residential Cation Exchange Water Softeners

601.3.5 (6.3.5)

NSF/ANSI 58—2017:
Reverse Osmosis Drinking Water Treatment Systems

601.3.6 (6.3.6)

NSF/ANSI 140—2019:
Sustainability Assessment for Carpet

901.4.1.4.3 (9.4.1.4.3)

NSF/ANSI 332—2015:
Sustainability Assessment for Resilient Floor Coverings
901.4.1.4.3 (9.4.1.4.3)
NSF/ANSI 336—2018:
Sustainability Assessment for Commercial Furnishings Fabric
901.4.1.4.3 (9.4.1.4.3)
NSF/ANSI 342—2019:
Sustainability Assessment for Wallcovering Products
901.4.1.4.3 (9.4.1.4.3)
NSF/ANSI 347—2018:
Sustainability Assessment for Single Ply Roofing Membranes
901.4.1.4.3 (9.4.1.4.3)
NSF/ANSI 350—2018:
On-Site Residential and Commercial Water Reuse Systems
601.3.7 (6.3.7)

NZS

Standards New Zealand Ministry of Business, Innovation & Employment 15 Stout Street, Wellington, 6011

AS/NZS 2269.0:2012:
Australian/NewZealand Standard: Plywood—Structural
801.4.2.4 (8.4.2.4)

SCAQMD

South Coast Air Quality Management District California Air Resources Board 1001 "I" Street; P.O. Box 2815, Sacramento, CA 95812

SCAQMD Rule 1113r, Amended February 5, 2016:
Architectural Coatings
801.4.2.2 (8.4.2.2)
SCAQMD Rule 1168, Amended October 6, 2017:
Adhesive and Sealant Applications
801.4.2.1 (8.4.2.1)

TCNA

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

ANSI A138.1—2011:
Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials
901.4.1.4.3 (9.4.1.4.3)

UL

Underwriters Laboratories Inc. 333 Pfingsten Road, Northbrook, IL 60062

UL 100—2016:

Standard for Sustainability for Gypsum Boards and Panels
901.4.1.4.3 (9.4.1.4.3)

UL 102—2012:
Standard for Sustainability for Door Leafs
901.4.1.4.3 (9.4.1.4.3)

UL 727—2018:
Standard for Oil-Fired Central Furnaces
Appendix B

UL 731—2018:
Standard for Oil-Fired Unit Heaters
Appendix B

UL 2854 (First edition, January 25, 2018):
Standard for Sustainability for Renewable Low-Impact Electricity Products
701.4.1.3 (7.4.1.3)

UL 2998 (2019):
Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners
801.3.1.3 (8.3.1.3)

US 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 (7.4.7.3)

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

USDA

United States Department of Agriculture Bio Preferred Program 1400 Independence Avenue, SW, Washington DC 20250

7 CFR Part 3201:
Guidelines for Designating Biobased Products for Federal Procurement
901.4.1.3 (9.4.1.3)

7 CFR Part 3202:
Voluntary Labeling Program for Biobased Products
901.4.1.3 (9.4.1.3)

USDOE

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

10 CFR Part 430, App N:
Uniform Test Method for Measuring the Energy Consumption of Furnaces
Appendix B

USEPA

United States Environmental Protection Agency Ariel Rios Building 1200 Pennsylvania Avenue, NW, Washington DC 20460

Code of Federal Regulations, Title 40 Part 50 (40 CFR 50), as amended July 1, 2004:
National Primary and Secondary Ambient Air Quality Standards

801.3.1.3 (8.3.1.3)

Code of Federal Regulations, Title 40 Part 770 (40 CFR 770), published December 12, 2016:
Formaldehyde Standards for Composite Wood Products

801.4.2.4 (8.4.2.4)

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

501.3.7 (5.3.7)

EPA 625/R-96/0106, January 1999:
Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, Sections TO-1, TO-11, TO-17

1001.7 (10.7)

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

1001.4.1 (10.4.1)

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

801.4.2 (8.4.2)

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

601.3.2.1 (6.3.2.1)

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

601.3.2.1 (6.3.2.1)

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

601.3.1.2 (6.3.1.2)

Version 1.0, December 23, 2016:
ENERGY STAR Program Requirements for Connected Thermostat Products

701.4.7.4 (7.4.7.4)

Version 1.1, July 26, 2018:
WaterSense Specification for Showerheads

601.3.2.1 (6.3.2.1)

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

701.4.7 (7.4.7)

Version 1.2, January 1, 2011:
ENERGY STAR Program Requirements for Commercial Griddles

701.4.7 (7.4.7)

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

601.3.2.1 (6.3.2.1)

Version 2.0, February 1, 2013:
ENERGY STAR Program Requirements for Commercial Dishwashers
601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 2.0, February 2, 2014:
ENERGY STAR Program Requirements for Water Coolers
701.4.7 (7.4.7)

Version 2.0, January 1, 2019:
ENERGY STAR Program Requirements for Uninterruptible Power Supplies
701.4.7 (7.4.7)

Version 2.0, July 7, 2020:
ENERGY STAR Program Requirements for Room Air Cleaners
701.4.7 (7.4.7)

Version 2.0, October 1, 2011:
ENERGY STAR Program Requirements for Hot Food Holding Cabinets
701.4.7 (7.4.7)

Version 2.1 June 20, 2017:
ENERGY STAR Program Requirements for Lamps (Light Bulbs)
701.4.7 (7.4.7)

Version 2.2, August 15, 2019:
ENERGY STAR Program Requirements for Luminaires
701.4.7.3 (7.4.7.3)

Version 2.2, October 7, 2015:
ENERGY STAR Program Requirements for Commercial Ovens
701.4.7 (7.4.7)

Version 3.0, January 2, 2018:
ENERGY STAR Program Requirements for Commercial Ice Makers
601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 3.0, May 1, 2013:
ENERGY STAR Program Requirements for Audio and Video
701.4.7 (7.4.7)

Version 3.0, October 1, 2014:
ENERGY STAR Program Requirements for Boilers
701.4.7 (7.4.7)

Version 3.0, October 1, 2014:
ENERGY STAR Program Requirements for Telephony
701.4.7 (7.4.7)

Version 3.0, October 1, 2016:
ENERGY STAR Program Requirements for Commercial Fryers
701.4.7 (7.4.7)

Version 3.0, October 11, 2019:
ENERGY STAR Program Requirements for Imaging Equipment
701.4.7 (7.4.7)

Version 3.2, April 16, 2015:
ENERGY STAR Program Requirements for Geothermal Heat Pumps
701.4.7 (7.4.7)

Version 3.2, April 16, 2015:
ENERGY STAR Program Requirements for Residential Water Heaters

701.4.7 (7.4.7)

Version 4.0, April 29, 2020:
ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines
701.4.7 (7.4.7)

Version 4.0, June 15, 2018:
ENERGY STAR Program Requirements for Residential Ceiling Fans
701.4.7 (7.4.7)

Version 4.0, March 27, 2017:
ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers
701.4.7 (7.4.7)

Version 4.1, February 1, 2013:
ENERGY STAR Program Requirements for Furnaces
701.4.7 (7.4.7)

Version 4.1, February 21, 2018:
ENERGY STAR Specifications for Residential Ventilating Fans Eligibility Criteria
701.4.3.6.3 (7.4.3.6.3)

Version 4.1, October 1, 2015:
ENERGY STAR Program Requirements for Residential Ventilating Fans
701.4.7 (7.4.7)

Version 4.1, October 26, 2015:
ENERGY STAR Program Requirements and Criteria for Room Air Conditioners
701.4.7 (7.4.7)

Version 5.0, October 31, 2019:
ENERGY STAR Program Requirements for Dehumidifiers
701.4.7 (7.4.7)

Version 5.0, September 15, 2014:
ENERGY STAR Program Requirements for Refrigerators and Freezers
701.4.7 (7.4.7)

Version 5.0, September, 15, 2015:
ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners
701.4.7 (7.4.7)

Version 5.1, January 1, 2018:
ENERGY STAR Program Requirements for Set-Top Boxes
701.4.7 (7.4.7)

Version 6.0, January 1, 2016:
ENERGY STAR Program Requirements Product Specification for Residential Dishwashers
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)

Version 7.1, November 16, 2018:
ENERGY STAR Program Requirements for Computers
701.4.7 (7.4.7)

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)

Version 8.0, January 28, 2020:
ENERGY STAR Program Requirements for Displays
701.4.7 (7.4.7)

Version 8.0, March 1, 2019:
ENERGY STAR Program Requirements for Televisions

701.4.7 (7.4.7)

WTO

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

WTO TBT—1994:
WTO Technical Barriers to Trade (TBT) Agreement Annex 3 Code of Good Practice for the Preparation, Adoption and Application of Standards

901.4.1.3.1 (9.4.1.3.1)

NORMATIVE APPENDIX A

PRESCRIPTIVE BUILDING ENVELOPE TABLES
This is a normative appendix and is part of this code.

TABLE A101.1 (TABLE A-1)
SINGLE-RAFTER ROOF REQUIREMENTS (I-P) (SUPERSEDES TABLE A2.4.2 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 A101.1 (TABLE A-1)
SINGLE-RAFTER ROOF REQUIREMENTS (SI) (SUPERSEDES TABLE A2.4.2 IN ANSI/ASHRAE/IES STANDARD 90.1)

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-38 U-0.165

NORMATIVE APPENDIX B

PRESCRIPTIVE EQUIPMENT EFFICIENCY TABLES FOR THE ALTERNATE REDUCED RENEWABLES AND INCREASED EQUIPMENT EFFICIENCY APPROACH IN SECTION 701.4.1.1 (7.4.1.1)

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

Informative Note: The first 11 tables appear in I-P units and are followed by 11 tables in SI units.

TABLE B101.1 (TABLE B-1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

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	
	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240

Air conditioners, water cooled	≥ 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 <	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360

	135,000 Btu/h	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 details on the referenced test procedures, including year and version of the test procedure.

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

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	
Water-to-air water loop (cooling mode)	< 17,000 Btu/h	All	86°F entering water	14.0 EER	ISO-13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	14.0 EER	
	> 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	14.0 EER	
Water-to-air ground water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	

Water-to-air ground loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	
Water-to-water water loop (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water-to-water groundwater (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine-to-water ground loop (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 (TABLE B-3)
ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 (TABLE B-4)
SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS, AND ROOM AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 <		10.3 *CEER*	9.8 *CEER*	

	28,000 Btu/h				
	≥ 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 (TABLE B-5)
WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 US Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.
c. Compliance of multiple firing rate units shall be at the maximum firing rate.
d. E_t = thermal *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a *flue damper*. A *vent damper* is an acceptable alternative to a *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
e. E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.
f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an *automatic flue damper*.

TABLE B101.6 (TABLE B-6)
GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

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/hd	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 (TABLE B-7)
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT	SUBCATEGORY OR RATING CONDITION[g]	PERFORMANCE REQUIRED [a, b, c, d, e, f, i]	TEST PROCEDURE[h]

	RATED CONDITIONS			
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 temperature75°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	All	R-507A test fluid 165°F entering gas temperature 105°F condensing	≥157,000 Btu/h × hp	CTI ATC-106

evaporative condensers		temperature 75°F entering wb		
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 subcooling95°F entering wb	≥176,000 Btu/h × hp	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the fan motor nameplate power.
b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
d. For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
e. The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.
f. All cooling towers, closed-circuit coolers, evaporative condensers, and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.
g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.
h. Informative Appendix G contains information on the referenced test procedures.
i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

TABLE B101.8 (TABLE B-8)

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

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED[a]	TEST PROCEDURE[b]
Electric table-top water heaters[c]	≤12 kW	≥ 20 gal and ≤ 120 gal	Very small	UEF ≥ 0.6323 - 0.0058*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.9188 - 0.0031 *V*	
			Medium	UEF≥ 0.9577 - 0.0023 *V*	
			High	UEF≥ 0.9844 - 0.0016*V*	
Electric resistance storage water heaters		≥ 20 gal and ≤ 55 gal	Very small	UEF≥ 0.8808 - 0.0008*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.9254 - 0.0003 *V*	
			Medium	UEF≥ 0.9307 - 0.0002*V*	
			High	UEF≥ 0.9349 - 0.0001 *V*	
		> 55 gal		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		> 75 gal	Very small	UEF≥ 1.0136 - 0.0028*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.09984 - 0.0014*V*	

			Medium	UEF≥ 0.9853 - 0.0010*V*	
			High	UEF≥ 0.9720 - 0.0007*V*	
Heat-pump water heaters		≤ 55 gal		EF≥ 2.00, FHR≥50 gal	DOE 10 CFR Part 430
		> 55 gal	EF≥ 2.20, FHR≥50 gal		
Gas-fired storage water heaters	≤75,000 Btu/h	≤ 55 gal		EF≥ 0.67, FHR≥67 gal	DOE 10 CFR Part 430
		> 55 gal	EF≥ 0.77, FHR≥67 gal		
	>75,000 Btu/h	≤ 140 gal		E_t≥ 0.94 or EF≥ 0.93 and SL≤ 0.84 × (*Q*/800 + 110√*V*), Btu/h	ANSI Z21.10.3
Gas instantaneous water heaters	>50,000 Btu/h and <200,000 Btu/h[d]	≥ 4000 (Btu/h)/gal and < 2 gal		EF≥ 0.90 and GPM≥2.5 over a 77°F rise	DOE 10 CFR Part 430
	≥75,000 Btu/h[c]	≤ 140 gal and ≥ 4,000 (Btu/h)/gal		E_t≥ 0.94 or EF≥ 0.93 SL = 0.84 × (*Q*/800 + 110√*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 + 110√*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	≥ 4,000 (Btu/h)/gal and < 10 gal		E_t≥80%	ANSI Z21.10.3
	>210,000 Btu/h	≥ 4,000 (Btu/h)/gal and ≥ 10 gal		E_t≥78% and SL≤ (*Q*/800 + 110√*V*), Btu/h	
Solar water heater		Electric backup		SEF≥1.8	ANSI Z21.10.3
		Gas backup		SEF≥1.2	
Hot-water supply boilers, gas and oil	>300,000 Btu/h and ≤ 12,500,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		E_t≥80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 4.000 (Btu/h)/gal and ≥ 10 gal		E_t≥80% SL≤(*Q*/800 + 110√*V*), Btu/h	ANSI Z21.10.3
Hot-water supply boilers, oil		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		E_t≥78% SL≤(*Q*/800 + 110√*V*), Btu/h	

Pool heaters, gas	All sizes			*Et*≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			*Et*≥ 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 (Et) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.
b. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.
c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."
d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.

TABLE B101.9 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (I-P)

PRODUCT	MEF[a]	WF[b], gal/ft^3
All commercial clothes washers	1.72	4.0

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.
b.*WF* = *water factor* (in gal/ft^3).

TABLE B101.10 (TABLE B-10)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.4 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 13.0 IEER	

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

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

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRF air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.3 EER 14.6 IEER	

	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	11.1 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.9 EER 13.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.7 EER 13.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 12.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.1 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit systems 86°F entering water	14.0 EER 16.0 IEER	AHRI 1230
	< 65,000 Btu/h	All	VRF multisplit systems with heat recovery 86°F entering water	13.8 EER 15.8 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system 86°F entering water	14.0 EER 16.0 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system with heat	13.8 EER 15.8 IEER	

			recovery 86°F entering water		
	≥ 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	13.2 EER	

			recovery 77°F entering water		
	≥ 135,000 Btu/h	All	VRF multisplit system 77°F entering water	11.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	10.8 EER	
VRF air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	8.5 HSPF	AHRI 1230
	≥ 65,000 Btu/h and< 135,000 Btu/h(cooling capacity)		VRF multisplit system 47°F db/43°F wb *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.

Informative Note: These tables are the same as Tables B101.1–B101.11 but are provided in SI units.

TABLE B101.1 (TABLE B-1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES STANDARD 90.1)

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_C3.87 $ICOP_C$	
		All other	Split systems and single package	3.52 COP_C3.81 $ICOP_C$	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.17 COP_C3.60 $ICOP_C$	
		All other	Split systems and single package	3.11 COP_C3.55 $ICOP_C$	

	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.05 COP_C3.40 $ICOP_C$	
		All other	Split systems and single package	2.99 COP_C3.34 $ICOP_C$	
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_C4.48 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	4.04 COP_C4.43 $ICOP_C$	
	≥40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C4.34 $ICOP_C$	
		All other	Split systems and single package	4.04 COP_C4.28 $ICOP_C$	
	≥70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C4.34 $ICOP_C$	
		All other	Split systems and single package	3.99 COP_C4.28 $ICOP_C$	

	≥223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C4.34 $ICOP_C$	
		All other	Split systems and single package	4.04 COP_C4.28 $ICOP_C$	
Air conditioners, evaporatively cooled	< 19 kW	All	Split systems and single package	4.10 COP_C4.48 $ICOP_C$	AHRI 210/240
	≥19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP_C4.48 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	4.04 COP_C4.43 $ICOP_C$	
	≥40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C4.19 $ICOP_C$	
		All other	Split systems and single package	3.90 COP_C4.13 $ICOP_C$	
	≥70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C4.19 $ICOP_C$	
		All other	Split systems and single package	3.90 COP_C4.13 $ICOP_C$	
	≥223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP_C4.19 $ICOP_C$	

		All other	Split systems and single package	3.90 COP_C4.13 $ICOP_C$	
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 details on the referenced test procedures, including year and version of the test procedure.

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

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_C3.60 $ICOP_C$	AHRI 340/360
		All other	Split systems and single package	3.25 COP_C3.55 $ICOP_C$	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.19 COP_C3.40 $ICOP_C$	
		All other	Split systems and single package	3.14 COP_C3.34 $ICOP_C$	
	>70 kW	Electric resistance (or none)	Split systems and single package	3.02 COP_C3.11 $ICOP_C$	
		All other	Split systems and single package	2.96 COP_C3.05 $ICOP_C$	
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	
		All	Split systems	2.17 COP_H	

Through-the-*wall*, air cooled (heating mode)	< 9 kW (cooling capacity)		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 (cooling capacity)		8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	AHRI 340/360
			–8.3°C db/9.4°C wb *outdoor air*	2.40 COP_H	
	>40 kW (cooling capacity)		8.3°C db/6.1°C wb *outdoor air*	3.20 COP_H	
			–8.3°C db/9.4°C wb *outdoor air*	2.10 COP_H	
Water-to-air water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	4.60 COP_H	ISO-1356-1
Water-to-air groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.70 COP_H	

Brine-to-air ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	3.20 COP_H	
Water-to-water water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	3.70 COP_H	ISO-13256-2
Water-to-water groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.10 COP_H	
Brine-to-water ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	2.50 COP_H	

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

TABLE B101.3 (TABLE B-3)
ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 (TABLE B-4)
SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS, AND ROOM AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES STANDARD 90.1)

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_C3.78 $ICOP_C$		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb *outdoor air*	3.22 COP_C3.63 $ICOP_C$		

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_C3.58 $ICOP_C$		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb *outdoor air*	3.11 COP_C3.40 $ICOP_C$		
SPVHP (heating mode)	< 19 kW	8.3°C db/6.1°C wb *outdoor air*	2.34 $SCOP_H$		AHRI 210/240
	≥19 kW and < 40 kW	8.3°C db/6.1°C wb *outdoor air*	3.30 COP_H		AHRI 340/360
	≥40 kW and < 70 kW	8.3°C db/6.1°C wb *outdoor air*	3.2 COP_H		
Room air conditioners, with louvered sides	< 1.8 kW		3.55 $CCOP_C$	3.37 $CCOP_C$	ANSI/AHAM RAC-1
	≥1.8 kW and < 2.3 kW		3.55 $CCOP_C$	3.37 $CCOP_C$	
	≥2.3 kW and < 4.1 kW		3.52 $CCOP_C$	3.37 $CCOP_C$	

	≥4.1 kW and < 5.9 kW		3.46 $CCOP_C$	3.28 $CCOP_C$	
	≥5.9 kW and < 8.2 kW		3.02 $CCOP_C$	2.87 $CCOP_C$	
	≥8.2 kW		2.90 $CCOP_C$	2.75 $CCOP_C$	
Room air conditioners, without louvered sides	< 1.8 kW		3.22 $CCOP_C$	3.08 $CCOP_C$	
	≥1.8 kW and < 2.3 kW		3.22 $CCOP_C$	3.08 $CCOP_C$	
	≥2.3 kW and < 3.2 kW		3.11 $CCOP_C$	2.96 $CCOP_C$	
	≥3.2 kW and < 4.1 kW		3.08 $CCOP_C$	2.93 $CCOP_C$	
	≥4.1 kW and < 5.9 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	
	≥5.9 kW		3.02 $CCOP_C$	2.87 $CCOP_C$	
Room air conditioner heat pump, with louvered sides	< 5.9 kW		3.17 $CCOP_C$	3.02 $CCOP_C$	
	≥5.9 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	

Room air conditioner heat pump, without louvered sides	< 4.1 kW		2.99 $CCOP_C$	2.84 $CCOP_C$	
	≥4.1 kW		2.81 $CCOP_C$	2.67 $CCOP_C$	
Room air conditioner, casement only	All capacities		3.08 $CCOP_C$	2.93 $CCOP_C$	
Room air conditioner, casement-slider	All capacities		3.34 $CCOP_C$	3.17 $CCOP_C$	

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

TABLE B101.5 (TABLE B-5)
WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/IES STANDARD 90.1)

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 US Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.
c. Compliance of multiple firing rate units shall be at the maximum firing rate.
d. E_t = thermal *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a *flue damper*. A *vent damper* is an acceptable alternative to a *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
e. E_c = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.
f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an *automatic flue damper*.

TABLE B101.6 (TABLE B-6)
GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)

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	
		≥87.9 kW and < 732.7 kW[d]	77% E_t	

	Gas fired natural draft	≥732.7 kW[a]	77% E_t	
	Oil fired[e]	< 87.9 kW	82% AFUE	10 CFR Part 430
		≥87.9 kW and < 732.7 kW[d]	81% E_t	10 CFR Part 431
		≥732.7 kW[a]	81% E_t	

a. These requirements apply to boilers with rated input of 2344 kW or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
c. E_t = thermal efficiency. See reference document for detailed information.
d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
e. Includes oil fired (residual).
f. Systems shall be designed with lower operating return hot-water temperatures (< 55°C) and use hot-water reset to take advantage of the higher efficiencies of condensing boilers.
g. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure. h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. Boilers shall not be equipped with a continuous pilot ignition system.

TABLE B101.7 (TABLE B-7)
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/IES STANDARD 90.1)

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	≥53.1 COP	CTI ATC-106

		temperature 23.9°C entering wb		
Air-cooled condensers	All	88°C entering gas temperature 52°C condensing temperature 8°C subcooling 35°C entering wb	≥69 COP	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the fan motor nameplate power.
b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
d. For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
e. The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.
f. All cooling towers, closed-circuit coolers, evaporative condensers and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.
g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.
h. Informative Appendix G contains information on the referenced test procedures.
i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

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

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED[a, d]	TEST PROCEDURE[b]

Electric table-top water heaters[c]	≤12 kW	≥75.7 L and ≤454 L	Very small	UEF≥ 0.6323 - 0.0015*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.9188 - 0.00082*V*	
			Medium	UEF≥ 0.9577 - 0.00061*V*	
			High	UEF≥ 0.9844 - 0.00042*V*	
Electric resistance storage water heaters		≥75.7 L and ≤ 208 L	Very small	UEF≥ 0.8808 - 0.00021*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.9254 - 0.000079*V*	
			Medium	UEF≥ 0.9307 - 0.000053 *V*	
			High	UEF≥ 0.9349 - 0.000026*V*	
		> 208 L		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		≥284 L	Very small	UEF≥ 1.0136 - 0.00074*V*	DOE 10 CFR Part 430
			Low	UEF≥ 0.09984 - 0.00037*V*	
			Medium	UEF≥ 0.9853 - 0.00026*V*	
			High	UEF≥ 0.9720 - 0.00018 *V*	

Heat-pump water heaters		≤208 L		EF ≥ 2.00, FHR≥ 190 L	DOE 10 CFR Part 430
		> 208 L		EF ≥ 2.20, FHR≥ 190 L	
Gas-fired storage water heaters	≤22.0 kW	≤208 L		EF ≥ 0.67, FHR≥ 250 L	DOE 10 CFR Part 430
		> 208 L		EF ≥ 0.77, FHR≥ 250 L	
	>22.0 kWh	≤530 L		*Et* ≥ 0.94 or EF≥ 0.93 and SL≤ 0.84 × (*Q*/234 + 56.5√*V*), W	ANSI Z21.10.3
Gas instantaneous water heaters	>14.6 kW and <58.6 kW	≥ 309.7 W/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 ≥ 309.7 W/L		E_t≥ 0.94 or EF≥ 0.93 SL = 0.84 × (*Q*/234 + 56.5√*V*), W	ANSI Z21.10.3
Oil storage water heaters	≤30.7 kW	≤190 L	Very small	EF = 0.2509 – 0.00032*V*	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.00042*V*	
			Medium	EF = 0.6078 – 0.00042*V*	
			High	EF = 0.6815 – 0.0037*V*	

	>30.7 kW	< 309.7 W/L		E_t≥80% and SL≤ (Q/234 + 56.5√V), 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	≥ 309.7 W/L and ≥ 30 L		E_t≥78% and SL≤ (Q/234 + 56.5√V), W	
Solar water heater		Electric backup		SEF≥1.8	ANSI Z21.10.3
		Gas backup		SEF≥1.2	
Hot-water supply boilers, gas and oil	>88 kW and ≤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 + 56.5√V), W	ANSI Z21.10.3
Hot-water supply boilers, oil		≥ 309.7 W/L and ≥ 30 L		E_t≥78% SL ≤ (Q/234 + 56.5√V), 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 × m^2/W	None

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum *W* based on a 21°C temperature difference between stored water and ambient requirements. In the EF equation, *V* is the rated volume in liters. In the SL equation, *V* is the rated volume in liters and *Q* is the nameplate input rate in kW.
b. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.
c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."
d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.

TABLE B101.9 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (SI)

PRODUCT	MEF[a]	WF[b], L/L
All commercial clothes washers	48.7	0.53

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many liters of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.
b.*WF* = *water factor* (in L/L).

TABLE B101.10 (TABLE B-10)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/IES STANDARD 90.1)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]

VRF air conditioners, air cooled	< 19 kW	All	VRF multisplit system	4.40 $SCOP_C$ 3.36 COP_C	AHRI 1230
	≥19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP_C 4.37 $ICOP_C$	
	≥40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP_C 4.22 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system	3.08 COP_C 3.81 $ICOP_C$	

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

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

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 < 40 kW	Electric resistance (or none)	VRF multisplit system	3.31 COP_C4.28 $ICOP_C$	
	≥19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.25 COP_C4.22 $ICOP_C$	

	≥40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.19 COP_C4.07 $ICOP_C$	
	≥40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.14 COP_C4.02 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system	3.02 COP_C4.02 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	2.96 COP_C3.66 $ICOP_C$	
VRF water source (cooling mode)	< 19 kW	All	VRF multisplit systems 30°C entering water	4.10 COP_C4.69 $ICOP_C$	AHRI 1230
	< 19 kW	All	VRF multisplit systems with heat recovery 30°C entering water	4.04 COP_C4.63 $ICOP_C$	
	≥19 kW and < 40 kW	All	VRF multisplit system 30°C entering water	4.10 COP_C4.69 $ICOP_C$	
	≥19 kW and < 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	4.04 COP_C4.63 $ICOP_C$	
	≥40 kW	All	VRF multisplit system 30°C entering water	3.40 COP_C4.10 $ICOP_C$	

	≥40 kW	All	VRF multisplit system with heat recovery 30°C entering water	3.28 COP_C4.04 $ICOP_C$	
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 (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	
			–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

PERFORMANCE OPTION FOR ENERGY EFFICIENCY
This is a normative appendix and is part of this code.

SECTION C101 (C1)
GENERAL

C101.1 (C1.1) Renewable, recovered, and purchased energy.
On-site renewable energy systems and *site* recovered energy: The modeling requirements for *on-site renewable energy systems* in the *proposed building performance* in ANSI/ASHRAE/IES Standard 90.1, Section G2.4.1, shall not apply and are superseded by Table C101.1 (C1.1), Section 15, "Renewable Energy Systems."

C101.2 (C1.2) Building performance calculations.
In addition to the requirements of ANSI/ASHRAE/IES Standard 90.1, Table G3.1, the *proposed design* shall comply with all modifications and additions in Table C101.1 (C1.1). All references to Table G3.1 in Table C101.1 (C1.1) refer to ANSI/ASHRAE/IES Standard 90.1, Appendix G, Table G3.1.

C101.3 (C1.3) Energy storage.
Electric and thermal storage systems, and ancillary energy consumption and charging, discharging, and standby losses associated with thermal and electric storage, shall be modeled in the *proposed design*.

C101.4 (C1.4) Modeling of district energy systems.
A *building project* served in whole or in part by a *district energy plant* shall comply with either Section C101.4.1 (C1.4.1) or C101.4.2 (C1.4.2).

C101.4.1 (C1.4.1) Modeling purchased district *heating or cooling*.
The *proposed building performance* and *baseline building performance* shall be calculated using the cost of purchased *district heating or cooling* for compliance with Section 701.5.1 (7.5.1) as defined in Standard 90.1, Sections G3.1.1.1, G3.1.1.2, and G3.1.1.3. CO_2e emission factors in Table 701.5.2 (7.5.2) for *district heating or cooling* shall be used for compliance with Section 701.5.2 (7.5.2).

C101.4.2 (C1.4.2) Performance modeling of district energy systems.
Two model simulation runs shall be completed for both the *proposed building performance* and *baseline building performance* in accordance with Sections C101.4.2(a) [C1.4.2(a)] and C101.4.2(b) [C1.4.2(b)].

a. The *proposed building performance* and *baseline building performance* shall be calculated using the cost of purchased *district heating or cooling* as defined in Standard 90.1, Sections G3.1.1.1, G3.1.1.2, and G3.1.1.3. The *proposed building* shall comply with Standard 90.1 using the Performance Rating Method.

b. Model the *district heating or cooling* in the *building project* using Standard 90.1, Normative Appendix G, with the following additions and alterations. All demands on the *district energy system* from the *building project* shall be modeled using time steps no longer than one hour.

Documentation of *district energy systems* in the *proposed building performance* model shall be provided in accordance with the requirements defined in Standard 90.1, Section G2.5, "Exceptional Calculation Methods." Projects shall comply with either Section C101.4.2(b)(1) [C1.4.2(b)(1)] or C101.4.2(b)(2) [C1.4.2(b)(2)].

1. 1.**District energy system monitoring path.** Data from energy metering equipment on an existing *district energy plant* shall be used to derive energy performance. All input energy used to operate the *district energy plant*, and all output *district heating or cooling* delivered by the *district thermal distribution system*, shall be metered. All *district energy plant* monitoring equipment shall be in place for at least one full 12 month period. Metered energy performance figures shall be used for the *proposed building performance* model and shall be derived at a level of detail no longer than one month. The *baseline building performance* model shall be completed in accordance with the requirements outlined in Table C101.2 (C1.2).
2. 2.**District energy system modeling path.** Complete the requirements of the *proposed* and *baseline building performance* models defined in Table C101.2 (C1.2).

C101.5 (C1.5) Modeling nonrenewable on-site generation and *combined heat and power systems*.
Nonrenewable on-site generation and *combined heat and power systems* shall be simulated as follows:

a. ***Baseline building performance.*** The baseline building shall not include nonrenewable on-site generation or nonrenewable *combined heat and power systems*.

b. ***Proposed building performance*** **.** For proposed building designs that include nonrenewable on-site generation or nonrenewable *combined heat and power systems*, the system shall be modeled as designed, including consumption of all pumps and auxiliary equipment required for operation of the system, in accordance with the requirements of Section C101.4 (C1.4).

TABLE C101.1 (TABLE C1.1)
MODIFICATIONS AND ADDITIONS TO ANSI/ASHRAE/IES STANDARD 90.1, APPENDIX G, TABLE G3.1

PROPOSED BUILDING PERFORMANCE	**BASELINE BUILDING PERFORMANCE**
1. Design Model No modifications	No modifications
2. Additions and Alterations No modifications	No modifications
3. Space Use Classification No modifications	No modifications

4. Schedules No modifications	No modifications
5. Building Envelope When the total area of penetrations from mechanical equipment listed in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-4, exceeds 1% of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate assembly with a default U-factor of 0.5 Btu/h × ft^2 × °F (3 W/m^2 × K).	No modifications
6. Lighting No modifications	No modifications
7. Thermal Blocks—HVAC Zones Designed No modifications	No modifications
8. Thermal Blocks—HVAC Zones Not Designed No modifications	No modifications
9. Thermal Blocks—Multifamily Residential Buildings No modifications	No modifications
10. HVAC Systems No modifications	No modifications
11. Service Hot-Water Systems No modifications	No modifications
12. Receptacle and Other Loads No modifications	No modifications
13. Modeling Limitations to the Simulation Program No modifications	No modifications

14. Exterior Conditions No modifications	No modifications
15. On-Site Renewable Energy Systems The reduction in the proposed building annual energy cost CO_2e emissions and source energy due to *renewable energy systems* shall be calculated as follows: a. **Annual Energy Cost.** The annual energy cost of the *proposed design* shall be adjusted to account for renewable energy systems as follows: 1. **On-Site Thermal Energy Performance Calculation.** The hourly thermal loads of the *proposed design* shall be reduced by the hourly thermal energy production of the *on-site renewable energy system* (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption. 2. **On-Site Electric Renewable Energy Systems—Net Metering.** The total electrical energy production of the *on-site renewable energy system* shall be calculated on an hourly basis, and the energy cost of the *proposed building performance* shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the *on-site renewable energy system*. **Exception:** For *building projects* with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the *on-site renewable energy system,* but the cost of imported electricity shall not be less than zero on a monthly basis. Electricity production of the on-site renewable energy system that has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the building performance at the wholesale rate as follows: Credit =(ExRR−ImRR)ExRR×ExkWh×WR $\text{Credit} = \frac{(\text{ExRR} - \text{ImRR})}{\text{ExRR}} \times \text{ExkWh} \times \text{WR}$	

where:

Credit = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity.

ExRR = month's value of exported electricity at retail rate.

ImRR = month's value of imported electricity at retail rate.

ExkWh = total kilowatt-hours exported in month.

WR = average monthly wholesale rate for the region where the building located.

[Informative Note: Thermal renewable energy is accounted for in (a)(1), so the renewable energy addressed in (a)(2) will always be on-site electricity. There is no need to apply the renewable energy procurement factors from Table 701.4.1.2 (7.4.1.2), as the multiplier will always be one (1).]

3. **Electricity Generation from Off-Site Community Renewable Energy Systems— Virtual-, Aggregated-, or Community- Net-Metering Tariff.** Renewable energy systems that credit the building project electricity account on an hourly basis shall be calculated according to (a)(2) except that the renewable energy procurement factor from Table 701.4.1.2 (7.4.1.2) shall be applied to each hour of electricity production from the community renewable energy system. The energy cost credit for other offsite renewable energy systems shall be calculated according to (a)(4).

4. **Electricity Generation from Other Off-Site Renewable Energy Systems.** The adjusted renewable energy is the actual renewable energy for each procurement source of renewable energy delivered to or credited to the building project multiplied by the appropriate renewable energy factors in Table 701.4.1.2 (7.4.1.2). The annual energy cost reduction credited to the proposed design shall be the total adjusted renewable energy multiplied by the virtual electric rate paid by the building. The virtual electric rate is the total retail cost for electricity for the year divided by the net consumption for the year in dollars per kWh ($/kWh).

b. **Annual CO_2e.** The annual CO_2e emissions of the proposed building shall be equal to the annual CO_2e associated with all building energy use minus the *adjusted renewable energy* multiplied by the electrical CO_2e emission factor from Table 701.5.2 (7.5.2). Each procurement source of renewable energy delivered to or credited to the building project shall be multiplied by the renewable energy factors in Table 701.4.1.2 (7.4.1.2).

$$PD-CO2e=\sum PDSEi\times ei-\sum REk\times REPFk\times ek$$

where:

PD-CO_2e = CO_2e emissions for the proposed design.

PDSE$_i$ = Proposed design site energy use for energy type *i*.

e_i = CO_2e emission factor for energy type *i*, taken from Table 701.5.2 (7.5.2).

RE_k = Annual renewable energy production for renewable energy type *k*.

$RPEF_k$ = Renewable energy factor from Table 701.4.1.2 (7.4.1.2) for renewable energy type *k*.

e_k = CO_2e emission factor for electricity taken from Table 701.5.2 (7.5.2).

c. **Zero Energy Performance Index.** The adjusted renewable energy of the proposed *building* shall be credited using the source-site multiplier for electricity from Table 701.5.2 (7.5.2). On-site thermal energy from solar shall be directly modeled according to Table C101.1 (C1.1), (15)(a)(1) and accounted for through the displacement of on-site fossil fuel or electricity.

Documentation: The documentation required in ANSI/ASHRAE/IES Standard 90.1, Section G2.5 (a), (b), and (e), shall be made available to the *AHJ*, upon request, for all *on-site renewable energy systems* in the *proposed design*.**15. On-Site Renewable Energy Systems**

The reduction in the proposed building annual energy cost CO_2e emissions and source energy due to *renewable energy systems* shall be calculated as follows:

a. **Annual Energy Cost.** The annual energy cost of the *proposed design* shall be adjusted to account for renewable energy systems as follows:

1. **On-Site Thermal Energy Performance Calculation.** The hourly thermal loads of the *proposed design* shall be reduced by the hourly thermal energy production of the *on-site renewable energy system* (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption.

2. **On-Site Electric Renewable Energy Systems—Net Metering.** The total electrical energy production of the *on-site renewable energy system* shall be calculated on an hourly basis, and the energy cost of the *proposed building performance* shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the *on-site renewable energy system*.

Exception: For *building projects* with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the *on-site renewable energy*

system, but the cost of imported electricity shall not be less than zero on a monthly basis.

Electricity production of the on-site renewable energy system that has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the building performance at the wholesale rate as follows:

Credit =(ExRR−ImRR)ExRR×ExkWh×WR

where:

Credit = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity.

ExRR = month's value of exported electricity at retail rate.

ImRR = month's value of imported electricity at retail rate.

ExkWh = total kilowatt-hours exported in month.

WR = average monthly wholesale rate for the region where the building located.

[Informative Note: Thermal renewable energy is accounted for in (a)(1), so the renewable energy addressed in (a)(2) will always be on-site electricity. There is no need to apply the renewable energy procurement factors from Table 701.4.1.2 (7.4.1.2), as the multiplier will always be one (1).]

3. **Electricity Generation from Off-Site Community Renewable Energy Systems— Virtual-, Aggregated-, or Community- Net-Metering Tariff.** Renewable energy systems that credit the building project electricity account on an hourly basis shall be calculated according to (a)(2) except that the renewable energy procurement factor from Table 701.4.1.2 (7.4.1.2) shall be applied to each hour of electricity production from the community renewable energy system. The energy cost credit for other offsite renewable energy systems shall be calculated according to (a)(4).

4. **Electricity Generation from Other Off-Site Renewable Energy Systems.** The adjusted renewable energy is the actual renewable energy for each procurement source of renewable energy delivered to or credited to the building project multiplied by the appropriate renewable energy factors in Table 701.4.1.2 (7.4.1.2). The annual energy cost reduction credited to the proposed design shall be the total adjusted renewable energy multiplied by the virtual electric rate paid by the building. The virtual electric rate is the total retail cost for electricity for the year divided by the net consumption for the year in dollars per kWh ($/kWh).

b. **Annual CO_2e.** The annual CO_2e emissions of the proposed building shall be equal to the annual CO_2e associated with all building energy use minus the *adjusted renewable energy* multiplied by the electrical CO_2e emission factor

from Table 701.5.2 (7.5.2). Each procurement source of renewable energy delivered to or credited to the building project shall be multiplied by the renewable energy factors in Table 701.4.1.2 (7.4.1.2). PD−CO2e=∑PDSEi×ei−∑REk×REPFk×ek $\text{PD-}CO_2e = \sum \text{PDSE}_i \times e_i - \sum \text{RE}_k \times \text{REPF}_k \times e_k$ where: **PD-CO_2e =** CO_2e emissions for the proposed design. **PDSE$_i$ =** Proposed design site energy use for energy type *i*. **e_i =** CO_2e emission factor for energy type *i*, taken from Table 701.5.2 (7.5.2). **RE$_k$ =** Annual renewable energy production for renewable energy type *k*. **RPEF$_k$ =** Renewable energy factor from Table 701.4.1.2 (7.4.1.2) for renewable energy type *k*. **e_k =** CO_2e emission factor for electricity taken from Table 701.5.2 (7.5.2). c. **Zero Energy Performance Index.** The adjusted renewable energy of the proposed *building* shall be credited using the source-site multiplier for electricity from Table 701.5.2 (7.5.2). On-site thermal energy from solar shall be directly modeled according to Table C101.1 (C1.1), (15)(a)(1) and accounted for through the displacement of on-site fossil fuel or electricity. **Documentation:** The documentation required in ANSI/ASHRAE/IES Standard 90.1, Section G2.5 (a), (b), and (e), shall be made available to the *AHJ*, upon request, for all *on-site renewable energy systems* in the *proposed design*.	

TABLE C101.2 (TABLE C1.2)
PERFORMANCE MODELING OF DISTRICT ENERGY SYSTEM REQUIREMENTS

PROPOSED BUILDING PERFORMANCE	**BASELINE BUILDING PERFORMANCE**
1. District Cooling Model all cooling systems at the *district energy plant*, including energy conversion equipment and associated controls. Include all energy-using equipment, whether new or existing, that will impact the delivery of *district cooling* to the *building project*. Required systems include but are not limited to the following: • •Chillers • •Makeup water pumping • •Primary pumping • •Heat rejection loop pumping	Model on-site cooling plant or packaged cooling as defined in Standard 90.1, Normative Appendix G, Tables G3.1.1-3 and G3.1.1-4, using energy

• •Heat rejection fans • •Water treatment and pressurization systems • •Heat exchanger losses	performance values from Standard 90.1, Normative Appendix G.
2. District Heating Model all heating systems at the *district energy plant*, including energy conversion equipment and associated controls. Include all energy-using equipment, whether new or existing, that will impact the delivery of *district heating* to the *building project*. Required systems include but are not limited to the following: • •Boilers • •Makeup water pumping • •Primary pumping • •Water treatment and pressurization equipment • •Heat exchanger losses	Model on-site heating plant or packaged heating as defined in Standard 90.1, Normative Appendix G, Tables G3.1.1-3 and G3.1.1-4, using energy performance values from Standard 90.1, Normative Appendix G.
3. District Thermal Distribution System Model all equipment involved with the *district thermal distribution system*. Required systems include but are not limited to the following: • •Distribution and tertiary pumping • •Heat exchanger and thermal distribution losses • •Thermal distribution losses from leakage or nonreturn of distribution medium	Model thermal distribution systems in accordance with Standard 90.1, Normative Appendix G.
4. Combined Heat and Power Systems Model *combined heat and power systems* using the following methodology. Allocate electricity to the *building project* as a fraction of the total electricity output of the *district energy system*, where the fraction is the thermal energy provided to the *building project* divided by the total thermal energy output of the *district energy system*. Use Equation C-1 to determine the amount of electricity generated from the *CHP* system to be applied to the *building project*. Alternatively, use Equation C-2 if the *CHP* system includes cooling generation from recovered heat or if there is an	Do not model *CHP*.

additional waste heat recovery stream Z_{OTHER} (e.g., a *CHP* system could extract steam and hot water on two separate loops).

CHP−ELECBLDG=(XHEAT×BLDGHEAT)×CHP−ELECTOTAL

$$CHP\_ELEC_{BLDG} = (X_{HEAT} \times BLDG_{HEAT}) \times CHP\_ELEC_{TOTAL}$$

(Equation C-1)

CHP ELEC−BLDG=[(XHEAT× BLDG HEAT)+(YCHW× BLDG CHW)+(ZOTHER× BLDG OTHER)]× CHP_ELEC TOTAL

(Equation C-2)

where:

CHP_ELEC_{BLDG} = *CHP* electricity generation allocated to the building.
***X_{HEAT}* =** Fraction of the *CHP* plant's total production of waste heat applied to the DES.
$BLDG_{HEAT}$ = Fraction of total district heat provided to the building.
CHP_ELEC_{TOTAL} = Total *CHP* electricity generated at the DES plant.
***Y_{CHW}* =** Fraction of the *CHP* system's total production of waste heat applied to producing chilled water in the DES.
$BLDG_{CHW}$ = Fraction of total district chilled water provided to the building.
***Z_{OTHER}* =** Fraction of the *CHP* system's total production of waste heat applied to an additional form of district energy.
$BLDG_{OTHER}$ = Fraction of an additional form of district energy that is provided to the building.

4. Combined Heat and Power Systems

Model *combined heat and power systems* using the following methodology.

Allocate electricity to the *building project* as a fraction of the total electricity output of the *district energy system*, where the fraction is the thermal energy provided to the *building project* divided by the total thermal energy output of the *district energy system*.

Use Equation C-1 to determine the amount of electricity generated from the *CHP* system to be applied to the *building project*. Alternatively, use Equation C-2 if the *CHP* system includes cooling generation from recovered heat or if there is an additional waste heat recovery stream Z_{OTHER} (e.g., a *CHP* system could extract steam and hot water on two separate loops).

CHP−ELECBLDG=(XHEAT×BLDGHEAT)×CHP−ELECTOTAL

(Equation C-1) CHP ELEC−BLDG=[(XHEAT× BLDG HEAT)+(YCHW× BLDG CHW)+(ZOTHER× BLDG OTHER)]× CHP_ELEC TOTAL $\mathrm{CHP}_{ELEC\text{-}BLDG} = [(X_{HEAT} \times \mathrm{BLDG}_{HEAT}) + (Y_{CHW} \times \mathrm{BLDG}_{CHW}) + (Z_{OTHER} \times \mathrm{BLDG}_{OTHER})] \times \mathrm{CHP\_ELEC}_{TOTAL}$ (Equation C-2) where: **CHP_ELEC$_{BLDG}$ =** *CHP* electricity generation allocated to the building. ***X*$_{HEAT}$ =** Fraction of the *CHP* plant's total production of waste heat applied to the DES. **BLDG$_{HEAT}$ =** Fraction of total district heat provided to the building. **CHP_ELEC$_{TOTAL}$ =** Total *CHP* electricity generated at the DES plant. ***Y*$_{CHW}$ =** Fraction of the *CHP* system's total production of waste heat applied to producing chilled water in the DES. **BLDG$_{CHW}$ =** Fraction of total district chilled water provided to the building. ***Z*$_{OTHER}$ =** Fraction of the *CHP* system's total production of waste heat applied to an additional form of district energy. **BLDG$_{OTHER}$ =** Fraction of an additional form of district energy that is provided to the building.	
5. Utility Tariffs Utility tariffs shall reflect the rates used on the *building project* determined in accordance with Standard 90.1, Section G2.4.2.	Same as *proposed design*.
6. Carbon Dioxide Equivalent Emissions Factors *Carbon dioxide equivalent* emission factors shall be applied to the energy supplied to the *district energy* system and reflect the values used in Table 701.5.2 (7.5.2), and shall be applied uniformly for all *building project* and *district energy systems*.	Same as *proposed design*.

INFORMATIVE APPENDIX G

INFORMATIVE REFERENCES

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

This appendix contains informative references for the convenience of users of this code and to acknowledge source documents when appropriate. Section numbers indicate where the reference occurs in this document.

AIA

American Institute of Architects 1735 New York Avenue NW, Washington, DC, 20006

AIA National/AIA California Council:
Integrated Project Delivery: A Guide, v. 1—2007
Appendix F

AISC

American Institute of Steel Construction 130 East Randolph, Suite 2000, Chicago, Illinois 60601

Brochure:
Steel Takes LEED® with Recycled Content
901.4.1.1 (9.4.1.1)

ASHRAE

ASHRAE 180 Technology Parkway NW, Peachtree Corners, GA 30092

ASHRAE Guideline 0—2013:
The Commissioning Process
1001.3.2 (10.3.2)

ASHRAE Guideline 1.1—2007 :
HVAC&R Technical Requirements for the Commissioning Process
1001.3.2 (10.3.2)

ASHRAE Guideline 4—2008 (RA 2013):
Preparation of Operating and Maintenance Documentation for Building Systems
1001.3.2 (10.3.2)

ASHRAE Handbook, 2021:
Fundamentals
Appendix C

ASHRAE Handbook, 2020:
HVAC Applications
Appendix F

APBP

Association of Pedestrian and Bicycle Professionals, PO Box 93, Cedarburg, WI 53012

Bicycle Parking Guidelines, 2nd Edition, 2010
501.3.7.2 (5.3.7.2)

ASTM
ASTM International100 Barr Harbor Dr., West Conshohocken, PA 19428-2959

ASTM C755—20:
Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation, Appendix X1 Problem Analysis
801.3.6 (8.3.6)

ASTM E1331—15 (2019):
Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry
801.4.1 (8.4.1)

ASTM E1477—98a (2017)e1:
Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
801.4.1 (8.4.1)

ASTM E2813—12e1:
Standard Practice for Building Enclosure Commissioning
1001.3.1.3.5 (10.3.1.3.5)

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 (8.4.1)

BUSMethodology
BUS Methodology

Occupant Satisfaction Evaluation Survey:
https://busmethodology.org.uk/
1001.3.2.1.5 (10.3.2.1.5)

CBE
Center for the Built Environment University of California, 390 Wurster Hall #1839, Berkeley, CA 94720-1839

https://cbe.berkeley.edu/research/occupant-survey-and-building-benchmarking/:
Indoor Environmental Quality (IEQ) Survey™
1001.9.7 (10.9.7)

CRI
Carpet and Rug Institute, 730 College Drive, Dalton, Georgia 30720

Green Label Plus:
(https://carpet-rug.org/testing/green-label-plus)
801.4.2.3 (8.4.2.3)

CSA
Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada

CSA S478—95 (R2007):
Guideline on Durability for Buildings
901.4.1 (9.4.1), 1001.10 (10.10)

DGS
State of California, Department of General Services, Procurement Division, Ziggurat Building 707 Third Street, West Sacramento, CA 95605-2811

RFP DGS-56275:
Section 5.7, "Indoor Air Quality Requirements for Open Office Panel Systems"
Appendix D

DHHS ATSDR
United States Department of Health and Human Services Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy NE, Atlanta, GA 30341

www.atsdr.cdc.gov/mrls:
Minimal Risk Levels (MRLs)
Table 1001.7.2 (10.7.2)

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

Portfolio Manager
1001.9.3.2 (10.9.3.2)

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

901.4.1.3.1 (9.4.1.3.1)

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

US GSA—2005:
The Building Commissioning Guide
1001.3.1 (10.3.1)

ICC
International Code Council, 500 New Jersey Ave NW, 6th Floor, Washington, DC 20001

IBC—2021:
International Building Code®
106.1, 801.3.1.8 (8.3.1.8), I201.1 (I2.1)

IECC—2021:
International Energy Conservation Code®
Appendix H

IFC—2021:
International Fire Code®
601.3.2.6 (6.3.2.6)

IPC—2021:
International Plumbing Code®
601.3.1.2.1 (6.3.1.2.1)

ICC/ASHRAE 700—2015:
National Green Building Standard
J101.1.1, J101.1.2, J101.1.3, J101.1.4, J101.1.5

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

IES MLO—11:
Model Lighting Ordinance (MLO)
501.3.6 (5.3.6)

IES HB—11:
The Lighting Handbook: Reference and Application
701.4.6 (7.4.6), 801.3.5 (8.3.5)

ITE
Institute of Transportation Engineers, 1099 14th Street NW, Suite 300 West, Washington, DC 20005-3438

4th Edition, 2004:
Parking Generation
1001.11 (10.11)

MTS
Market Transformation to Sustainability, 1511 Wisconsin Avenue, N.W., Washington, D.C. 20007

MTS 2012:1:
Integrative Process (IP)— ANSI Consensus National Standard Guide—Design and Construction of Sustainable Buildings and Communities
Appendix F

NIBS

National Institute of Building Sciences, 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905

NIBS Guideline 3—2012:
Building Enclosure Commissioning Process BECx
1001.6 (10.6)

NIST
National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899

BEES Online 2.0:
Building Environmental and Economic Sustainability (BEES)
901.4.1.4.4 (9.4.1.4.4)

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

NREL/TP-550-38617:
Source Energy and Emissions Factors for Energy Use in Buildings
Table 701.5.2 (7.5.2)

RFCI
Resilient Floor Covering Institute, 115 Broad Street, Suite 201, LaGrange, GA 30240

801.4.2.3 (8.4.2.3)

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

901.4.1.3.1 (9.4.1.3.1)

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

ANSI/SMACNA 008—2008:
IAQ Guidelines for Occupied Buildings under Construction, Second Edition
1001.4.2 (10.4.2)

SRI
Steel Recycling Institute, 680 Andersen Drive, Pittsburgh, PA 15220

Brochure:
Steel Takes LEED® with Recycled Content
901.4.1.1 (9.4.1.1)

UL
Underwriters Laboratory, 2211 Newmarket Parkway, #110, Marietta, GA, 30067

UL2762—2011:
EcoLogo Sustainability for Adhesives
801.4.2.1.2 (8.4.2.1.2)

UL2818—2013:
Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing
801.4.2 (8.4.2), 801.5.2 (8.5.2)

UL2821—2013:
Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings
801.4.2 (8.4.2), 801.5.2 (8.5.2)