2014 Oregon Energy Efficiency Specialty Code New Oregon Amendments

This document outlines all new Oregon Amendments adopted during the code promulgation process for the 2014 Oregon Energy Efficiency Specialty Code (OEESC), based on the 2012 International Energy Conservation Code (IECC). This document may be useful for those seeking a synopsis of only the new Oregon Amendments.

CHAPTER 1
ADMINISTRATION

101.4.3 Change in space conditioning. **Increasing the heating and/or cooling capacity of a** ~~Any~~ nonconditioned space ~~that is altered to become *conditioned space*~~ shall ~~be~~ required ~~d~~ **the thermal envelope** to be brought into ~~full~~ compliance with ~~this~~ **the applicable** requirements of this code. **Nonconditioned spaces include semi-conditioned and low energy spaces.**

~~**101.4.4 Mixed occupancy.** Where a building includes both *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions of Chapter 4 for *residential* and Chapter 5 for *commercial*.~~

101.4.~~5~~4 Historic buildings. See Section ~~3407~~ **3409** of the *Building Code*.

101.5 Compliance. *Residential buildings* shall meet the provisions of Chapter 4. *Commercial buildings* shall meet the provisions of Chapter 5.

101.5.1 Low energy buildings. The following buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this code shall be exempt from the *building thermal envelope* provisions of this code:

1. Those with a peak design rate of **heating and cooling** energy ~~usage~~ **output** less than 3.4**2** Btu/h/ft^2 (10.7 W/m^2) or 1.0 watt/ft^2 (10.7 W/m^2) of floor area for space conditioning purposes.
2. Those that do not contain *conditioned space.*

101.5.2 Semi-conditioned buildings for freeze protection heating. Buildings, or portions thereof, that are only heated for freeze protection shall comply with the prescriptive building thermal envelope assemblies listed in Table 502.2(1) with the following exception: walls between the semi-conditioned space and either the exterior or *conditioned spaces* are not required to provide the continuous insulation listed in the table; only the cavity insulation R-value minimums are required. Heating systems in freeze protected spaces shall be controlled by single setpoint, non-adjustable thermostat(s) that control to no greater than 45F (7C). Total heating output capacity shall not exceed the following allowances:

1. Climate Zone 4C: 10 Btu/hr-ft^2 (32 W/m^2) or 3 Watts/ft^2

2. Climate Zone 5B: 15 Btu/hr-ft^2 (47 W/m^2) or 4.5 Watts/ft^2

101.5.3 Small structures. The thermal envelope for the building types listed in this section shall have the roof insulated to the minimum prescriptive value listed in Table 502.2(1). All other opaque envelope provisions of Section 502 are exempt.

1. **Unoccupied buildings less than 500 ft^2 (46.5 m^2), such as equipment shelters, pump houses, and communication sheds.**
2. **Occupied free-standing shelter structures, such as guard shacks, less than 150 ft^2 (13.9 m^2).**

101.5.4 Agricultural structures. Greenhouses and exempt agricultural buildings per the *Building Code* are exempt from this code.

SECTION 103
CONSTRUCTION DOCUMENTS

~~Reserved~~

103.1 Information on the construction documents. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include but are not limited to, as applicable, insulation materials and their R-values; fenestration U-factors and SHGCs; system design criteria; mechanical and service water heating system and equipment types, sizes and efficiencies; economizer description; equipment and system controls; fan motor horsepower (hp) and controls; duct sealing, duct and pipe insulation and location; lighting fixture schedule with wattage and control narrative; air sealing details; COMcheck compliance report for the State of Oregon or appropriate Division approved form.

Exception: The code official is authorized to waive the requirements for construction documents, COMcheck reports, or other supporting data if the code official determines these are not necessary to confirm compliance with this code.

SECTION 202
GENERAL DEFINITIONS

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

RESIDENTIAL BUILDING. For this code, includes R-3 buildings **regulated under the *Residential Code*: one- and two-family dwellings and townhouses**~~., as well as R-2 and R-4 buildings three stories or less in height above grade~~.

SPOT HEATING. Infrared heating within a nonconditioned space of a limited area for the purpose of limited-duration, localized comfort for occupants only.

SECTION 401
GENERAL
CHAPTER 4
RESIDENTIAL ENERGY

PART I—ENERGY CONSERVATION

SECTION 401
SCOPE

401.1 General. ~~The provisions of this c~~ **For one- and two-family residences and townhomes, C**hapter **11 of the *Residential Code* shall apply.** ~~regulate the exterior envelope, as well as, the design, construction and~~

~~selection of heating, ventilating and air-conditioning systems, lighting and piping insulation, required for the purpose of effective conservation of energy within a *building* or structure governed by this code.~~

(NOTE: remainder of chapter is deleted.)

CHAPTER 5
COMMERCIAL ENERGY EFFICIENCY

SECTION 502
BUILDING ENVELOPE REQUIREMENTS

502.1 General ~~(Prescriptive)~~

502.1.1 Insulation and fenestration criteria. The *building thermal envelope* **opaque assemblies** shall meet the requirements of **Table 502.1.1 and Section 502.2** ~~Tables 502.2(1)~~. **Fenestration shall meet the requirements of Section** 502.3. **Values from tables shall be** based on the climate zone specified in Chapter 3. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *R*-values from the "Group R" column of Table ~~502.2(1)~~ **502.1.1**. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *R*-values from the "All other" column of Table ~~502.2(1)~~ **502.1.1**. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table 502.3 shall comply with Section 502.1.3, Simplified trade-off approach or Section 506.1, Whole Building Approach.

~~Exception:~~ ~~Mass walls complying with Table 502.1.3.~~

502.1.2 U-factor alternative. Opaque assemblies with a *U*-factor, *C*-factor, or *F*-factor equal or less than that specified in Table 502.1.2 shall be permitted as an alternative to the *R*-value in Table ~~502.2(1)~~ **502.1.1**. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *U*-factor, *C*-factor, or *F*-factor from the "Group R" column of Table 502.1.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *U*-factor, *C*-factor or *F*-factor from the "All other" column of Table 502.1.2. **Appendix A of ASHRAE 90.1-2010 shall be used for determining values for opaque assemblies.**

~~Exception:~~ ~~Mass walls complying with Table 502.1.3.~~

502.1.3 Simplified trade-off approach. Buildings may demonstrate compliance with the thermal performance standards of this section by using the Simplified Trade-off Approach (STA). The STA is an analytical method to determine if the energy performance of a proposed building's envelope is at least equivalent to a similar building meeting the prescriptive path approach. Information and criteria for demonstrating compliance using the STA path **using COMcheck software** is available at www.bcd.oregon.gov.

TABLE ~~502.2(1)~~ 502.1.1
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

CLIMATE ZONE	5 AND MARINE 4	
	All other	**Group R**
Roofs		
Insulation entirely above deck	R-20ci	R-20ci
Metal buildings (with R-**3.**5 thermal blocks[a,b])	R-13 + R-13	R-19
Attic and other	R- 38	R-38
Walls, Above Grade		
Mass	R-11.4ci	R-13.3ci
Metal building[b]	R-13 + R-5.6ci	R-13 + R-
Metal framed	R-13 + R-7.5ci	R-13 + R-
Wood framed and other	R-13 + R-3.8ci **or R-21**	R-13 +R-3.8ci **or R-21**
Walls, Below Grade		
Below grade wall[d]	R-7.5ci	R-7.5ci
Floors		
Mass	R-10ci	R-12.5ci
Joist/Framing (steel/wood)	R-30	R-30
Slab-on-Grade Floors		
Unheated slabs	N R	R-10 for 24 in.
Heated slab	R-15 for 24 in.	R-15 for 24 in.
Opaque Doors		
Swinging	U-0.70	U-0.70
Roll-up or sliding	U-0.50	U-0.50

For SI: 1 inch = 25.4 mm.

ci = Continuous insulation. NR = No requirement.

a. ~~When using R-value compliance method, a t~~Thermal spacer block**s** ~~is~~ **are** required~~, otherwise use the U-factor compliance method. [see Tables 502.1.2 and 502.2(2)]~~.

b. Assembly descriptions can be found in Table 502.2(2).

c. When heated slabs are placed below grade, below-grade walls must meet the exterior insulation requirements for perimeter insulation according to the heated slab-on-grade construction.

TABLE 502.1.2
BUILDING ENVELOPE REQUIREMENTS
OPAQUE ELEMENT, MAXIMUM U-FACTORS

CLIMATE ZONE	5 AND MARINE 4	
	All other	Group R
Roofs		
Insulation entirely	U-0.048	U-0.048
Metal buildings[c]	U-0.055	U-0.055
Attic and other	U-0.027	U-0.027
Walls, Above Grade		
Mass[b]	U-0.150[c]	U-0.090
Metal building	U-0.069	U-0.069
Metal framed	U-0.064	U-0.064
Wood framed and other	U-0.064	U-~~0.051~~ **0.064**
Walls, Below Grade		
Below-grade wall[a]	C-0. 119	C-0. 119
Floors		
Mass	U-0.074	U-0.064
Joist/Framing	U-0.033	U-0.033
Slab-on-Grade Floors		
Unheated slabs	F-0.730	F-0.540
Heated slabs[a]	F-0.860	F-0.860

a. When heated slabs are placed below-grade, below grade walls must meet the F-factor requirements for perimeter insulation according to the heated slab-on-grade construction.

~~b.Effective 1-1-2012.~~

~~c.~~**b.** Exception: Integral insulated concrete block walls complying with ASTM C90 with all cores filled and meeting both of the following: 1) At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation, and 2) the structure encloses one of the following uses: Gymnasiums, Auditorium, Church Chapel, Arena, Kennel, Manufacturing Plant, Indoor Swimming Pool, Pump station, Water and Waste Water Treatment Facility, **Restroom/concessions, mechanical/electrical structures,** Storage Facility, Storage Area, Warehouse (Storage and retail), Motor vehicle service Facility.

c. R-3.5 spacer blocks required for all metal roof assemblies; see Table 502.2(2)

~~**TABLE 502.1.3**~~
~~**MASS WALL PERFORMANCE REQUIREMENTS[a]**~~

~~COMPONENT~~	~~MAXIMUM GLAZING FRACTION~~	~~MAXIMUM U-FACTOR~~	~~MINIMUM R-VALUE~~
~~Masonry, with integral insulation[b]~~	~~15%~~	~~0.300~~	~~—~~
~~Masonry, with integral insulation[c]~~	~~30%~~	~~0.2 10~~	~~—~~
~~Masonry or concrete with interior insulation~~	~~30%~~	~~0.130~~	~~11~~
~~Masonry or concrete with continuous exterior insulation~~	~~15%~~	~~0.300~~	~~1.4~~
~~Masonry or concrete with continuous exterior insulation~~	~~30%~~	~~0.210~~	~~2.8~~

~~a. Effective 7-1-2010 through 12-31-2011.~~
~~b. All cores to be filled. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation.~~
~~c.All cores except bond beams must contain rigid insulation inserts approved for use in reinforced masonry walls.~~

502.2 Specific insulation requirements ~~(Prescriptive)~~. Opaque assemblies **constructed per Section 502.2** shall comply with **R-values per** Table ~~502.2(1)~~ **502.1.1**.

Exception: Opaque assemblies that comply with Table 502.1.2 U-factors in lieu of R-values per Section 502.1.2.

502.2.1 Roof assembly. The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table ~~502.2(1)~~ **502.1.1**, based on construction materials used in the roof assembly.

Exception: Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted U-factor is equivalent to the same assembly with the R-value specified in Table ~~502.2(1)~~ **502.1.1**.

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

502.2.1.1 Roof Curbs. Portions of curb skylights and equipment above the roof deck shall be insulated with minimum R-5 insulation.

Exception: Skylight curbs included as a component of an NFRC 100 rated assembly shall not be required to be insulated.

502.2.2 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section 502.2.2.1 or 502.2.2.2.

502.2.2.1 Above-grade walls. Above-grade walls are those walls covered by Section 502.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

502.2.2.2 Below-grade walls. Below-grade walls covered by Section 502.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

502.2.3 Above-grade walls. The minimum thermal resistance (R-value) of the insulating material(s) installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table ~~502.2(1)~~ **502.1.1**, based on framing type and construction materials used in the wall assembly. The R-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table ~~502.2(1)~~ **502.1.1**. "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1900 kg/m_3).

502.2.4 Below-grade walls. The minimum thermal resistance (R-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table ~~502.2(1)~~ **502.1.1**, and shall extend to a depth of 10 feet (3048mm) below the outside finished ground level, or to the level of the floor, whichever is less.

502.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table ~~502.2(1)~~ **502.1.1**, based on construction materials used in the floor assembly.

"Mass floors" shall include floors weighing at least (1)35 pounds per square foot (170 kg/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg/m^3).

502.2.6 Slabs on grade. The minimum thermal resistance (R-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table ~~502.2(1)~~ **502.1.1**. The insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table.

502.2.7 Opaque doors. Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table ~~502.2(1)~~ **502.1.1** and be considered as part of the gross area of above-grade walls that are part of the building envelope.

502.3 Fenestration ~~(Prescriptive).~~ Fenestration shall comply with Table 502.3.

TABLE 502.2(2)
METAL BUILDING ~~ENVELOPE REQUIREMENTS-OPAQUE~~ ASSEMBLY~~IES~~ DESCRIPTIONS[a]

ROOFS	DESCRIPTION	~~REFERENCE~~
R-19	Standing seam roof with single fiberglass insulation layer. This construction is R-19 faced fiberglass insulation batts draped perpendicular over the purlins. A minimum R-3.5 thermal spacer block is placed above the purlin/batt, and the roof deck is secured to the	~~ASHRAE/IESNA 90.1 Table A2.3 including Addendum "G"~~

R- 13 + R-13 R-13 + R-19	Standing seam roof with two fiberglass insulation layers. The first *R*-value is for faced fiberglass insulation batts draped over purlins. The second *R*-value is for unfaced fiberglass insulation batts installed parallel to the purlins. A minimum R-3.5 thermal spacer block is placed above the purlin/batt, and the roof deck is secured to the purlins.	~~ASHRAE/IESNA 90.1 Table A2.3 including Addendum "G"~~
R-1 1 + R-19 FC	Filled cavity fiberglass insulation. A continuous vapor barrier is installed below the purlins and uninterrupted by framing members. Both layers of uncompressed, unfaced fiberglass insulation rest on top of the vapor barrier and are installed parallel, between the purlins. A minimum R-3.5 thermal spacer block is placed above the purlin/batt, and the roof deck is secured to the purlins.	~~ASHRAE/IESNA 90.1 Table A2.3 including Addendum "G"~~
WALLS		
R-16, R-19	Single fiberglass insulation layer. The construction is faced fiberglass insulation batts installed vertically and compressed between the metal wall panels and the steel framing.	~~ASHRAE/IESNA 90.1 Table A3.2 including Addendum "G"~~
R-13 + R-5.6ci R-19 + R-5.6ci	The first *R*-value is for faced fiberglass insulation batts installed perpendicular and compressed between the metal wall panels and the steel framing. The second rated *R*-value is for continuous rigid insulation installed between the metal wall panel and steel framing, or on the interior of the steel framing.	~~ASHRAE/IESNA 90.1 Table A3.2 including Addendum "G"~~

a. ASHRAE 90.1-2010, Table A3.2 reference for U-factors and alternate assemblies

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	5 AND MARINE 4
Vertical fenestration (30% maximum of above-grade wall)	
Fenstration type	**U-Factor**
Framing materials other than metal with or without metal reinforcement or cladding	
~~*U*-factor~~**Fixed, operable, and doors with greater than 50% glazing**	0.35
Metal framing with or without thermal break	
Fixed: including curtain wall/storefront ~~*U*-factor~~	0.45
Entrance door ~~*U*-factor~~	0.80
All other[a] ~~*U*-factor~~[a]	0.46
SHGC-all frame types	0.40
Skylights (3% maximum of roof area)	
U-factor	0.60
SHGC	0.40

NR = No requirement.

PF = Projection factor (see Section 502.3 .2).

a. All others includes operable windows, ~~fixed windows~~ and non-entrance doors **with greater than 50% glazing**.

502.3.1 Maximum area. The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table 502.3. The skylight area shall not exceed the percentage of the gross roof area specified in Table 502.3.

502.3.2 Maximum U-factor and SHGC. For vertical fenestration and skylights, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in Table 502.3.

Exception: Buildings complying with STA approach per Section 502.1.3.

502.4 Air leakage ~~(Mandatory)~~. The thermal envelope of buildings shall comply with sections 502.4.1 through 502.4.7

~~**502.4.1 Window and door assemblies.** The air leakage of window and sliding or swinging door assemblies that are part of the building envelope shall be determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, or NFRC 400 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer and shall not exceed the values in Section 502.4.2.~~

~~**Exception:** Site constructed windows and doors that are weatherstripped or sealed in accordance with Section 502.4.3.~~

~~**502.4.2 Curtain wall, storefront glazing and commercial entrance doors.** Curtain wall, *storefront* glazing and commercial-glazed swinging entrance doors and revolving~~

~~doors shall be tested for air leakage at 1.57 pounds per square foot (psf) (75 Pa) in accordance with ASTM E 283. For curtain walls and *storefront* glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per~~

~~square foot (cfm/ft^2) (5.5 m^3/h × m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage rate shall be 1.00 cfm/ft^2 (18.3 m^3/h × m^2) of door area when tested in accordance with ASTM E 283.~~

~~**502.4.3 Sealing of the building envelope.** Openings and penetrations in the building envelope shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and location. Joints and seams shall be sealed in the same manner or taped or covered with a moisture vapor permeable wrapping material. Sealing materials spanning joints between construction materials shall allow for expansion and contraction of the construction materials.~~

502.4.1 Air barriers A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof. The air barrier shall comply with Sections 502.4.1.1 and 502.4.1.2.

502.4.1.1 Air barrier construction. The continuous air barrier shall be constructed to comply with the following:

1. **The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.**
2. **Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. Air barrier penetrations shall be sealed in accordance with Section C402.4.2. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.**
3. **Recessed lighting fixtures shall comply with Section 504.2.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.**
   Exception: Buildings that comply with Section 502.4.1.2.3 are not required to comply with Items 1 and 3.

502.4.1.2 Air barrier compliance options. A continuous air barrier for the opaque building envelope shall comply with Section 502.4.1.2.1, 502.4.1.2.2, or 502.4.1.2.3.

502.4.1.2.1 Materials. Materials with an air permeability no greater than 0.004 cfm/ft2 (0.02 L/s . m2) under a pressure differential of 0.3 inches water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 15 shall be deemed to comply with this section provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions:

1. **Plywood with a thickness of net less than 3/8 inch (10 mm).**
2. **Orientated strand board having a thickness of not less than 3/8 inch (10 mm).**
3. **Extruded polystyrene insulation board having a thickness of not less than ½ inch (12 mm).**
4. **Foil-back polyisocyanurate insulation board having a thickness of not less than ½ inch (12 mm).**
5. **Closed-cell spray foam with a minimum density of 1.5 pcf (2.4 kg/m3) having a thickness of not less than 1 ½ inches (36 mm).**
6. **Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m3) and having a thickness of not less than 4.5 inches (113 mm).**
7. **Exterior or interior gypsum board having a thickness of not less than ½ inch (12 mm).**
8. **Cement board having a thickness of not less than ½ inch (12 mm).**
9. **Built-up roofing membrane.**
10. **Modified bituminous roof membrane.**
11. **Fully adhered single-ply roof membrane.**
12. **A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch (16 mm).**

13. **Cast-in-place and precast concrete.**
14. **Fully grouted concrete block masonry.**
15. **Sheet steel or aluminum.**

502.4.1.2.2 Assemblies. Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft2 (0.2 L/s . m2) under a pressure differential of 0.3 inches of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with this section. Assemblies listed in Items 1 and 2 shall be deemed to comply provided joints are sealed and requirements of Section C402.4.1.1 are met.

1. **Concrete or masonry walls coated with one application either of block filler and two applications of a paint or sealer coating.**
2. **A Portland cement/sand parge, stucco or plaster minimum ½ inch (12 mm) in thickness.**

502.4.1.2.3 Building test. The completed building shall be tested and the air leakage rate of the building envelope shall not exceed 0.40 cfm/ft2 at a pressure differential of 0.3 inches water gauge (2.0 L/s . m2 at 75 Pa) in accordance with ASTM E 779 or an equivalent method approved by the code official.

502.4.2 Air barrier penetrations. Penetrations of the air barrier and paths of air leakage shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Joints and seals shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials shall be appropriate to the construction materials being sealed. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.

502.4.3 Air leakage of fenestration and doors. The air leakage of fenestration assemblies and doors and access openings from conditioned space to shafts, chutes, stairways and elevator lobbies shall meet the provisions of Table 502.4.3. Testing shall be in accordance with the applicable reference test standard in Table 502.4.3 by an accredited, independent testing laboratory and labeled by the manufacturer.

Exceptions:

1. **Field-fabricated fenestration assemblies that are sealed in accordance with Section 502.4.1.**
2. **Fenestration in buildings that comply with Section 502.4.1.2.3 are not required to meet the air leakage requirements in Table 502.4.3.**
3. **Doors and access panels that are continuously gasketed, weatherstripped or sealed.**
4. **Door openings required to comply with Section 714 or 715.4 of the ~~*International*~~ *Building Code*; or doors and door openings required by the ~~*International*~~ *Building Code* to comply with UL 1784.**

~~**502.4.4 Doors and access openings to shafts, chutes, stairways, and elevator lobbies. Doors and access openings from conditioned space to shafts, chutes, stairways and elevator lobbies shall either meet the requirements of Section 502.4.3 or shall be gasketed, weatherstripped or sealed.**~~

~~**Exception: Door openings required to comply with Section 714 or 715.4 of the *International Building Code*; or doors and door openings required by the *International Building Code* to comply with UL 1784 shall not be required to comply with Section 502.2.4.4.**~~

TABLE 502.4.3
MAXIMUM AIR INFILTRATION RATE
FOR FENESTRATION ASSEMBLIES

FENESTRATION ASSEMBLY	**MAXIMUM RATE (CFM/FT^2)**	**TEST PROCEDURE**
Windows	**0.30**	**AAMA/WDMA/CSA101/I.S.2/A440 or NFRC 400**
Sliding doors	**0.30**	
Swinging doors	**0.30**	
Skylights – with condensation weepage openings	**0.30**	
Skylights – all other	**0.30**	
Curtain walls	**0.06**	**NFRC 400 or ASTM E 283 at 1.57 psf (75 Pa)**
Storefront glazing	**0.06**	
Commercial glazed swinging entrance doors	**1.00**	
Revolving doors	**1.00**	
Garage doors	**0.40**	**ANSI/DASMA 105, NFRC 400, or ASTM E 283 at 1.57 psf (75 Pa)**

502.4.4 Outdoor air intakes and exhaust openings. Stair and elevator shaft vents and other ~~outdoor air intakes and exhaust~~ **ventilation** openings integral to the building envelope shall be equipped with not less than a Class I motorized, leakage-rated damper with a maximum leakage rate of 4 cfm per square foot (6.8 L/s· C m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D.

Stair and shaft vent dampers shall be capable of being automatically closed during normal building operation and interlocked to open as required by **the Building Code** ~~fire and smoke detection systems~~.

Exceptions:

1. **Mechanical systems intake, exhaust and relief openings shall comply with Section 503.2.4.5**
2. **Elevator shaft vents complying with Oregon Elevator Specialty Code.**

SECTION 503
BUILDING MECHANICAL SYSTEMS

503.2 Provisions applicable to all mechanical systems ~~(Mandatory)~~.

503.2.3 HVAC equipment performance requirements. Equipment shall meet the minimum efficiency requirements of Tables 503.2.3(1), 503.2.3(2), 503.2.3(3), 503.2.3(4), 503.2.3(5), 503.2.3(6), 503.2.3(7), ~~and~~ 503.2.3(8)**, 503.2.3(9) and 503.2.3(10)** when tested and rated in accordance with the applicable test procedure. The efficiency shall be verified through certification under an *approved* certification program or, if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrates that the combined efficiency of the specified components meets the requirements herein.

Exceptions:

1. Equipment that does not have minimum efficiency ratings set via national standards, such as waste oil fueled equipment.

2. Water-cooled centrifugal water-chilling packages **meeting the requirements of Section 503.2.3.1** ~~listed in Table 503.2.3(7) not designed for operation at ARHI Standard 550/590 test conditions of 44°F (7°C) leaving chilled water temperature and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 I/s.kW) condenser water flow shall have maximum full load and NPLV ratings adjusted using the following equations:~~

~~Adjusted maximum full load kW/ton rating = [full load kW/ton from Table 503.2.3(7)]/K_{adj}~~

~~Adjusted maximum NPLV rating = [IPLV from Table 503.2.3(7)]/K_{adj}~~

~~where:~~

~~K_{adj} = 6.174722 - 0.303668(X) +0.00629466$(X)^2$ - 0.000045780$(X)^3$~~

~~X = DT*std* + LIFT~~

~~DT_{std} = {24+[full load kW/ton from Table 503.2.3(7)] × 6.83}/Flow~~

~~Flow = Condenser water flow (GPM)/Cooling Full Load Capacity (tons)~~

~~LIFT = CEWT - CLWT (°F)~~

~~CEWT = Full Load Condenser Entering Water Temperature (°F)~~

~~CLWT = Full Load Leaving Chilled Water Temperature (°F)~~

~~The adjusted full load and NPLV values are only applicable over the following full-load design ranges:~~

~~Minimum Leaving Chilled~~
~~Water Temperature: 38°F (3.3°C)~~

~~Maximum Condenser Entering~~
~~Water Temperature: 102°F (38.9°C)~~

~~Condensing Water Flow: 1 to 6 gpm/ton 0.018 to 0. 1076 l/s kW) and X > 39 and <60~~

~~Chillers designed to operate outside of these ranges or applications utilizing fluids or solutions with secondary coolants (e.g., glycol solutions or brines) with a freeze point of 27°F (2.8°C) or lower for freeze protection are not covered by this code.~~

503.2.3.1 Water-cooled centrifugal chilling packages. Efficiencies of equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 2.4 gpm/ton evaporator fluid flow and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 I/s · kW) condenser water flow, shall not exceed the adjusted maximum full-load kW/ton (FL_{adj}) and part load (PLV_{adj}) ratings requirements using Equations 5-1 and 5-2.

$FL_{adj} = FL / K_{adj}$ (Equation 5-1)

$PLV_{adj} = IPLV / K_{adj}$ (Equation 5-2)

where:

$K_{adj} = A \times B$

FL = full-load kW/Ton value as specified in Table 503.2.3(7)

FL_{adj} = maximum full-load kW/Ton rating, adjusted for non-standard conditions

IPLV = IPLV value as specified in Table 503.2.3(7)

PLV_{adj} = maximum *IPLV* rating, adjusted for non-standard conditions

$A = 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.9302$

B= 0.0015 x 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:

1. **Minimum Evaporator Leaving Temperature:36°F**
2. **Maximum Condenser Leaving Temperature:115°F**
3. **$20°F \leq LIFT \leq 80°F$**

TABLE 503.2.3(1)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split System	13.0 SEER	13.0 SEER	AHRI 210/240
			Single Package	14.0 SEER	14.0 SEER	
Through-the-wall (air cooled)	≤ 30,000 Btu/h[b]	All	Split system	12.0 SEER	12.0 SEER	
			Single Package	12.0 SEER	12.0 SEER	
Small-duct high-velocity (air cooled)	< 65,000 Btu/h[b]	All	Split System	11.0 SEER	11.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	11.2 EER 12.8 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.6 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.4 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 12.2 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	10.0 EER 11.6 IEER	
		All other	Split System and Single Package	9.8 EER 9.9 IEER	9.8 EER 11.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	9.7 EER 11.2 IEER	
		All other	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 11.0 IEER	
Air conditioners, water cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 13.9 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.5 EER 12.5 IEER	12.5 EER 13.9 IEER	
		All other	Split System and Single Package	12.3 EER 12.5 IEER	12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h And < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.4 EER 12.6 IEER	12.4 EER 13.6 IEER	
		All other	Split System and Single Package	12.2 EER 12.4 IEER	12.2 EER 13.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance	Split System and Single Package	12.2 EER 12.4 IEER	12.2 EER 13.5 IEER	

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
		(or None)				
		All other	Split System and Single Package	12.0 EER 12.2 IEER	12.0 EER 13.3 IEER	
Air conditioners, evaporatively cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	11.9 EER 12.1 IEER	
	< 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.0 EER 12.2 IEER	12.0 EER 12.2 IEER	
		All other	Split System and Single Package	11.8 EER 12.0 IEER	11.8 EER 12.0 IEER	
	< 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.9 ERR 12.1 IERR	11.9 ERR 12.1 IEER	
		All other	Split System and Single Package	11.7 ERR 11.9 IEER	11.7 ERR 11.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.7 ERR 11.9 ERR	11.7 ERR 11.9 ERRT	
		All other	Split System and Single Package	11.5 ERR 11.7 ERR	11.5 ERR 11.7 ERR	
Condensing units, air cooled	≥ 135,000 Btu/h			10.5 EER 11.8 IEER	10.5 EER 11.8 IEER	AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	13.5 EER 14.0 IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	13.5 EER 14.0 IEER	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

~~**TABLE 503.2.3(1)**~~
~~**UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS**~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~SUBCATEGORY OR RATING CONDITION~~	~~MINIMUM EFFICIENCY[b]~~	~~TEST PROCEDURE[a]~~
~~Air conditioners, Air cooled~~	~~< 65,000 Btu/h[d]~~	~~Split system~~	~~13.0 SEER~~	~~AHRJ 210/240~~
		~~Single package~~	~~13.0 SEER~~	

	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.2EER [e] 11.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	11.0 EER[e] 11.2IEER	AHRJ 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	10.0 EER[e] 10.1IEER	
	≥ 760,000 Btu/h	Split system and single	9.7 EER[e]	
Through-the-wall Air cooled	< 30,000 Btu/h[d]	Split system	12.0 SEER	AHRJ 210/240
		Single package	12.0 SEER	
Air conditioners, Water and evaporatively cooled	< 65,000 Btu/h	Split system and single	12.1 EER	AHRJ 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.5EER [e] 11.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	11.0 EER[e] 11.2IEER	AHRJ 340/360
	≥ 240,000 Btu/h	Split system and single	11.5 EER[e]	

For SJ: 1 British thermal unit per hour = 0.293 1 W.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled air conditioners <65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA); SEER values are those set by NAECA.

TABLE 503.2.3(2)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Air cooled (cooling mode)	< 65,000 Btu/h[b]	All	Split System	14.0 SEER	14.0 SEER	AHRI 210/240
			Single Packaged	14.0 SEER	14.0 SEER	
Through-the-wall, air cooled	≤ 30,000 Btu/h[b]	All	Split System	12.0 SEER	12.0 SEER	
			Single Packaged	12.0 SEER	12.0 SEER	
Single-duct high-velocity air cooled	< 65,000 Btu/h[b]	All	Split System	11.0 SEER	11 SEER	
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.0 IEER	AHRI 340/360
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 11.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 10.7 IEER	10.6 EER 11.6 IEER	
		All other	Split System and Single Package	10.4 EER 10.5 IEER	10.4 EER 11.4 IEER	
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 10.6 IEER	
		All other	Split System and Single Package	9.3 EER 9.4 IEER	9.3 EER 10.4 IEER	
Water to Air: Water Loop (cooling mode)	<17,000 Btu/h	All	86 °F entering water	12.2 EER	12.2 EER	ISO 13256-1
	≥17,000 Btu/h and <65,000 Btu/h	All	86 °F entering water	13 EER	13 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	86 °F entering water	13 EER	13 EER	
Water to Air: Ground Water (cooling mode)	<135,000 Btu/h	All	59 °F entering water	18.0 EER	18.0 EER	ISO 13256-1
Brine to Air: Ground Loop (cooling mode)	<135,000 Btu/h	All	77 F entering water	14.1 EER	14.1 EER	ISO 13256-1
Water to Water: Water Loop (cooling mode)	<135,000 Btu/h	All	86 °F entering water	10.6 EER	10.6 EER	ISO-13256-2
Water to Water: Ground Water (Cooling Mode)	<135,000 Btu/h	All	59 °F entering water	16.3 EER	16.3 EER	

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Brine to Water: Ground Loop (cooling mode)	<135,000 Btu/h	All	77 °F entering water	12.1 EER	12.1 EER	
Air cooled (heating mode)	<65,000 Btu/h[b]	—	Split System	8.2 HSPF	8.2 HSPF	AHRI 210/240
		—	Single Package	8.0 HSPF	8.0 HSPF	
Through-the-wall, (air cooled, heating mode)	≤30,000 Btu/h[b] (cooling capacity)	—	Split System	7.4 HSPF	7.4 HSPF	
		—	Single Package	7.4 HSPF	7.4 HSPF	
Small-Duct high velocity (air cooled, heating mode)	<65,000 Btu/h[b]	—	Split System	6.8 HSPF	6.8 HSPF	
Air Cooled (Heating Mode)	≥65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	—	47ºF db/43ºF wb Outdoor Air	3.3 COP	3.3 COP	AHRI 40/360
			17ºF db/15ºF wb Outdoor Air	2.25 COP	2.25 COP	
	≥135,000 Btu/h (Cooling Capacity)	—	47ºF db/43ºF wb Outdoor Air	3.2 COP	3.2 COP	
			17ºF db/15ºF wb Outdoor Air	2.05 COP	2.05 COP	
Water to Air: Water Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68 °F entering water	4.3 COP	4.3 COP	ISO 13256-1
Water to Air Ground Water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50 °F entering water	3.7 COP	3.7 COP	
Brine to Air: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32 °F entering fluid	3.2 COP	3.2 COP	
Water to Water: Water Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68 °F entering water	3.7 COP	3.7 COP	ISO 13256-2
Water to Water: Ground Water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50 °F entering water	3.1 COP	3.1 COP	
Brine to Water: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32 °F entering fluid	2.5 COP	2.5 COP	

For SI: 1 British thermal unit per hour = 0.2931 W. $^{o}C = [(^{o}F) - 32]/1.8$

a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

TABLE 503.2.3(2)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR	MINIMUM EFFICIENCY[b]	TEST PROCEDURE[a]
Air cooled, (Cooling mode)	< 65,000 Btu/h[d]	Split system	13.0 SEER	AHRI 2 10/240
		Single package	13.0 SEER	
	~65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.0 EER[e] 11.2	
	~ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	10.6 EER[e] 10.7 IEER	AHRI 340/360
	~ 240,000 Btu/h	Split system and single	9.5 EER[e]	
Through-the-Wall (Air cooled, cooling mode)	< 30,000 Btu/hd	Split system	12.0 SEER	AHRI 2 10/240
		Single package	12.0 SEER	
Water Source (Cooling mode)	< 17,000 Btu/h	86°F entering water	11.2 EER	AHRI/ASHRAE 13256-1
	~ 17,000 Btu/h and < 135,000 Btu/h	86°F entering water	12.0 EER	AHRIASHRAE 13256-1
Groundwater Source (Cooling mode)	< 135,000 Btu/h	59°F entering water	16.2 EER	AHRI/ASHRAE 13256-1
Ground source (Cooling mode)	< 135,000 Btu/h	77°F entering water	13.4 EER	AHRI/ASHRAE 13256-1
Air cooled (Heating mode)	< 65,000 Btu/h[d] (Cooling capacity)	Split system	7.7 HSPF	AHRI 210/240
		Single package	7.7 HSPF	
	~ 65,000 Btu/h and < 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb Outdoor air	3.3 COP	
	~ 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb Outdoor air	3.2 COP	AHRI 340/360
Through-the-wall (Air cooled heating mode)	<30,000 Btu/h	Split System	7.4 HSPF	AHRI 2 10/240
		Single package	7.4 HSPF	
Water source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	68°F entering water	4.2 COP	AHRI/ASHRAE 13256-1

~~Groundwater source (Heating mode)~~	~~< 135,000 Btu/h (Cooling capacity)~~	~~50°F entering water~~	~~3.6 COP~~	~~AHRI/ASHRAE 13256-1~~
~~Ground source (Heating mode)~~	~~< 135,000 Btu/h (Cooling capacity)~~	~~32°F entering water~~	~~3.1 COP~~	~~AHRI/ASHRAE 13256-1~~

~~For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.293 1 W.~~

~~db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F.~~

~~a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.~~

~~b. IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.~~

~~c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.~~

~~d. Single-phase air-cooled heat pumps <65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA), SEER and HSPF values are those set by NAECA.~~

TABLE 503.2.3(3)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,
PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,
SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
PTAC (cooling mode) new construction	All Capacities	95°F db outdoor air	14.0 – (0.300 × Cap/1000)[c] EER	AHRI 310/380
PTAC (cooling mode) replacements[b]	All Capacities	95°F db outdoor air	10.9 - (0.213 × Cap/1000) EER	
PTHP (cooling mode) new construction	All Capacities	95°F db outdoor air	14.0 - (0.300 × Cap/1000) EER	
PTHP (cooling mode) replacements[b]	All Capacities	95°F db outdoor air	10.8 - (0.213 × Cap/1000) EER	
PTHP (heating mode) new construction	All Capacities	—	3.2 - (0.026 × Cap/1000) COP	
PTHP (heating mode) replacements[b]	All Capacities	—	2.9 - (0.026 × Cap/1000) COP	
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	9.0 EER	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/ 75°F wb outdoor air	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/ 75°F wb outdoor air	8.6 EER	
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	9.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/ 75°F wb outdoor air	8.9 EER	
	≥ 135,000 Btu/h and	95°F db/ 75°F wb outdoor air	8.6 EER	

	< 240,000 Btu/h			
SPVHP (heating mode)	<65,000 Btu/h	47°F db/ 43°F wb outdoor air	3.0 COP	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/ 43°F wb outdoor air	3.0 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/ 75°F wb outdoor air	2.9 COP	
Room air conditioners, with louvered slides	< 6,000 Btu/h	—	9.7 SEER	ANSI/AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h	—	9.7 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h	—	9.8 EER	
	≥ 14,000 Btu/h and < 20,000 Btu/h	—	9.7 SEER	
	≥ 20,000 Btu/h	—	8.5 EER	
Room air conditioners, with louvered slides	< 8,000 Btu/h	—	9.0 EER	
	≥ 8,000 Btu/h and < 20,000 Btu/h	—	8.5 EER	
	≥ 20,000 Btu/h	—	8.5 EER	
Room air-conditioner heat pumps with louvered sides	< 20,000 Btu/h	—	9.0 EER	
	≥ 20,000 Btu/h	—	8.5 EER	
Room air-conditioner heat pumps without louvered sides	< 14,000 Btu/h	—	8.5 EER	
	≥ 14,000 Btu/h	—	8.0 EER	
Room air conditioner casement only	All capacities	—	8.7 EER	
Room air conditioner casement-slider	All capacities	—	9.5 EER	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

"Cap" = The rated cooling capacity of the project 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 calculations.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. Replacement unit 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 inches (406 mm) in height and less than 42 inches (1067 mm) in width.

~~TABLE 503.2.3(3)~~
~~PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~SUBCATEGORY OR~~	~~MINIMUM EFFICIENCY[b]~~	~~TEST PROCEDURE~~

PTAC (Cooling mode) Standard size	All capacities	95°F db outdoor air	12.5 - (0.213 . Cap/1000) EER	AHRI 310/380
PTAC (Cooling mode) Nonstandard size	All capacities	95°F db outdoor air	10.9 - (0.213 . Cap/1000) EER	
PTHP (Cooling mode) Standard size	All capacities	95°F db outdoor air	12.3 - (0.213 . Cap/1000) EER	
PTHP (Cooling mode) Nonstandard size	All capacities	95°F db outdoor air	10.8 - (0.213 . Cap/1000) EER	
PTHP (Heating mode) New construction	All capacities	—	3.2 - (0.026 . Cap/1000) COP	
PTHP (Heating mode) Replacements	All capacities	—	2.9 - (0.026 . Cap/1000) COP	
SPVAC, (Cooling mode)	<65,000 Btu/h	95°F db/75°F wb Outdoor ai	9.0 EER	AHRI 390
	≥ 65,000 Btu/h and <135,000 Btu/h	95°F db/75ºF wb Outdoor air	8.9 EER	
	≥ 135,000 Btu/h and <240,000 Btu/h	95°F db/75ºF wb Outdoor air	8.6 EER	
SPVHP, (Cooling mode)	<65,000 Btu/h	95°F db/75°F wb Outdoor ai	9.0 EER	AHRI 390
	≥ 65,000 Btu/h and <135,000 Btu/h	95°F db/75ºF wb Outdoor air	8.9 EER	
	≥ 135,000 Btu/h and <240,000 Btu/h	95°F db/75ºF wb Outdoor air	8.6 EER	
SPVAC, (Heating mode)	<65,000 Btu/h	47°F db/43°F wb Outdoor ai	3.0 COP	AHRI 390
	≥ 65,000 Btu/h and <135,000 Btu/h	47°F db/43ºF wb Outdoor air	3.0 COP	
	≥ 135,000 Btu/h and <240,000 Btu/h	47°F db/43ºF wb Outdoor air	2.9 COP	

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.293 1 W.

db = dry-bulb temperature, °F.

wb = wet-bulb temperature, °F.

~~a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.~~

~~b. Cap means threated cooling capacity of the product in Btu/h. If the unit's capacity is less than7,000Btu/h, use 7,000 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.~~

~~c. Replacement units must 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 inches (406 mm) high and less than 42 inches (1067 mm) wide.~~

TABLE 503.2.3(4)
WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS,
WARM AIR DUCT FURNACES AND UNIT HEATERS, MINIMUM EFFICIENCY REQUIREMENTS

f. E_c ~~= Combustion efficiency.~~ Units ~~must~~ **shall** also include an IID, have jackets not exceeding 0.75 percent 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.

~~g. E_t = Thermal efficiency. Units must also include an IID, have jacket losses not exceeding 0.75 percent 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.~~

TABLE 503.2.3(7)
WATER CHILLING PACAKAGES – EFFICIENCY REQUIREMENTS[a, b, c]

Equipment Type	Size Category	Units	Before 1/1/2015		As of 1/1/2015		Test Procedure
			Path A	Path B	Path A	Path B	
Air-Cooled Chillers	< 150 Tons	EER (Btu/W)	≥ 9.562 FL	NA[d]	≥ 10.100 FL	≥ 9.700 FL	AHRI 550/590
			≥ 12.500 IPLV		≥ 13.700 IPLV	≥ 15,800 IPLV	
	≥ 150 Tons		≥ 9.562 FL	NA[d]	≥ 10.100 FL	≥ 9.700 FL	
			≥ 12.500 IPLV		≥ 14.000 IPLV	≥ 16.100 IPLV	
Air-Cooled without Condenser, Electrically Operated	All Capacities	EER (Btu/W)	Air-cooled chillers without condenser shall be rated with matching condensers and complying with air-cooled chiller efficiency requirements				
Water-Cooled, Electrically Operated Positive Displacement	<75 Tons	kW/ton	≤ 0.780 FL	≤ 0.800 FL	≤ 0.750 FL	≤ 0.780 FL	
			≤ 0.630 IPLV	≤ 0.600 IPLV	≤ 0.600 IPLV	≤ 0.500 IPLV	
	≥75 tons and <150 tons		≤ 0.775 FL	≤ 0.790 FL	≤ 0.720 FL	≤ 0.750 FL	
			≤ 0.615 IPLV	≤ 0.586 IPLV	≤ 0.560 IPLV	≤ 0.490 IPLV	
	≥150 tons and <300 tons		≤ 0.680 FL	≤ 0.718 FL	≤ 0.660 FL	≤ 0.680 FL	
			≤ 0.580 IPLV	≤ 0.540 IPLV	≤ 0.540 IPLV	≤ 0.440 IPLV	
	≥300 tons and <600 tons		≤ 0.620 FL	≤ 0.639 FL	≤ 0.610 FL	≤ 0.625 FL	
			≤ 0.540 IPLV	≤ 0.490 IPLV	≤ 0.520 IPLV	≤ 0.410 IPLV	
	≥600 tons		≤ 0.620 FL	≤ 0.639 FL	≤ 0.560 FL	≤ 0.585 FL	

Equipment Type	Size Category	Units	Before 1/1/2015		As of 1/1/2015		Test Procedure
			Path A	Path B	Path A	Path B	
			≤ 0.540 IPLV	≤ 0.490 IPLV	≤ 0.500 IPLV	≤ 0.380 IPLV	
Water-Cooled, Electrically Operated Centrifugal	≤150 Tons	kW/ton	≤ 0.780 FL	≤ 0.639 FL	≤ 0.610 FL	≤ 0.695 FL	
			≤ 0.630 IPLV	≤ 0.450 IPLV	≤ 0.550 IPLV	≤ 0.440 IPLV	
	≥150 tons and <300 tons		≤ 0.634 FL	≤ 0.639 FL	≤ 0.610 FL	≤ 0.635 FL	
			≤ 0.596 IPLV	≤ 0.450 IPLV	≤ 0.550 IPLV	≤ 0.400 IPLV	
	≥300 tons and <400 tons		≤ 0.576 FL	≤ 0.600 FL	≤ 0.560 FL	≤ 0.595 FL	
			≤ 0.549 IPLV	≤ 0.400 IPLV	≤ 0.520 IPLV	≤ 0.390 IPLV	
	≥400 tons and <600 tons		≤ 0.576 FL	≤ 0.600 FL	≤ 0.560 FL	≤ 0.585 FL	
			≤ 0.549 IPLV	≤ 0.400 IPLV	≤ 0.500 IPLV	≤ 0.380 IPLV	
	≥600 Tons		≤ 0.570 FL	≤ 0.590 FL	≤ 0.560 FL	≤ 0.585 FL	
			≤ 0.539 IPLV	≤ 0.400 IPLV	≤ 0.500 IPLV	≤ 0.380 IPLV	
Air-Cooled, Absorption, Single Effect	All Capacities	COP	≥ 0.600 FL	NA[d]	≥ 0.600 FL	NA[d]	AHRI 560
Water-Cooled Absorption, Single Effect	All Capacities	COP	≥ 0.700 FL	NA[d]	≥ 0.700 FL	NA[d]	
Absorption, Double-Effect, Indirect-Fired	All Capacities	COP	≥ 1.000 FL	NA[d]	≥ 1.000 FL	NA[d]	
			≥ 1.050 IPLV		≥ 1.050 IPLV		
Absorption Double-Effect Direct-Fired	All Capacities	COP	≥ 1.000 FL	NA[d]	≥ 1.000 FL	NA[d]	
			≥ 1.000 IPLV		≥ 1.050 IPLV		

a. The requirements for centrifugal chiller shall be adjusted for non-standard rating conditions in accordance with Section 503.2.3.1 and are only applicable for the range of conditions listed in Section 503.2.3.1. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full load and IPLV requirements shall be met or exceeded to comply with this code. Where there is a Path B, compliance can be with either Path A or Path B for any application.

c. FL is the full load performance requirements and IPLV is for the part load performance requirements.

d. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

~~**TABLE 503.2.3(7)**~~
~~**WATER CHILLING PACKAGES, EFFICIENCY REQUIREMENTS[a]**~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~UNITS~~	~~AS OF 1/1/2010c~~				~~TEST PROCEDURE[b]~~
			~~PATH A~~		~~PATH B~~		
			~~FULL LOAD~~	~~IPLV~~	~~FULL~~	~~IPLV~~	
~~Air-cooled chillers~~	~~< 150 tons~~	~~EER~~	~~≥ 9.562~~	~~≥ 12.500~~	~~NA[d]~~	~~NA[d]~~	~~AHRI 550/590~~
	~~≥ 150 tons~~	~~EER~~	~~≥ 9.562~~	~~≥ 12.750~~	~~NA[d]~~	~~NA[d]~~	
~~Air cooled without condenser, electrical operated~~	~~All capacities~~	~~EER~~	~~Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements~~				

Water cooled, electrically operated, reciprocating	All capacities	kW/ton	Reciprocating units must comply with water cooled positive displacement efficiency requirements				
Water-cooled, electrically operated, positive displacement	< 75 tons	kW/ton	~ 0.780	~ 0.630	~ 0.800	~ 0.600	
	~ 75 tons and < 150 tons	kW/ton	~0.775	~0.615	~0.790	~0.586	
	~ 150 tons and < 300 tons	kW/ton	~ 0.680	~ 0.580	~ 0.7 18	~ 0.540	
	~ 300 tons	kW/ton	~ 0.620	~ 0.540	~ 0.639	~ 0.490	
Water-cooled, electrically operated, centrifugal	< 150 tons	kW/ton	~0.634	~0.596	~0.639	~0.450	
	~ 150 tons and < 300 tons	kW/ton					
	~ 300 tons and < 600 tons	kW/ton	~ 0.576	~ 0.549	~ 0.600	~ 0.400	
	~ 600 tons	kW/ton	~ 0.570	~ 0.539	~ 0.590	~ 0.400	
Air cooled, absorption single	All capacities	COP	~ 0.600	NR[e]	NA[d]	NA[d]	AHRI 560
Water-cooled, absorption single effect	All capacities	COP	~ 0.700	NR[e]	NA[d]	NA[d]	
Absorption double effect, indirect-fired	All capacities	COP	~ 1.000	~ 1.050	NA[d]	NA[d]	
Absorption double effect, direct-fired	All capacities	COP	~ 1.000	~ 1.000	NA[d]	NAd	

For SI: 1 ton = 3517 W, 1 British thermal unit per hour = 0.293 1 W.

a. The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is < 40°F.

b. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or B.

d. NA means that this requirement is not applicable and cannot be used for compliance.

e. NR means that there are no minimum requirements for this category.

TABLE 503.2.3(8)
MINIMUM EFFICIENCY REQUIREMENTS:
HEAT REJECTION EQUIPMENT

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

	RATED CONDITIONS			
Propeller or axial fan open circuit cooling towers	All	95°F Entering Water 85°F Leaving Water 75°F Entering wb	≥ 40.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open circuit cooling towers	All	95°F Entering Water 85°F Leaving Water 75°F Entering wb	≥ 20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed circuit cooling towers	All	102°F Entering Water 90°F Leaving Water 75°F Entering wb	≥ 14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal closed circuit cooling towers	All	102°F Entering Water 90°F Leaving Water 75°F Entering wb	≥ 7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Propeller or axial fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F *entering wb*	≥ 134,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia Test Fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F *entering wb*	≥ 110,000 Btu/h·hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F *entering wb*	≥ 157,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A Test Fluid 165°F entering gas temperature 105°F condensing temperature 75°F *entering wb*	≥ 135,000 Btu/h·hp	CTI ATC-106
Air-cooled condensers	All	125°F Condensing Temperature 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db	≥ 176,000 Btu/h·hp	ARI 460

For SI: °C = [(°F)-32]/1.8, L/s · kW = (gpm/hp)/(11.83), COP = (Btu/h · hp)/(2550.7)
db = dry bulb temperature, °F, wb = wet bulb temperature, °F.

a. 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 wet and dry heat exchange sections.

b. 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 403.2.3(8) divided by the fan nameplate rated motor power.

c. For purposes of this table, closed circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 403.2.3(8) divided by the sum of the fan nameplate rated motor power and the spray pump nameplate rated motor power.

d. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.

e. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure. The certification requirements do not apply to field erected cooling towers.

f. Where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program, or, where a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report.

g. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project specific accessories and / or options included in the capacity of the cooling tower.

h. 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.

i. 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 shall meet the minimum efficiency requirements listed above with R-507A as the test fluid.

~~**TABLE 503.2.3(8)**~~
~~**HEAT REJECTION EQUIPMENT- MINIMUM EFFICIENCY REQUIREMENTS**~~

~~EQUIPMENT TYPE~~	~~TOTAL SYSTEM HEAT~~	~~SUBCATEGORY OR RATING~~	~~PERFOR MANCE~~	~~TEST PROCEDURE[c,]~~
~~Propeller or Axial Fan Open-Circuit Cooling Towers~~	~~All~~	~~95°F Entering Water 85°F Leaving Water 75°F~~	~~≥ 38.2 gpm/hp~~	~~CTI ATC-105 and CTI STD-201~~
~~Centrifugal Fan Open-Circuit Cooling Tower~~	~~< 1,100 gpm[f]~~	~~95°F Entering Water 85°F Leaving Water 75°F Entering wb~~	~~≥ 20.0 gpm/hp~~	~~CTI ATC-105 and CTI STD-201~~
~~Low Profile Centrifugal Fan Open-Circuit Cooling Towers[g]~~	~~1,100 gpm[f]~~	~~95°F Entering Water 85°F Leaving Water 75°F Entering wb~~	~~≥ 30.0 gpm/hp~~	~~CTI ATC-105 and CTI STD-201~~
~~Propeller or Axial Fan Closed-Circuit Cooling Towers~~	~~All~~	~~102°F Entering Water 90°F Leaving Water 75°F Entering wb~~	~~≥ 14.0 gpm/hp~~	~~CTI ATC-105S and CTI STD-201~~
~~Centrifugal Closed-Circuit Cooling Towers~~	~~All~~	~~102°F Entering Water 90°F Leaving Water 75°F Entering wb~~	~~≥ 7.0 gpm/hp~~	~~CTI ATC-105S and CTI STD-201~~
~~Air-Cooled Condensers~~	~~All~~	~~125°F Condensing Temperature R-22 Test Fluid 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db~~	~~≥ 176,000 Btu/h·hp~~	~~ARI 460~~

~~For SI: °C = [(°F) - 32]/1.8~~

~~a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of tower at thermal rating conditions listed in this table 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 this table divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate horsepower.~~

~~c. For purposes of this table, air-cooled condenser performance is defined as heat rejected from refrigerant divided by the fan motor nameplate power.~~

~~d. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.~~

~~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.~~

~~f. Open circuit cooling towers 1,100 gpm or larger that are ducted (inlet or discharge) or have external sound~~

~~attenuation that require external static pressure capability may meet the requirements of towers smaller than 1,100 gpm.~~

~~g. Low profile cooling towers, where required by local planning department, must meet the performance as specified in this table.~~

TABLE 503.2.3 (9)
MINIMUM EFFICIENCY AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS

Equipment Type	Net Sensible Cooling Capacity[a]	MinimumSCOP-127[b] Efficiency Downflow units / Upflow units	Test Procedure
Air conditioners, air cooled	65,000 Btu/h	2.20 / 2.09	ANSI/ASHRAE 127
	≥65,000 Btu/h and < 240,000 Btu/h	2.10 / 1.99	
	≥240,000 Btu/h	1.90 / 1.79	
Air conditioners, water cooled	65,000 Btu/h	2.60 / 2.49	
	≥65,000 Btu/h and < 240,000 Btu/h	2.50 / 2.39	
	≥240,000 Btu/h	2.40 /2.29	
Air conditioners, water cooled with fluid economizer	65,000 Btu/h	2.55 /2.44	
	≥65,000 Btu/h and < 240,000 Btu/h	2.45 / 2.34	
	≥240,000 Btu/h	2.35 / 2.24	
Air conditioners, glycol cooled (rated at 40% propylene glycol)	65,000 Btu/h	2.50 / 2.39	
	≥65,000 Btu/h and < 240,000 Btu/h	2.15 / 2.04	
	≥240,000 Btu/h	2.10 / 1.99	
Air conditioners, glycol cooled (rated at 40% propylene glycol) with fluid economizer	65,000 Btu/h	2.45 / 2.34	
	≥65,000 Btu/h and < 240,000 Btu/h	2.10 / 1.99	
	≥240,000 Btu/h	2.05 / 1.94	

a. Net sensible cooling capacity: The total gross cooling capacity less the latent cooling less the energy to the air movement system. (Total Gross – latent – Fan Power).

b. Sensible coefficient of performance (SCOP-127): a ratio calculated by dividing the net sensible cooling capacity in watts by the total power input in watts (excluding re-heaters and humidifiers) at conditions defined in ASHRAE Standard 127. The net sensible cooling capacity is the gross sensible capacity minus the energy dissipated into the cooled space by the fan system.

TABLE 503.2.3(10)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW AIR-TO-AIR AND APPLIED HEAT PUMPS

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 12.9 IEER	
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	10.8 EER 12.7 IEER	

	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.6 EER 12.3 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	10.4 EER 12.1 IEER	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	9.5 EER 11.0 IEER	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	9.3 EER 10.8 IEER	
VRF Water source (cooling mode)	<65,000 Btu/h	All	VRF Multi-split systems *86°F entering water*	12.0 EER	AHRI 1230
	<65,000 Btu/h	All	VRF Multi-split systems with Heat Recovery *86°F entering water*	11.8 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System *86°F entering Water*	12.0 EER	
	≥65.000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System with Heat Recovery *86°F entering water*	11.8 EER	
	≥135.000 Btu/h	All	VRF Multi-split System *86°F entering water*	10.0 EER	
	≥135.000 Btu/h	All	VRF Multi-split System with Heat Recovery *86°F entering water*	9.8 EER	
VRF Groundwater source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System *59°F entering water*	16.2 EER	AHRI 1230
	<135,000 Btu/h	All	VRF Multi-split System with Heat Recovery *59°F entering water*	16.0 EER	
	≥135,000 Btu/h	All	VRF Multi-split System *59°F entering water*	13.8 EER	
	≥135,000 Btu/h	All	VRF Multi-split System with Heat Recovery *59°F entering water*	13.6 EER	
VRF Ground source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System *77°F entering water*	13.4 EER	AHRI 1230
	<135,000 Btu/h	All	VRF Multi-split System with Heat Recovery *77°F entering water*	13.2 EER	
	≥135,000 Btu/h	All	VRF Multi-split System *77°F entering water*	11.0 EER.	
	≥135,000 Btu/h	All	VRF Multi-split System with Heat Recovery *77°F entering water*	10.8 EER	

VRF Air Cooled (heating mode)	**<65,000 Btu/h (cooling capacity)**	**---**	**VRF Multi-split System**	**7.7 HSPF**	**AHRI 1230**
	≥65.000 Btu/h and –<135,000 Btu/h (cooling capacity)	**---**	**VRF Multi-split system *47°F db/43°F wb outdoor air* *17°F db/157 wb outdoor air***	**3.3 COP 2.25 COP**	
	≥135,000 Btu/h (cooling capacity)	**---**	**VRF Multi-split System *47°F db/43°F wb outdoor air* *177 db/15°F wb outdoor-air***	**3.2 COP 2.05 COP**	
VRF Water source (heating mode)	**<135,000 Btu/h (cooling capacity)**	**---**	**VRF Multi-split System 68°F entering water**	**4.2 COP**	**AHRI 1230**
	≥135,000 Btu/h (cooling capacity)	**---**	**VRF Multi-split System 68°F entering water**	**3.9 COP**	
VRF Groundwater source (heating mode)	**<135,000 Btu/h (cooling capacity)**	**---**	**VRF Multi-split System 50°F entering water**	**3.6 COP**	**AHRI 1230**
	≥135,000 Btu/h (cooling capacity)	**---**	**VRF Multi-split System 50°F entering water**	**3.3 COP**	
VRF Ground source (heating mode)	**<135,000 Btu/h (cooling capacity)**	**---**	**VRF Multi-split System 32°F entering water**	**3.1 COP**	**AHRI 1230**
	≥135,000 Btu/h (cooling capacity)	**---**	**VRF Multi-split System 32°F entering water**	**2.8 COP**	

503.2.4.5 Shutoff dampers and controls. ~~Both~~ outdoor air supply ~~and~~ exhaust, **and relief** shall be equipped with not less than Class I motorized dampers with a maximum leakage rate of 4 cfm per square foot (6.8 L/s · C m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D, that will automatically shut when the systems or spaces served are not in use.

Exceptions:

1. Gravity dampers shall be permitted for outside air intake or exhaust airflows of 300 cfm (0.14 m^3/s) or less.
2. **Relief dampers integral to packaged cooling equipment.**
3. **Type I grease exhaust systems.**

503.2.5.1 Demand controlled ventilation. Demand control ventilation (DCV) is required for spaces ~~larger than 500 ft^2 (46.5 m^2) for simple systems and spaces larger than 150 ft^2 (13.9 m^2) for multiple zone systems and~~ with an average occupant load of 25 people or more per 1000 ft^2 (93 m^2) of floor area (as established in Table 403.3 of the *Mechanical Code)* and served by systems with one or more of the following:

1. An air-side economizer;
2. Automatic modulating control of the outdoor air damper; or
3. A design outdoor airflow greater than 3,000 cfm (1400 L/s).

Exceptions:

1. **Spaces smaller than 500 ft2 (46.5 m^2) served by single-zone systems.**
2. **Spaces smaller than 150 ft2 (13.9 m^2) served by multiple-zone systems.**
3. Systems with energy recovery complying with Section 503.2.6.
4. Spaces less than 750 ft^2 (69.7 m^2) where an occupancy sensor turns the fan off, closes the ventilation damper, or closes the zone damper when the space is unoccupied.

503.2.5.2 Kitchen hoods. Kitchen makeup air shall be provided as required by the *Mechanical Code.* For each kitchen with a total exhaust capacity greater than 5,000 cfm (2360 L/s), 50 percent of the required makeup air shall be (a) unheated or heated to no more than 60°F (15.55°C); and (b) uncooled or evaporatively cooled.

~~Each kitchen with a total Type 1 exhaust capacity greater than 5,000 cfm (2360 L/s) shall be equipped with a demand ventilation system on at least 75 percent of the exhaust and makeup air. Such systems shall be equipped with automatic controls that reduce airflow in response to cooking appliance operation.~~

Exceptions:

1. Where hoods are used to exhaust ventilation air that would otherwise be exhausted by other fan systems. Air transferred from spaces served by other fan systems may not be used if those systems are required to meet either Sections 503.2.5.1 or 503.2.6. Occupancy schedule of HVAC system supplying transfer air shall be similar to kitchen exhaust hood operating schedule.
2. ~~Kitchen exhaust systems that include exhaust air energy recovery complying with Section 503.2.6.~~

503.2.5.2.1 Variable Flow Exhaust. Each kitchen with a total Type 1 exhaust capacity greater than 5,000 cfm (2360 L/s) shall be equipped with a demand ventilation system on at least 75 percent of the exhaust and makeup air. Such systems shall be equipped with automatic controls that reduce airflow in response to cooking appliance operation.

503.2.5.3 Enclosed parking garage ventilation controls. In Group S-2, enclosed parking garages used for storing or handling automobiles operating under their own power having ventilation exhaust rates 30,000 cfm (14 157 L/s) and greater shall employ automatic carbon monoxide sensing devices. These devices shall modulate the ventilation system to maintain a maximum average concentration of carbon monoxide of 50 parts per million during any 8-hour period, with a maximum concentration not greater than 200 parts per million for a period not exceeding 1 hour. The system shall be capable of producing a ventilation rate of ~~1.5~~ **0.75** cfm per square foot ($0.0076 m^3/s \cdot m^2$) of floor area. Failure of such devices shall cause the exhaust fans to operate in the ON position.

503.2.7.1.3 High-pressure duct systems. Ducts designed to operate at static pressures in excess of 3 inches w.g. (746 Pa) shall be insulated and sealed in accordance with Section 503.2.7. In addition, ducts and plenums shall be leak-tested in accordance with

the SMACNA *HVAC Air Duct Leakage Test Manual* with the rate of air leakage (CL) less than or equal to 6.0 as determined in accordance with Equation ~~5-2~~ **5-3**.

$CL = F \times P^{0.65}$ **(Equation ~~5-2~~ 5-3)**

where:

F = The measured leakage rate in cfm per 100 square feet of duct surface.

P = The static pressure of the test.

503.2.8.1 Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesives tape shall not be permitted as the means of protection and shall be used per manufacturer's specfications.

TABLE 503.2.8
~~MINIMUM PIPE INSULATION~~
~~(thickness in inches)~~

~~FLUID~~	~~NOMINAL PIPE~~	
	~~1.5~~	~~1.5~~
~~Steam~~	~~1 1/2~~	~~3~~
~~Hot water~~	~~1 1/2~~	~~2~~
~~Chilled water, brine or refrigerant~~	~~1 1/2~~	~~11/2~~

~~For SI: 1 inch = 25.4 mm.~~

~~a. Based on insulation having a conductivity (k) not exceeding 0.27 Btu per inch/h · ft^2 · °F.~~

~~b. For insulation with a thermal conductivity not equal to 0.27 Btu · inch/h· ft^2 · °F at a mean temperature of 75°F, the minimum required pipe thickness is adjusted using the following equation;~~

~~$T = r[(1 + t/r)^{K/k} - 1]$~~

~~where:~~

~~T = Adjusted insulation thickness (in).~~

~~r = Actual pipe radius (in).~~

~~t = Insulation thickness from applicable cell in table (in).~~

~~K = New thermal conductivity at 75°F (Btu · in/hr · ft^2 · °F). k = 0.27 Btu · in/hr · ft^2 · °F.~~

MINIMUM PIPE INSULATION THICKNESS (thickness in inches)[a]

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu · in./(h · ft^2 ·°F)	Mean Rating Temperature, °F	< 1	1 to < 1 ½	1 ½ to <4	4 to < 8	< 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5

40 – 60	**0.21 – 0.27**	**75**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**
< 40	**0.20 – 0.26**	**75**	**0.5**	**1.0**	**1.0**	**1.0**	**1.5**

For SI: 1 inch = 25.4 mm.

a. For piping smaller than 1 ½ inch (38 mm) and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch (25 mm) shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less that 1 inch (25 mm).

b. For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows:

$$T = r\{(1 + t/r)^{K/k} - 1\}$$

where:

T = minimum insulation thickness,

r = actual outside radius of pipe,

t = insulation thickness listed in the table for applicable fluid temperature and pipe size,

K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu x in/h x ft2 x °F) and

k = the uppper value of the conductivity range listed in the table for the applicable fluid temperature

c. For direct-buried heating and hot water system piping, reduction of these thicknesses, by 1 ½ inches (38 mm) shall be permitted (before thickness adjustment required in footnote b but not to thicknesses less than 1 inch (25 mm).

TABLE 503.2.10.1(1)
FAN POWER LIMITATION

	LIMIT	**CONSTANT VOLUME**	**VARIABLE VOLUME**
Option 1: Fan system motor	Allowable nameplate motor	hp ≤ CFMS *0.0011	hp ≤ CFMS *0.00
Option 2: Fan system bhp	Allowable fan system	bhp ≤ CFMS *0.00094	bhp ≤CFMS *0.00 13 +

where:

CFM_S = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.

hp = The maximum combined motor nameplate horsepower.

Bhp = The maximum combined fan brake horsepower.

A= Sum of [PD × CFM_D/4131].

where:

PD = Each applicable pressure drop adjustment from Table 503.2.10.1(2) in. w.c.

CFM_D = The design airflow through each applicable device from Table 503.2.10.1(2) in cubic feet per minute.

503.2.11.~~Heating outside a building.~~ Heating Unenclosed Spaces. Systems installed to provide heat outside a building shall be **infra-red** radiant systems. Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically de-energized when no occupants are present.

503.2.11.1 Spot heating within enclosed spaces. Infra-red spot heating meeting the control requirements of Section 503.2.11 shall be allowed within unconditioned and semi-heated spaces without requiring the envelope to comply as a conditioned space. Spot heating shall be limited to the larger of 500 ft^2 (m^2) or 10 percent of the floor area.

503.3 Simple HVAC systems and equipment ~~(Prescriptive)~~.

503.4.1 Economizers. Supply air economizers shall be provided on each cooling system and shall be capable of operating at 100 percent outside air, even if additional mechanical cooling is required to meet the cooling load of the building.

Exceptions:

1. Systems utilizing water economizers that are capable of cooling supply air by direct or indirect evaporation or both and providing 100 percent of the expected system cooling load at outside air temperatures of 50°F (10°C) dry bulb/45°F (7°C) wet bulb and below.
2. Cooling equipment less than 54,000 Btu/h (15 827 W) total cooling capacity. The total capacity of all such units without economizers shall not exceed 240,000 Btu/h (70342W) per building area served by one utility meter or service, or 10 percent of its total installed cooling capacity, whichever is greater. That portion of the equipment serving dwelling units and guest rooms is not included in determining the total capacity of units without economizers.
3. Ground-coupled heat pumps with cooling capacity of 54,000 Btu/h (15 827 W) or less.
4. Systems where internal/external zone heat recovery is used.
5. Systems used to cool any dedicated computer server room, electronic equipment room or telecom switch room having a**n** ~~water~~ economizer system capable of cooling air by direct and/or indirect evaporation and providing 100 percent of the expected systems cooling load at outside air temperatures of 45°F (7°C) dry bulb and 40°F (8°C) wet bulb and below.
6. Economizer cooling is not required for new cooling systems serving an existing dedicated computer server room, electronic equipment room or telecom switch room in existing buildings up to a total of 600,000 Btu/h (~~17 586~~ **17 5,800** W) of new cooling equipment.
7. Economizer cooling is not required for new cooling systems serving a new dedicated computer server room, electronic equipment room or telecom switch room in existing buildings up to a total of 240,000 Btu/h (~~70 344~~ **70,300** W) of new cooling equipment.
8. Systems using condenser heat recovery, up to the cooling capacity used to provide condenser heat recovery.

SECTION 504
SERVICE WATER HEATING
~~(Mandatory)~~

TABLE 504.2
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	*SIZE CATEGORY (input)*	*SUBCATEGORY OR RATING CONDITION*	*PERFORMANCE REQUIRED[a,b]*	*TEST PROCEDURE*
Water heaters	*≤ 12 kW[d]*	*Resistance*	*0.97 - 0.00 132V, EF*	*DOE 10 CFR Part 430*

Electric	> 12 kW	Resistance	(0.3 ÷ 27/V_m), %h	ANSI Z21. 10.3
	≤24 amps and ≤250 volts	Heat pump	0.93 - 0.00 132V, EF	DOE 10 CFR Part 430
Storage water heaters, Gas	≤75,000 Btu/h	≥20 gal	0.67 - 0.0019V, EF	DOE 10 CFR Part 430
	> 75,000 Btu/h and ≤155,000 Btu/h	< 4,000 Btu/h/gal	80% E (Q / 800 + 110V) SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E (Q/ 800 + 110 V) SL, Btu/h	
Instantaneous water heaters, Gas	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥4,000 (Btu/h)/gal and < 2 ga	0.62 - 0.0019V, EF	DOE 10 CFR Part 430
	≥200,000 Btu/h	≥4,000 Btu/h/gal and < 10 ga	80% E	ANSI Z21.10.3
	≥200,000 Btu/h	≥4,000 Btu/h/gal and≥10 gal	80% E (Q/800+ 110 V)SL, Btu/h	
Storage water heaters, Oil	≤105,000 Btu/h	≥20 gal	0.59 - 0.00 19V, EF	DOE 10 CFR Part 430
	≥105,000 Btu/h	< 4,000 Btu/h/gal	80% E (Q/800+ 110 V)SL, Btu/h	ANSI Z21.10.3
Instantaneous water heaters, Oil	≤210,000 Btu/h	≥4,000 Btu/h/gal and < 2 ga	0.59 - 0.0019V, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥4,000 Btu/h/gal and < 10 ga	80% E	ANSI Z21.10.3
	≥210,000 Btu/h	≥4,000 Btu/h/gal and≥10 gal	78% E (Q/800+ 110 V)SL, Btu/h	
Hot water supply boilers, Gas and Oil	≥300,000 Btu/h and < 12,500,000 Btu/h	≥4,000 Btu/h/gal and < 10 ga	80% E	ANSI Z21.10.3
Hot water supply boilers, Gas	≥300,000 Btu/h and < 12,500,000 Btu/h	≥4,000 Btu/h/gal and ≥10 gal	80% E (Q/800 + 110 V) SL, Btu/h	
Hot water supply boilers, Oil	> 300,000 Btu/h and < 12,500,000 Btu/h	> 4,000 Btu/h/gal and > 10 gal	78% E (Q/800 + 110 V) SL, Btu/h	
Pool heaters, Gas and Oi	All	—	82% E	ASHRAE 146

Heat pump pool heaters	***All***	—	***4.0 COP***	***AHRI 1160***
Unfired storage tanks	***All***	—	***Minimum insulation requirement R-12.5 (h · ft²· °F)/Btu***	***(none)***

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.293 1 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Energy factor (EF) and thermal efficiency (*E*) are minimum requirements. In the EF equation, *V* is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, *Q* is the nameplate input rate in Btu/h. In the equations for electric water heaters, *V*is the rated volume in gallons and V_m is the measured volume gallons. In the SL equation for oil and gas water heaters and boilers, *V*is the rated volume in gallons.

c. Instantaneous waterheaters with inputrates below 200,000 Btu/h shall comply withthese requirements if the waterheateris designedto heat water to temperatures 180°F or higher.

d. Electric water heaters with an input rating of 12kW or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12kW.

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY (input)~~	~~SUBCATEGORY OR RATING CONDITION~~	~~PERFORMANCE REQUIRED~~[a, b]	~~TEST PROCEDURE~~
~~———~~	~~≤12 kW~~	~~Resistance ≥20 gal~~	~~0.97 - 0.00 132V, EF~~	~~DOE 10 CFR Part 430~~
	~~> 12 kW~~	~~Resistance ≥20 gal~~	~~1.73V + 155 SL, Btu/h~~	~~Section G.2 of ANSI~~
	~~≤24 amps and ≤250 volts~~	~~Heat pump~~	~~0.93 - 0.00 132V, EF~~	~~DOE 10 CFR Part 430~~
~~Storage water heaters, Gas~~	~~≤75,000 Btu/h~~	~~≥20 gal~~	~~0.67 - 0.0019V, EF~~	~~DOE 10 CFR Part~~
	~~> 75,000 Btu/h and <155,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~80% E_t (Q / 800 + 110~~	~~Sections G. 1 and G.2 of ANSI Z21.10.3~~
	~~> 155,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~80% E_t (Q/800 + 110 $\sqrt{V}$) SL.~~	
~~Instantaneous water heaters, Gas~~	~~> 50,000 Btu/h and < 200,000~~	~~≥4,000 (Btu/h)/gal~~	~~0.62 - 0.00 19V, EF~~	~~DOE 10 CFR Part 430~~
	~~≥200,000 Btu/~~	~~≥4,000 Btu/h/gal and~~	~~80% E_t~~	~~Sections G.1 and G.2 of ANSI Z21.10.3~~
	~~≥200,000 Btu/~~	~~≥4,000 Btu/h/gal and~~	~~80% E (Q/800 + 110 $\sqrt{V}$)SL.~~	
~~Storage water heaters, Oil~~	~~≤105,000 Btu/h~~	~~≥20 gal~~	~~0.59 - 0.0019V, EF~~	~~DOE 10 CFR Part~~
	~~> 105,000 Btu/h~~	~~< 4,000 Btu/h/gal~~	~~78% E_t (Q/800 + 110 $\sqrt{V}$) SL.~~	~~Sections G.1 and G.2 of~~
~~Instantaneous water heaters, Oil~~	~~≤210,000 Btu/~~	~~≥4,000 Btu/h/gal and < 2 ga.~~	~~0.59 - 0.00 19V, EF~~	~~DOE 10 CFR Part 430~~
	~~> 210,000 Btu/~~	~~≥4,000 Btu/h/gal and~~	~~80% E_t~~	~~Sections G.1 and G.2 of ANSI Z21.10.3~~
	~~> 210,000 Btu/~~	~~≥4,000 Btu/h/gal and~~	~~78% E_t (Q/800 + 110 $\sqrt{V}$)SL.~~	
~~Hot water supply boilers, Gas and Oil~~	~~≥300,000 Btu/h and <12,500,000 Btu/h~~	~~≥4,000 Btu/h/gal and~~	~~80% E_t~~	

Hot water supply boilers, Gas	≥ 300,000 Btu/h and <12,500,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t (Q/800 + 110 $\sqrt{V}$)SL, Btu/h	C.2 of ANSI Z21.10.3
Hot water supply boilers,	> 300,000 Btu/h and <12,500,000	> 4,000 Btu/h/gal and	78% E_t (Q/800 + 110 $\sqrt{V}$)SL,	
Pool heaters,	All	—	78% E_t	ASHRAE 146
Heat pump pool	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h · ft^2 · °F)/Btu	(none)

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.293 1 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Energy factor (EF) and thermal efficiency (Et) are minimum requirements. In the EF equation, V is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, Q is the nameplate input rate in Btu/h. In the SL equation for electric water heaters, V is the rated volume in gallons. In the SL equation for oil and gas water heaters and boilers, V is the rated volume in gallons.

c. Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

504.6 Hot water system controls. Systems designed to maintain usage temperatures in hot water pipes, such as hot water recirculating systems or heat trace, shall be turned off automatically when the hot water system is not operational and shall have demand sensing controls (flow switch in cold water make-up pipe, return water aquastat temperature sensor) that turn off the system when there is no demand when the system is operational. A check valve or similar device shall be located between the circulator pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop. **Gravity or thermosyphon circulation loops are prohibited.**

Exceptions:

1. Where public health standards require 24 hours per day operation of pumps for uses such as swimming pools, spas and hospitals.
2. Service water heating systems used to provide multiple functions (e.g., space heating and DHW) as part of an integrated system.
3. Where coupled with water heating capacity less than 100,000 Btu/h (29 kW).

504.7 Pools, spas and hottubs. Pools, spas and hottubs shall be provided with energy conserving measures in accordance with Sections 504.7.1 through 504.7.3.

Swimming pools and spas are regulated by the Oregon Health Authority per O.A.R. 333-062. In the event of conflict with this code, O.A.R. 333-062 shall prevail.

1. Where pumps are required to operate solar-and waste-heat-recovery heating systems.

504.7.3 Covers. Heated pools, spas and hottubs shall be equipped with a vapor retardant cover on or at the water surface. Pools, spas and hottubs heated to more than 90°F (32°C) shall have a cover with a minimum insulation value of R-12.

Exception: Pools, spas and hottubs deriving over 60 percent of the energy for heating from site-recovered energy or solar energy source.

504.7.4 Heat recovery. Heated indoor swimming pools, spas, or hot tubs with water surface area greater than 200 square feet (19 m^2) shall provide **heat recovery utilizing either:** ~~for energy conservation by an exhaust air heat recovery system that heats ventilation air, pool water, or domestic hot water. The heat recovery system shall be capable of decreasing the exhaust air temperature at design heating conditions by 28°F (15.5°C)~~

1. **Compressorized dehumidification system with integral reheat and:**

   a. **Condensor heat recovery for water heating of pool and/or service hot water, or**

   b. **Exhaust air heat recovery that recovers 50 percent of the total energy from the pool enclosure exhaust air stream at design temperatures.**

2. **An air-to-air exchange system with variable outdoor air/exhaust and variable heat exchanger bypass, set to maintain maximum space relative humidity of 60%. At 50F dry bulb and 80-percent relative humidity outdoor conditions, the heat exchanger shall increase the total energy of the incoming outdoor air by 60 percent or shall increase the sensible energy of the outdoor air by 70 percent.**

Exception: Pools, spas, or hot tubs that include system(s) that provide equivalent recovered energy on an annual basis through one of the following methods:

1. Heated by renewable energy,
2. ~~Dehumidification heat recovery when the evaporative coil is located upstream of the exhaust air stream,~~
2. Waste heat recovery, or
3. A combination of these system(s) sources capable of providing at least 70 percent of the heating energy required over an operating season.

SECTION 505
ELECTRICAL POWER AND LIGHTING SYSTEMS
(Mandatory)

505.2 Interior Lighting controls (Mandatory). Lighting systems shall be provided with controls as required in Sections 505.2.1, 505.2.2, 505.2.3 and 505.2.4.

505.2.1 ~~Interior~~ Llighting controls. At least one local shutoff lighting control shall be provided for every 2,000 square feet (185.8 m^2) of lit floor area and each area enclosed by walls or floor-to-ceiling partitions. The required controls shall be located within the area served by the controls or be a remote switch that identifies the lights served and indicates their status.

505.2.3 Sleeping unit controls. *Sleeping units* in hotels, motels, boarding houses or similar buildings shall have at least one master switch at the main entry door that controls all permanently

wired luminaires and switched receptacles, except those in the bathroom(s). **Bathrooms shall have a control device installed to automatically turn off the bathroom lighting, except for night lighting not exceeding 5 watts, within 60 minutes of the occupant leaving the space.**

505.2.4 Reserved.

505.3 Reserved. ~~**Tandem wiring (Mandatory).** The following luminaires located within the same area shall be tandem wired:~~

1. ~~Fluorescent luminaires equipped with one, three or odd-numbered lamp configurations, that are recess-mounted within 10 feet (3048 mm) center-to-center of each other.~~
2. ~~Fluorescent luminaires equipped with one, three or any odd-numbered lamp configuration, that are pendant- or surface-mounted within 1 foot (305 mm) edge-to-edge of each other.~~

~~**Exceptions:**~~

1. ~~Where electronic high-frequency ballasts are used.~~
2. ~~Luminaires on emergency circuits.~~
3. ~~Luminaires with no available pair in the same area.~~

TABLE 505.5.2(a)
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	**(W/ft^2)**
Automotive Facility	0.79
Convention Center	~~1.16~~**1.08**
Court House	~~1.08~~**1.05**
Dining: Bar Lounge/Leisure	~~1.19~~**0.99**
Dining: Cafeteria/Fast Food	~~1.34~~**0.90**
Dining: Family	~~1.5~~**0.89**
Dormitory	1.0
Exercise Center	~~0.92~~**0.88**
Gymnasium	~~1.07~~**1.00**
Healthcare—clinic	0.89
Hospital	1.08
Hotel	1.0
Library	1.17
Manufacturing Facility/**Data Center**	1.24
Motel	1.0
Motion Picture Theater	~~1.18~~**0.83**
Multifamily	0.58
Museum	1.04
Office	0.91
Parking Garage	~~0.26~~**0.25**
Penitentiary	1.0
Performing Arts Theater	~~1.46~~**1.39**
Police	0.89
Fire Station	0.74

Post Office	0.98
Religious Building	~~1.18~~**1.05**
Retail[b]	1.32
School/University	1.01
Sports Arena	~~1.03~~**0.78**
Town Hall	0.94
Transportation	~~0.85~~**0.77**
Warehouse	~~0.73~~**0.66**
Workshop	1.2

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m^2.

TABLE 505.5.2(b)
SPACE-BY-SPACE METHOD MAXIMUM ALLOWABLE LIGHTING POWER DENSITY (LPD)

COMMON SPACE TYPES	LPD (W/ft²)[1]
Office-enclosed[2]	0.97
Office-open plan[2]	0.93
Conference/Meeting/Multipurpo	1.11
Classroom/Lecture/Training	1.23
Lobby	~~1.28~~**0.90**
For Hotel	1.1**0**
For Performing Arts Theater	~~3.24~~**2.00**
For Motion Picture Theater	~~1.01~~**0.52**
Audience/Seating Area	~~0.84~~**0.79**
For Gymnasium	0.4**0**
For Exercise Center	~~0.27~~**0.40**
For Convention Center	0.7**0**
For Religious Buildings	~~1.60~~**1.53**
For Sports Complex	0.4
For Performing Arts Theater	~~2.52~~**2.43**
For Motion Picture Theater	1.11
For Transportation	0.46
Atrium-first three floors	0.6**0**
Atrium-each additional floors	0.16
Lounge/Recreation	~~1.16~~**0.73**
For Hospital	0.71
Dining Area[2]	—
For Hotel/Motel	~~1.23~~**0.82**
For Bar Lounge/Leisure	~~1.4~~**1.31**
For Family Dining	~~2.1~~**0.89**
Food Preparation	~~1.07~~**0.99**
Laboratory	1.4**0**
Restrooms	0.82
Dressing/Locker Room	0.52
Corridor/Transition	0.41
For Hospital	0.94
For Manufacturing Facility	0.41
Stairs-active	0.49
Active Storage	~~0.66~~**0.63**
For Hospitals	0.79
Inactive Storage	0.26
For Museum	0.66
Electrical/Mechanical/**Data**	~~1.24~~**0.95**
Workshop[4]	1.64
BUILDING SPECIFIC SPACE TYPES	
Courthouse/Police Station	
Courtroom	~~1.78~~**1.72**
Judges Chambers	~~1.18~~**1.17**
Gymnasium/Exercise Center	—
Playing Area	~~1.35~~**1.20**
Exercise Area	~~0.76~~**0.72**
Fire Stations	—
Fire Station Engine Room	0.64
Sleeping Quarters	0.27
Post Office - Sorting Area	1.01
Convention Center - Exhibit	1.09
Library[2]	—
Card File and Cataloging	0.96
Stacks	1.47
Reading Area	1.07
Hospital	—
Emergency	2.34
Recovery	0.74
Nurse Station	0.85
Exam/Treatment Room	1.26
Pharmacy	0.99
Patient Room	0.59
Operating Room	1.92
Nursery	0.48
Medical Supply	1.23
Physical Therapy	0.80
Radiology	0.35
Laundry-Washing	0.52
Automotive - Service/Repair	0.63
Museum	—
General Exhibition	1.0**0**
Restoration	1.58
Bank/Office - Banking Activity	1.31
Religious Buildings	—
Worship-pulpit, choir	~~2.29~~**1.53**
Fellowship Hall	~~0.81~~**0.64**
Retail	1.5
Mall Concourse	~~1.5~~**1.10**
Fitting Room	1.06
Sports Arena Complex	—
Ring Sports Area	2.7**0**
Court Sports Area	2.0**0**
Indoor Playing Field Area	1.35
Warehouse	—
Fine Material Storage	~~1.24~~**0.95**
Medium/Bulky Material	~~0.81~~**0.58**
Parking Garage – Garage	~~0.2~~**0.19**
Transportation	—
Airport - Concourse	~~0.57~~**0.36**
Air/Train/Bus – Baggage	~~0.89~~**0.76**
Terminal – Ticket Counter	~~1.31~~**1.08**

For SI: 1 foot = 304.8 mm, 1 square foot = 0.929 m^2, $W/m^2 = W/ft^2 \times 10.764$

1. The watts per square foot may be increased by 2 percent per foot of ceiling height above 20 feet unless specified differently by another footnote.
2. The watts per square foot of room may be increased by 2 percent per foot of ceiling height above 9 feet.
3. Hotel banquet room, conference rooms, or exhibit hall watt per square foot of room may be increased by 2 percent per foot of ceiling height above 12 feet.

~~**Tables 505.6.2(3) and 505.6.2(4).** Deleted.~~

505.6.3 Exterior lighting controls. Lighting not designated for dusk-to-dawn operation shall be controlled by either a combination of a photosensor and a time switch, or an astronomical time switch. Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or photosensor. All time switches shall retain programming and the time setting during loss of power for a period of at least 10 hours. Lighting designated to operate more than 2000 hours per year for uncovered parking areas shall be equipped with motion sensors that will reduce the luminaire power by 33 percent or turn off one-third the luminaires when no activity is detected.

TABLE 505.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		Zone 1	Zone 2	Zone 3	Zone 4
	Outdoor Sales				
	Open areas (including vehicle sales lots) **and food service**	0.25 W/ft^2	0.25 W/ft^2	0.5 W/ft^2	0.7 W/ft^2
	Street frontage for vehicle sales lots [in] addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded betweensurfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades **and Roof paths**[a]	No allowance	0.1 W/ft^2 for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft^2 for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft^2 for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through

	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m^2.

a. Roof lighting: larger of either total roof area or total access/maintenance walkway path length

CHAPTER 6
REFERENCE STANDARDS

AAMA

American Architectural Manufacturers Association
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173-4268

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A c440—~~05~~11	Specifications for Windows, Doors and Unit Skylights.	~~402.4.4,~~ 502.4.1

~~**ACCA**~~

~~Air Conditioning Contractors of America~~
~~2800 Shirlington Road, Stuite 300~~
~~Arlington, VA 22206~~

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~Manual J-11~~	~~Residential Load Calculation Eight Edition. . . . . .~~	~~.R403.6~~
~~Manual S-10~~	~~Residential Equipment Selection . . . . . .~~	~~.R403.6~~

AHRI

Air Conditioning, Heating, and Refrigeration Institute
4100 North Fairfax Drive
Suite 200
Arlington, VA 22203

Standard reference number	Title	Referenced in code section number
ISO/AHRI/ASHRAE 13256-1 (2005)	Water-source Heat Pumps—Testing and Rating for Performance— Part 1: Water-to-air and Brine-to-air Heat Pumps	Table ~~C~~4**5**03.2.3(2)
ISO/AHRI/ASHRAE 13256-2 (1998)	Water-source Heat Pumps—Testing and Rating for Performance— Part 2: Water-to-water and Brine-to-water Heat Pumps	Table ~~C~~4**5**03.2.3(2)
210/240—08	Unitary Air Conditioning and Air-source Heat Pump Equipment	Table ~~C~~4**5**03.2.3(1), Table ~~C~~4**5**03.2.3(2)

310/380—04	Standard for Packaged Terminal Air Conditioners and Heat Pumps	Table ~~C4~~**5**03.2.3(3)
340/360—2007	Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment	Table ~~C4~~**5**03.2.3(1), Table ~~C4~~**5**03.2.3(2)
365—09	Commercial and Industrial Unitary Air-conditioning Condensing Units	Table ~~C4~~**5**03.2.3(1), Table ~~C4~~**5**03.2.3(6)
390—03	Performance Rating of Single Package Vertical Air Conditioners and Heat Pumps	Table ~~C4~~**5**03.2.3(3)
400—01	Liquid to Liquid Heat Exchangers with Addendum 2	Table ~~C4~~**5**03.2.3(9)
440—08	Room Fan Coil	~~C4~~**5**03.2.8
460—05	Performance Rating Remote Mechanical Draft Air-cooled Refrigerant Condensers	Table ~~C4~~**5**03.2.3(8)
550/590—03	Water Chilling Packages Using the Vapor Compression Cycle—with Addenda	~~C4~~**5**03.2.3.1, Table ~~C4~~**5**03.2.3(7), Table ~~C4~~**5**06.2(6)
560—00	Absorption Water Chilling and Water-heating Packages	Table ~~C4~~**5**03.2.3(7)
1160—08	Performance Rating of Heat Pump Pool Heaters	Table ~~C4~~**5**04.2

AMCA

Air Movement and Control Association International 30 West University Drive Arlington Heights, IL 60004-1806

Standard reference number	Title	Referenced in code section number
500D—07	Laboratory Methods for Testing Dampers for Rating	502.4.~~4~~**5**

ANSI

American National Standards Institute 25 West 43rd Street Fourth Floor New York, NY 10036

Standard reference number	Title	Referenced in code section number
Z21.10.3-~~01~~/**CSA 4.3—04**	Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating Tank and Instantaneous – ~~with Addenda Z21.103a-2003 and Z21.10.3b-2004~~	Table 504.2
Z21.47-~~03~~/**CSA 2.3—06**	Gas-fired Central Furnaces	Table 503.2.3(4)

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
ASHRAE Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
~~119—88 (RA 2004)~~	~~Air Leakage Performance for Detached Single-family Residential Buildings . . . . . Table 405.5.2(1)~~	
~~13256-1 (2005)~~	~~Water-source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps (ANSI/ASHRAE/IESNA 90.1-2004). . . . . Table 503 .2.3(2)~~	
90. 1—~~2007~~ **2010**	Energy Standard for Buildings Except Low-rise Residential Buildings (ANSI/ASHRAE/IESNA 90.1-~~2007~~ **2010**.	501.1, 501.2, 502.1.1, Table 502.2(2)
ASHRAE—200~~5~~**9**	ASHRAE Handbook of Fundamentals.	~~402.1.4, Table 405.5.2(1)~~ **303.1.3**
~~ASHRAE 193-2010~~	~~Method of Test for Determining the Airtightness of HVAC Equipment . . .~~	~~.R403.2.2.1~~
ASHRAE—2004	ASHRAE HVAC Systems and Equipment Handbook-2004.	.503.2.1

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

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~PTC 4.1 - 1964 (Reaffirmed 1991)~~	~~Steam Generating Units. . . . . Table 503.2.3(5)~~	

ASTM International
100 Barr Harbor Drive
ASTM West Conshohocken, PA 19428-2859

Standard reference number	Title	Referenced in code section number

~~C 90—06b~~	~~Specification for Load-bearing Concrete Masonry Units . . . . . Table 502.2(1)~~	
E 283—04	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen . . . . . .~~402.4.5,~~ 502.4.2, 502.4.8	

CSA

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario, Canada L4W 5N6

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA		
101/I.S.2/A440—08**11**	Specifications for Windows, Doors and Unit Skylights.	~~402.4.4,~~ 502.4.1

DOE

U.S. Department of Energy
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
(Current Edition)	State Energy Prices and Expenditure Report.	~~405.3~~, 506.2

~~**ICC**~~

~~International Code Council, Inc. 500 New Jersey Avenue.~~

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~IBC—09~~	~~International Building Code®. . . . . 201.3, 303.2, 402.2.9~~	
~~IFC—09~~	~~International Fire Code®. . . . . 201.3~~	
~~IFGC—09~~	~~International Fuel Gas Code®. . . . . 201.3~~	
~~IMC—09~~	~~International Mechanical Code. . . . . .503.2.5, 503.2.6, 503.2.7.1, 503.2.7.1.1, 503.2.7.1.2, 503.2.9.1, 503.3.1, 503.4.5~~	
~~IPC—09~~	~~International Plumbing Code®. . . . . 201.3~~	

~~IRC—09 International Residential Code®. . . . .201.3, 403.2.2, 403.6, 405.6.1, Table 405.5.2(1)~~

Illuminating Engineering Society of North America
120 Wall Street,
17th Floor New
York, NY 10005-
400 1

IESNA

Standard reference number	Title	Referenced in code section number
90.1—~~2007~~ **2010**	Energy Standard for Buildings Except Low-rise Residential Buildings	501.1, 501.2, 502.1.1, Table 502.2(2)

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

ISO

Standard reference number	Title	Referenced in code section number
ISO/AHRI/ASHRAE 13256-1 (2005)	Water-source Heat Pumps—Testing and Rating for Performance— Part 1: Water-to-air and Brine-to-air Heat Pumps	503.2.3(2)
ISO/AHRI/ASHRAE 13256-2 (1998)	Water-Source Heat Pumps—Testing and Rating for Performance— Part 2: Water-to-water and Brine-to-water Heat Pumps	503.2.3(2)