

SUBCHAPTER 2

ALL OCCUPANCIES—MANDATORY REQUIREMENTS FOR THE MANUFACTURE, CONSTRUCTION AND INSTALLATION OF SYSTEMS, EQUIPMENT AND BUILDING COMPONENTS

SECTION 110.0 SYSTEMS AND EQUIPMENT—GENERAL

Sections 110.1 through 110.10 establish requirements for manufacturing, construction and installation of certain systems, equipment, appliances and building components that are installed in buildings regulated by Part 6.

Systems, equipment, appliances and building components may be installed in a building regulated by Part 6 only if:

(a) The manufacturer has certified that the system, equipment, appliances or building component complies with the applicable manufacturing provisions of Sections 110.1 through 110.10; and

(b) The system, equipment or building component complies with all applicable installation provisions of Sections 110.1 through 110.10.

SECTION 110.1 MANDATORY REQUIREMENTS FOR APPLIANCES

(a) Any appliance regulated by the Appliance Efficiency Regulations, Title 20 California Code of Regulations, Section 1601 et seq., may be installed only if the appliance fully complies with Section 1608(a) of those regulations.

(b) Except for those circumstances described in Section 110.1(c), conformance with Part 6-specific efficiency requirements shall be verified utilizing data from either:

1. The Energy Commission's database of certified appliances maintained pursuant to Title 20 California Code of Regulations Section 1606, and which is available at: www.energy.ca.gov/appliances/database/; or
2. An equivalent directory published by a federal agency; or
3. An approved trade association directory as defined in Title 20 California Code of Regulations Section 1606(h).

(c) Conformance with Part 6-specific efficiency requirements may be demonstrated either by utilizing minimal efficiency values defined in Part 6 or by criteria approved by the Commission pursuant to Section 10-109 of Title 24, Part 1, when:

1. data to verify conformance with Part 6-specific efficiency requirements is not available pursuant to subdivision (b); or
2. field verification and diagnostic testing is required for compliance with Part 6 and there is not an applicable field verification and diagnostic test protocol available in Part 6 that is suitable to the appliance; or
3. the appliance meets the requirements of Section 110.1(a) and has been site-modified in a way that affects its performance; or

4. the system has received a waiver under 10 CFR Section 430.27 or Section 431.401 and that waiver fails to specify how the efficiency of the system shall be determined.

SECTION 110.2 MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

Certification by manufacturers. Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified to the Commission that the equipment complies with all the applicable requirements of this section.

(a) **Efficiency.** Equipment shall meet the applicable efficiency requirements in Tables 110.2-A through 110.2-K, subject to the following:

1. If more than one efficiency standard is listed for any equipment in Tables 110.2-A through 110.2-K, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in Tables 110.2-A through 110.2-K, the equipment shall comply with the applicable efficiency standard when tested with each listed test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the efficiency standards applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

Exception 1 to Section 110.2(a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ANSI/AHRI Standard 550/590 test conditions of 44°F leaving chilled water temperature and 85°F entering condenser water temperature with 3 gallons per minute per ton condenser water flow shall have a maximum full load kW/ton and NPLV ratings adjusted using the following equation:

Adjusted maximum full-load kW/ton rating = (full-load kW/ton from Table 110.2-D)/ K_{adj}

Adjusted maximum NPLV rating = (IPLV from Table 110.2-D)/ K_{adj}

Where:

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

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

$$\text{LIFT} = L_{vg} \text{Cond} - L_{vg} \text{Evap} \text{ (}^\circ\text{F)}$$

$L_{vg} \text{Cond}$ = Full-load leaving condenser fluid temperature (°F)

$L_{vg} \text{Evap}$ = Full-load leaving evaporator fluid temperature (°F)

$$B = (0.0015 \times L_{vg} \text{Evap}) + 0.934$$

The adjusted full-load and NPLV values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum Leaving Evaporator Fluid Temperature: 36°F
- Maximum Leaving Condenser Fluid Temperature: 115°F
- LIFT \geq 20°F and \leq 80°F

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

Exception 2 to Section 110.2(a): Positive displacement (air- and water-cooled) chillers with a leaving evaporator fluid temperature higher than 32°F shall show compliance with Table 110.2-D when tested or certified with water at standard rating conditions, per the referenced test procedure.

(b) **Controls for heat pumps with supplementary electric resistance heaters.** Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

Exception 1 to Section 110.2(b): The controls may allow supplementary heater operation during:

- A. Defrost; and
- B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

Exception 2 to Section 110.2(b): Room air-conditioner heat pumps.

(c) **Thermostats.** All unitary heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat.

1. **Setback capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to program the temperature setpoints for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 110.2(b).

Exception to Section 110.2(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, fireplaces or decorative

gas appliances, wood stoves, room air conditioners and room air-conditioner heat pumps.

(d) **Gas-fired and oil-fired furnace standby loss controls.** Gas-fired and oil-fired forced-air furnaces with input ratings \geq 225,000 Btu/hr shall also have an intermittent ignition or interrupted device (IID), and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings \geq 225,000 Btu/hr, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

(e) **Open and closed circuit cooling towers.** All open and closed circuit cooling tower installations shall comply with the following:

1. Be equipped with conductivity or flow-based controls that maximize cycles of concentration based on local water quality conditions. Controls shall automate system bleed and chemical feed based on conductivity, or in proportion to metered makeup volume, metered bleed volume, recirculating pump run time, or bleed time. Conductivity controllers shall be installed in accordance with manufacturer's specifications in order to maximize accuracy.
2. Documentation of maximum achievable cycles of concentration. Building owners shall document the maximum cycles of concentration based on local water supply as reported annually by the local water supplier, and using the calculator approved by the Energy Commission. The calculator is intended to determine maximum cycles based on a Langelier Saturation Index (LSI) of 2.5 or less. Building owner shall document maximum cycles of concentration on the mechanical compliance form which shall be reviewed and signed by the Professional Engineer (P.E.) of Record.
3. Be equipped with a flow meter with an analog output for flow either hardwired or available through a gateway on the makeup water line.
4. Be equipped with an overflow alarm to prevent overflow of the sump in case of makeup water valve failure. Overflow alarm shall send an audible signal or provide an alert via the energy management control system to the tower operator in case of sump overflow.
5. Be equipped with efficient drift eliminators that achieve drift reduction to 0.002 percent of the circulated water volume for counter-flow towers and 0.005 percent for cross-flow towers.

Exception to Section 110.2(e): Towers with rated capacity $<$ 150 tons.

(f) **Low leakage air-handling units.** To qualify as a low leakage air-handling unit for use for meeting the requirements for applicable low leakage air-handling unit compliance credit(s) available in the performance standards set forth in Sections 150.1(b) and 140.1, the manufacturer shall certify to the Energy Commission that the air-handling unit meets the specifications in Reference Joint Appendix JA9.

**TABLE 110.2-A
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS**

Equipment Type	Size Category	Efficiency ^a		Test Procedure ^c
		Before 1/1/2015	After 1/1/2015	
Air conditioners, air cooled both split system and single package	> 65,000 Btu/h and < 135,000 Btu/h	11.2 EER ^b 11.4 IEER ^b	Applicable minimum efficiency values as determined by Title 20 California Code of Regulations Section 1605.1	ANSI/AHRI 340/360
	> 135,000 Btu/h and < 240,000 Btu/h	11.0 EER ^b 11.2 IEER ^b		ANSI/AHRI 340/360
	> 240,000 Btu/h and < 760,000 Btu/h	10.0 EER ^b 10.1 IEER ^b		
	> 760,000 Btu/h	9.7 EER ^b 9.8 IEER ^b		
Air conditioners, water cooled	> 65,000 Btu/h and < 135,000 Btu/h	12.1 EER ^b 12.3 IEER ^b		ANSI/AHRI 340/360
	> 135,000 Btu/h and < 240,000 Btu/h	12.5 EER ^b 12.5 IEER ^b		ANSI/AHRI 340/360
	> 240,000 Btu/h and < 760,000 Btu/h	12.4 EER ^b 12.6 IEER ^b		ANSI/AHRI 340/360
	> 760,000 Btu/h	12.2 EER ^b 12.4 IEER ^b		ANSI/AHRI 340/360
Air conditioners, evaporatively cooled	> 65,000 Btu/h and < 135,000 Btu/h	12.1 EER ^b 12.3 IEER ^b		ANSI/AHRI 340/360
	> 135,000 Btu/h and < 240,000 Btu/h	12.0 EER ^b 12.2 IEER ^b		ANSI/AHRI 340/360
	> 240,000 Btu/h and < 760,000 Btu/h	11.9 EER ^b 12.1 IEER ^b		ANSI/AHRI 340/360
	> 760,000 Btu/h	11.7 EER ^b 11.9 IEER ^b		ANSI/AHRI 340/360
Condensing units, air cooled	> 135,000 Btu/h	10.5 EER 11.8 IEER		ANSI/AHRI 365
Condensing units, water cooled	> 135,000 Btu/h	13.5 EER 14.0 IEER		
Condensing units, evaporatively cooled	> 135,000 Btu/h	13.5 EER 14.0 IEER		

a. IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 340/360 test procedures.

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

c. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-B
UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY ^a	TEST PROCEDURE ^c
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.0 EER ^b 11.2 IEER ^b	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.6 EER ^b 10.7 IEER ^b	
	≥ 240,000 Btu/h		9.5 EER ^b 9.6 IEER ^b	
Water source (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	86°F entering water	12.0 EER	ISO-13256-1
Groundwater source (cooling mode)	< 135,000 Btu/h	59°F entering water	16.2 EER	ISO-13256-1
Ground source (cooling mode)	< 135,000 Btu/h	77°F entering water	13.4 EER	ISO-13256-1
Water source water-to-water (cooling mode)	< 135,000 Btu/h	86°F entering water	10.6 EER	ISO-13256-2
Groundwater source water-to-water (cooling mode)	< 135,000 Btu/h	59°F entering water	16.3 EER	ISO-13256-1
Ground source brine-to-water (cooling mode)	< 135,000 Btu/h	77°F entering water	12.1 EER	ISO-13256-2
Air cooled (heating mode) Split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	3.3 COP	ANSI/AHRI 340/360
		17°F db/15°F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	3.2 COP	
		17°F db/15°F wb outdoor air	2.05 COP	
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	4.2 COP	ISO-13256-1
Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.6 COP	ISO-13256-1
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	3.1 COP	ISO-13256-1
Water source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	3.7 COP	ISO-13256-2
Groundwater source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.1 COP	ISO-13256-2
Ground source brine-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	2.5 COP	ISO-13256-2

a. IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 340/360 test procedures.

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

c. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-C
AIR-COOLED GAS-ENGINE HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY	TEST PROCEDURE ^a
Air-cooled gas-engine heat pump (cooling mode)	All capacities	95°F db outdoor air	0.6 COP	ANSI Z21.40.4A
Air-cooled gas-engine heat pump (heating mode)	All capacities	47°F db/43°F wb outdoor air	0.72 COP	ANSI Z21.40.4A

a. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-D
WATER CHILLING PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS^{a, b}**

EQUIPMENT TYPE	SIZE CATEGORY	PATH A EFFICIENCY ^{a, b}	PATH B EFFICIENCY ^{a, b}	TEST PROCEDURE ^c
Air cooled, with condenser electrically operated	< 150 tons	≥ 9.562 EER ≥ 12.500 IPLV	N.A. ^d	AHRI 550/590
	≥ 150 tons	≥ 9.562 EER ≥ 12.750 IPLV	N.A. ^d	
Air cooled, without condenser electrically operated	All capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the aircooled chiller efficiency requirements.		AHRI 550/590
Water cooled, electrically operated reciprocating	All capacities	Reciprocating units must comply with the watercooled positive displacement efficiency requirements.		AHRI 550/590
Water cooled, electrically operated, positive displacement	< 75 tons	≤ 0.780 kW/ton ≤ 0.630 IPLV	≤ 0.800 kW/ton ≤ 0.600 IPLV	AHRI 550/590
	≥ 75 tons and < 150 tons	≤ 0.775 kW/ton ≤ 0.615 IPLV	≤ 0.790 kW/ton ≤ 0.586 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.680 kW/ton ≤ 0.580 IPLV	≤ 0.718 kW/ton ≤ 0.540 IPLV	
	≥ 300 tons	≤ 0.620 kW/ton ≤ 0.540 IPLV	≤ 0.639 kW/ton ≤ 0.490 IPLV	
Water cooled, electrically operated, centrifugal	> 150 ton	≤ 0.634 kW/ton ≤ 0.596 IPLV	≤ 0.639 kW/ton ≤ 0.450 IPLV	AHRI 550/590
	≥ 150 tons and < 300 tons	≤ 0.634 kW/ton ≤ 0.596 IPLV	≤ 0.639 kW/ton ≤ 0.450 IPLV	
	≥ 300 tons and < 600 tons	≤ 0.576 kW/ton ≤ 0.549 IPLV	≤ 0.600 kW/ton ≤ 0.400 IPLV	
	≥ 600 tons	≤ 0.570 kW/ton ≤ 0.539 IPLV	≤ 0.590 kW/ton ≤ 0.400 IPLV	
Air cooled absorption single effect	All capacities	≥ 0.600 COP	N.A. ^d	ANSI/AHRI 560
Water cooled absorption single effect	All capacities	≥ 0.700 COP	N.A. ^d	
Absorption double effect, indirect-fired	All capacities	≥ 1.000 COP ≥ 1.050 IPLV	N.A. ^d	
Absorption double effect, direct-fired	All capacities	≥ 1.000 COP ≥ 1.000 IPLV	N.A. ^d	
Water cooled gas engine driven chiller	All capacities	≥ 1.2 COP ≥ 2.0 IPLV	N.A. ^d	ANSI Z21.40.4

a. No requirements for:

- Centrifugal chillers with design leaving evaporator temperature < 36°F; or
- Positive displacement chillers with design leaving fluid temperatures ≤ 32°F; or
- Absorption chillers with design leaving fluid temperature < 40°F

b. Must meet the minimum requirements of Path A or Path B. However, both the full load (COP) and IPLV must be met to fulfill the requirements of the applicable path.

c. See Section 100.1 for definitions.

d. NA means not applicable.

**TABLE 110.2-E
PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS— MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY (Input)	SUBCATEGORY OR RATING CONDITION	EFFICIENCY ^a		TEST PROCEDURE ^c
			Before 10/08/2012	After 10/08/2012	
PTAC (cooling mode) Newly constructed or newly conditioned buildings or additions	All capacities	95°F db outdoor air	12.5 - (0.213 × Cap/1000) ^a EER	13.8 - (0.300 × Cap/1000) ^a EER	ANSI/AHRI/ CSA 310/380
PTAC (cooling mode) Replacements ^b	All capacities	95°F db outdoor air	10.9 - (0.213 × Cap/1000) ^a EER	10.9 - (0.213 × Cap/1000) ^a EER	
PTHP (cooling mode) Newly constructed or newly conditioned buildings or additions	All capacities	95°F db outdoor air	12.3 - (0.213 × Cap/1000) ^a EER	14.0 - (0.300 × Cap/1000) ^a EER	
PTHP (cooling mode) Replacements ^b	All capacities	95°F db outdoor air	10.8 - (0.213 × Cap/1000) ^a EER	10.8 - (0.213 × Cap/1000) ^a EER	
PTHP (heating mode) Newly constructed or newly conditioned buildings or additions	All capacities	—	3.2 - (0.026 × Cap/1000) ^a COP	3.7 - (0.052 × Cap/1000) ^a COP	
PTHP (heating mode) Replacements ^b	All capacities	—	2.9 - (0.026 × Cap/1000) ^a COP	2.9 - (0.026 × Cap/1000) ^a COP	
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER	9.0 EER	ANSI/AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb outdoor air	8.9 EER	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb outdoor air	8.6 EER	8.6 EER	
SPVHP (cooling mode)	< 65,000 Btu/h	95°F d /75°F wb outdoor air	9.0 EER	9.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb outdoor air	8.9 EER	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb outdoor air	8.6 EER	8.6 EER	
SPVHP (heating mode)	< 65,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP	3.0 COP	
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP	3.0 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb outdoor air	2.9 COP	2.9 COP	

- a. Cap means the rated cooling capacity of the product in Btu/h. If the unit’s capacity is less than 7,000 Btu/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.
- b. Replacement units must be factory labeled as follows: “MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEWLY CONSTRUCTED BUILDINGS.” Replacement efficiencies apply only to units with existing sleeves less than 16 inches high or less than 42 inch wide and having a cross-sectional area less than 670 square inches.
- c. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-F
HEAT TRANSFER EQUIPMENT**

EQUIPMENT TYPE	SUBCATEGORY	MINIMUM EFFICIENCY ^a	TEST PROCEDURE ^b
Liquid-to-liquid heat exchangers	Plate type	NR	ANSI/AHRI 400

- a. NR = No requirement
- b. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-G
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT**

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED ^{a, b, c, d}	TEST PROCEDURE ^e
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	42.1 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 air 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 air wb	14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air cooled condensers	All	125°F condensing temperature R22 test fluid 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	176,000 Btu/h-hp	ANSI/AHRI 460

- a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated conditions 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 given rated conditions divided by the sum of the fan motor nameplate rated power and the integral spray pump motor nameplate power.
- c. For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
- d. Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory-assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer’s stated performance, whichever is less. Base models of open factory-assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field-erected cooling towers.
- e. Applicable test procedure and reference year are provided under the definitions.

**TABLE 110.2-H
ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW (VRF) AIR CONDITIONERS MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
VRF Air conditioners, Air cooled	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	ANSI/AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.2 EER 13.1 IEER ^b	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.0 EER 12.9 IEER ^b	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.0 EER 11.6 IEER ^b	

- a. Applicable test procedure and reference year are provided under the definitions.
- b. IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 1230 test procedures.

**TABLE 110.2-I
ELECTRICALLY OPERATED VARIABLE REFRIGERANT FLOW
AIR-TO-AIR AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE ^b
VRF Air cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system ^a	11.0 EER 12.9 IEER ^c	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system ^a	10.6 EER 12.3 IEER ^c	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system ^a	9.5 EER 11.0 IEER ^c	
VRF Water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system ^a 86°F entering water	12.0 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system ^a 86°F entering water	12.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system ^a 86°F entering water	10.0 EER	
VRF Groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 59°F entering water	16.2 EER	AHRI 1230
	≥ 135,000 Btu/h	All	VRF multisplit system ^a 59°F entering water	13.8 EER	
VRF Ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system ^a 77°F entering water	13.4 EER	AHRI 1230
	≥ 135,000 Btu/h	All	VRF multisplit system ^a 77°F entering water	11.0 EER	
VRF Air cooled (heating mode)	> 65,000 Btu/h (cooling capacity)	—	VRF multisplit system	7.7 HSPF	AHRI 1230
	> 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb outdoor air	3.3 COP	
		—	VRF multisplit system 17°F db/15°F wb outdoor air	2.25 COP	
	> 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb outdoor air	3.2 COP	
—		VRF multisplit system 17°F db/15°F wb outdoor air	2.05 COP		
VRF Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	4.2 COP	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	3.9 COP	
VRF Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.6 COP	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.3 COP	
VRF Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering water	3.1 COP	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering water	2.8 COP	

- a. Deduct 0.2 from the required EERs and IEERs for variable refrigerant flow (VRF) multisplit system units with a heating recovery section.
- b. Applicable test procedure and reference year are provided under the definitions.
- c. IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 1230 test procedures.

**TABLE 110.2-J
WARM-AIR FURNACES AND COMBINATION
WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS^{c,f}**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION ^b	MINIMUM EFFICIENCY ^{d,e}	TEST PROCEDURE ^a
Warm-Air furnace, gas-fired	< 225,000 Btu/h	Maximum capacity	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h	Maximum capacity	80% E_t	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-Air furnace, oil-fired	< 225,000 Btu/h	Maximum capacity	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h	Maximum capacity	81% E_t	Section 42, Combustion, UL 727
Warm-Air duct furnaces, gas-fired	All capacities	Maximum capacity	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air unit heaters, gas-fired	All capacities	Maximum capacity	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air unit heaters, oil-fired	All capacities	Maximum capacity	80% E_c	Section 40, Combustion, UL 731

- a. Applicable test procedure and reference year are provided under the definitions.
- b. Compliance of multiple firing rate units shall be at maximum firing rate.
- c. Combustion units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.
- d. E_t = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
- e. E_c = combustion efficiency (100% less flue losses). See test procedure for detailed discussion.
- f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

**TABLE 110.2-K
GAS- AND OIL-FIRED BOILERS, MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SUBCATEGORY	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY ^{b,c}	TEST PROCEDURE ^a
Boiler, hot water	Gas-Fired	< 300,000 Btu/h	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	80% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h ^e	82% E_c	
	Oil-Fired	< 300,000 Btu/h	84% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	82% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h ^e	84% E_c	
Boiler, steam	Gas-Fired	< 300,000 Btu/h	80% AFUE	DOE 10 CFR Part 430
	Gas-Fired all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	79% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h ^e	79% E_t	DOE 10 CFR Part 431
	Gas-Fired, natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	77% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h ^e	77% E_t	DOE 10 CFR Part 431
	Oil-Fired	< 300,000 Btu/h	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	81% E_t	DOE 10 CFR Part 431
> 2,500,000 Btu/h ^e		81% E_t	DOE 10 CFR Part 431	

- a. Applicable test procedure and reference year are provided under the definitions.
- b. E_c = combustion efficiency (100% less flue losses). See reference document for detailed information.
- c. E_t = thermal efficiency. See test procedure for detailed information.
- d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit’s controls.
- e. Included oil-fired (residual).

SECTION 110.3 MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any service water-heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. **Temperature controls for service water-heating systems.** Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 2, Chapter 49 of the ASHRAE Handbook, HVAC Applications Volume.

Exception to Section 110.3(a)1: Residential occupancies.

(b) **Efficiency.** Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 110.1, subject to the following:

1. If more than one standard is listed in the Appliance Efficiency Regulations, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in the Appliance Efficiency Regulations, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its “maximum rated capacity” or “minimum rated capacity,” the capacity shall be as provided for and allowed by the controls, during steady-state operation.

(c) **Installation.** Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr, outlets that require higher than service water temperatures as listed in the ASHRAE Handbook, Applications Volume, shall have separate remote heaters, heat exchangers or boosters to supply the outlet with the higher temperature.
2. **Controls for hot water distribution systems.** Service hot water systems with circulating pumps or with electrical heat trace systems shall be capable of automatically turning off the system.
3. **Temperature controls for public lavatories.** The controls shall limit the outlet temperature to 110°F.
4. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:
 - A. External insulation with an installed *R*-value of at least R-12; or

B. Internal and external insulation with a combined *R*-value of at least R-16; or

C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.

5. **Water heating recirculation loops serving multiple dwelling units, high-rise residential, hotel/motel and nonresidential occupancies.** A water heating recirculation loop is a type of hot water distribution system that reduces the time needed to deliver hot water to fixtures that are distant from the water heater, boiler or other water heating equipment. The recirculation loop is comprised of a supply portion, connected to branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. A water heating recirculation loop shall meet the following requirements:
 - A. **Air release valve or vertical pump installation.** An automatic air release valve shall be installed on the recirculation loop piping on the inlet side of the recirculation pump and no more than 4 feet from the pump. This valve shall be mounted on top of a vertical riser at least 12" in length and shall be accessible for replacement and repair. Alternatively, the pump shall be installed on a vertical section of the return line.
 - B. **Recirculation loop backflow prevention.** A check valve or similar device shall be located between the recirculation pump and the water heating equipment to prevent water from flowing backwards through the recirculation loop.
 - C. **Equipment for pump priming.** A hose bibb shall be installed between the pump and the water heating equipment. An isolation valve shall be installed between the hose bibb and the water heating equipment. This hose bibb is used for bleeding air out of the pump after pump replacement.
 - D. **Pump isolation valves.** Isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in item C.
 - E. **Cold water supply and recirculation loop connection to hot water storage tank.** Storage water heaters and boilers shall be plumbed in accordance with the manufacturer's specifications. The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.
 - F. **Cold water supply backflow prevention.** A check valve shall be installed on the cold water supply line between the hot water system and the next closest tee on the cold water supply line. The system shall comply with the expansion tank requirements as described in the *California Plumbing Code* Section 608.3.

6. **Service water heaters in state buildings.** Any newly constructed building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy.

Exception to Section 110.3(c)6: Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

SECTION 110.4 MANDATORY REQUIREMENTS FOR POOL AND SPA SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any pool or spa heating system or equipment may be installed only if the manufacturer has certified that the system or equipment has all of the following:

1. **Efficiency.** A thermal efficiency that complies with the Appliance Efficiency Regulations; and
2. **On-off switch.** A readily accessible on-off switch, mounted on the outside of the heater that allows shutting off the heater without adjusting the thermostat setting; and
3. **Instructions.** A permanent, easily readable and weatherproof plate or card that gives instruction for the energy efficient operation of the pool or spa heater and for the proper care of pool or spa water when a cover is used; and
4. **Electric resistance heating.** No electric resistance heating; and

Exception 1 to Section 110.4(a)4: Listed package units with fully insulated enclosures, and with tight-fitting covers that are insulated to at least R-6.

Exception 2 to Section 110.4(a)4: Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.

(b) **Installation.** Any pool or spa system or equipment shall be installed with all of the following:

1. **Piping.** At least 36 inches of pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment; and
2. **Covers.** A cover for outdoor pools or outdoor spas that have a heat pump or gas heater.
3. **Directional inlets and time switches for pools.** If the system or equipment is for a pool:
 - i. The pool shall have directional inlets that adequately mix the pool water; and
 - ii. A time switch or similar control mechanism shall be installed as part of a pool water circulation control system that will allow all pumps to be set or programmed to run only during off-peak electric demand period, and for the minimum time necessary

to maintain the water in the condition required by applicable public health standards.

SECTION 110.5 NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, AND POOL AND SPA HEATERS: PILOT LIGHTS PROHIBITED

Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:

- (a) Fan-type central furnaces.
- (b) Household cooking appliances.

Exception to Section 110.5(b): Household cooking appliances without an electrical supply voltage connection and in which each pilot consumes less than 150 Btu/hr.

- (c) Pool heaters.
- (d) Spa heaters.

SECTION 110.6 MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of fenestration products and exterior doors other than field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified, that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft² of window area, 0.3 cfm/ft² of door area for residential doors, 0.3 cfm/ft² of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft² for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E 283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²), incorporated herein by reference.

Exception to Section 110.6(a)1: Field-fabricated fenestration and field-fabricated exterior doors.

2. **U-factor.** The fenestration product's U-factor shall be rated in accordance with NFRC 100, or use the applicable default U-factor set forth in Table 110.6-A.

Exception 1 to Section 110.6(a)2: If the fenestration product is a vertical skylight or is site-built fenestration product in a building covered by the nonresidential standards with less than 1,000 square feet of site-built fenestration, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

Exception 2 to Section 110.6(a)2: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product or in a

vertical site-built fenestration product, in a building covered by the nonresidential standards, the default U -factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

3. **Solar heat gain coefficient SHGC.** The fenestration product's SHGC shall be rated in accordance with NFRC 200, or use the applicable default SHGC set forth in Table 110.6-B.

Exception 1 to Section 110.6(a)3: If the fenestration product is a skylight or is a vertical site-built fenestration product in a building covered by the nonresidential standards with less than 1,000 square feet of sitebuilt fenestration, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

Exception 2 to Section 110.6(a)3: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product or in a vertical site-built fenestration product, in a building covered by the nonresidential standards, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

4. **Visible transmittance (VT).** The fenestration product's VT shall be rated in accordance with NFRC 200 or ASTM E 972. For tubular skylights VT shall be rated using NFRC 203.

Exception 1 to Section 110.6(a)4: If the fenestration product is a skylight or is a vertical site-built fenestration product in a building covered by the nonresidential standards with less than 1,000 square feet of site-built fenestration, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

Exception 2 to Section 110.6(a)4: If the fenestration product is an alteration consisting of any area; replacement of glass in a skylight product or in a vertical site-built fenestration product, in a building covered by the nonresidential standards, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

5. **Labeling.** Fenestration products shall:

- A. Have a temporary label for manufactured fenestration products or a label certificate when the component modeling approach (CMA) is used and for

site-built fenestration meeting the requirements of Section 10-111(a)1. The label listing the certified U -factor, SHGC and VT, shall not be removed before inspection by the enforcement agency. The temporary label shall certify that the air leakage requirements of Section 110.6(a)1 are met for each product line; and

- B. Have a permanent label or label certificate when the component modeling approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)2 if the product is rated using NFRC procedures.

6. **Fenestration acceptance requirements.** Before an occupancy permit is granted site-built fenestration products in other than low-rise residential buildings shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified in the Reference Nonresidential Appendix NA7 to ensure that site-built fenestration meets Standards requirements, including a matching label certificate for product(s) installed and be readily accessible at the project location. A certificate of acceptance certifying that the fenestration product meets the acceptance requirements shall be completed, signed and submitted to the enforcement agency.

Exception to Section 110.6(a): Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of field-fabricated fenestration and exterior doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U -factors from Table 110.6-A and SHGC values from Table 110.6-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

Exception to Section 110.6(b): Unframed glass doors and fire doors need not be weatherstripped or caulked.

**TABLE 110.6-A
DEFAULT FENESTRATION PRODUCT U-FACTORS**

FRAME ^{1,2}	PRODUCT TYPE	SINGLE PANE ^{3,4} U-FACTOR	DOUBLE PANE ^{1,3,4} U-FACTOR	GLASS BLOCK ^{2,3} U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	NA
	Doors	1.25	0.77	NA
	Skylight	1.98	1.3	NA
Metal, thermal break	Operable	NA	0.66	NA
	Fixed	NA	0.55	NA
	Greenhouse/garden window	NA	1.12	NA
	Doors	NA	0.59	NA
	Skylight	NA	1.11	NA
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Doors	0.99	0.53	NA
	Greenhouse/garden window	1.94	1.06	NA
	Skylight	1.47	0.84	NA

1. For all dual-glazed fenestration products, adjust the listed *U*-factors as follows:
 - a. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.
 - b. Add 0.05 to any product with true divided lite (dividers through the panes).
2. Translucent or transparent panels shall use glass block values when not rated by NFRC 100.
3. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.
4. Windows with window film applied that is not rated by NFRC 100 shall use the default values from this table.

**TABLE 110.6-B
DEFAULT SOLAR HEAT GAIN COEFFICIENT**

FRAME TYPE	PRODUCT	GLAZING	FENESTRATION PRODUCT SHGC		
			Single Pane ^{2,3} SHGC	Double Pane ^{2,3} SHGC	Glass Block ^{1,2} SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	NA
	Fixed	Tinted	0.68	0.60	NA
Metal, thermal break	Operable	Clear	NA	0.63	NA
	Fixed	Clear	NA	0.69	NA
	Operable	Tinted	NA	0.53	NA
	Fixed	Tinted	NA	0.57	NA
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	NA
	Fixed	Tinted	0.63	0.55	NA

1. Translucent or transparent panels shall use glass block values when not rated by NFRC 200.
2. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.
3. Windows with window film applied that is not rated by NFRC 200 shall use the default values from this table.

SECTION 110.7 MANDATORY REQUIREMENTS TO LIMIT AIR LEAKAGE

All joints, penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather-stripped or otherwise sealed to limit infiltration and exfiltration.

SECTION 110.8 MANDATORY REQUIREMENTS FOR INSULATION, ROOFING PRODUCTS AND RADIANT BARRIERS

(a) **Insulation certification by manufacturers.** Any insulation shall be certified by Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12 – 13, Article 3, “Standards for Insulating Material.”

(b) **Installation of urea formaldehyde foam insulation.** Urea formaldehyde foam insulation may be applied or installed only if:

1. It is installed in exterior side walls; and
2. A 4-mil-thick plastic polyethylene vapor retarder or equivalent plastic sheathing vapor retarder is installed between the urea formaldehyde foam insulation and the interior space in all applications.

(c) **Flamespread rating of insulation.** All insulating material shall be installed in compliance with the flamespread rating and smoke density requirements of the CBC.

(d) **Installation of insulation in existing buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of subsections 1, 2 and 3 below. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of subsections 1, 2 and 3 below.

1. **Attics.** If insulation is installed in the existing attic of a low-rise residential building, the *R*-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall meet the requirements of Section 150.0(a).

Exception to Section 110.8(d)1: Where the accessible space in the attic is not large enough to accommodate the required *R*-value, the entire accessible space shall be filled with insulation, provided such installation does not violate Section 1203.2 of Title 24, Part 2.

2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an *R*-value of at least R-12, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 605.0 of the CMC.

(e) **Insulation placement on roof/ceilings.** Insulation installed to limit heat loss and gain through the top of conditioned spaces shall comply with the following:

1. Insulation shall be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to, placing insulation either above or below the roof deck or on top of a drywall ceiling; and
2. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed, and the space between the ceiling and the roof is either directly or indirectly conditioned space and shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements; and
3. Insulation shall not be placed on top of a suspended ceiling with removable ceiling panels to meet the roof/ceiling requirement of Sections 120.7, 140.3 and 141.0; and

Exception to Section 110.8(e)3: When there are conditioned spaces with a combined floor area no greater than 2,000 square feet in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 feet, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

4. Insulation shall be installed below the roofing membrane or layer used to seal the roof from water penetration unless the insulation has a maximum water absorption of 0.3 percent by volume when tested according to ASTM Standard C 272.

Note: Vents that do not penetrate the roof deck, that are designed for wind resistance for roof membranes, are not within the scope of Section 110.8(e)2.

(f) **Insulation for demising walls in nonresidential buildings.** The opaque portions of framed demising walls in nonresidential buildings shall be insulated with an installed *R*-value of no less than R-13 between framing members.

(g) **Insulation requirements for heated slab floors.** Heated slab floors shall be insulated according to the requirements in Table 110.8-A.

1. Insulation materials in ground contact must:
 - A. Comply with the certification requirements of Section 110.8(a); and
 - B. Have a water absorption rate for the insulation material alone without facings that is no greater than 0.3 percent when tested in accordance with Test Method A - 24 Hour-Immersion of ASTM C 272.
 - C. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E96.

**TABLE 110.8-A
SLAB INSULATION REQUIREMENTS FOR HEATED SLAB-ON-GRADE**

INSULATION LOCATION	INSULATION ORIENTATION	INSTALLATION REQUIREMENTS	CLIMATE ZONE	INSULATION R-FACTOR
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16 inches or to the frost line, whichever is greater. Insulation may stop at the top of the footing where this is less than the required depth. For below grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or to the frost line, whichever is greater.	1 – 15	5
			16	10
Between heated slab and outside foundation wall	Vertical and horizontal	Vertical insulation from top of slab at inside edge of outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in plan view.	1 – 15	5
			16	10 vertical and 7 horizontal

2. Insulation installation must:

- A. Be covered with a solid guard that protects against damage from ultraviolet radiation, moisture, landscaping operation, equipment maintenance and wind; and
- B. Include a rigid plate, which penetrates the slab and blocks the insulation from acting as a conduit for insects from the ground to the structure above the foundation.

(h) **Wet insulation systems.** When insulation is installed on roofs above the roofing membrane or layer used to seal the roof from water penetration, the effective R-value of the insulation shall be as specified in Reference Joint Appendix JA4.

(i) **Roofing products solar reflectance and thermal emittance.**

- 1. In order to meet the requirements of Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H or 150.2(b)2, a roofing product’s thermal emittance and an aged solar reflectance shall be certified and labeled according to the requirements of Section 10-113.

Exception 1 to Section 110.8(i)1: Roofing products that are not certified according to Section 10-113 shall assume the following default aged solar reflectance/thermal emittance values:

- A. For asphalt shingles: 0.08/0.75
- B. For all other roofing products: 0.10/0.75

- 2. If CRRC testing for an aged solar-reflectance is not available for any roofing products, the aged value shall be derived from the CRRC initial value using the equation $\rho_{aged} = [0.2 + \beta[\rho_{initial} - 0.2]]$, where $\rho_{initial}$ = the initial solar reflectance and soiling resistance β is listed by product type in Table 110.8-B.

**TABLE 110.8-B
VALUES OF SOILING RESISTANCE BY PRODUCT TYPE**

PRODUCT TYPE	CRRC PRODUCT CATEGORY	β
Field-Applied coating	Field-Applied coating	0.65
Other	Not a field-applied coating	0.70

- 3. Solar Reflectance Index (SRI), calculated as specified by ASTM E 1980-01, may be used as an alternative to thermal emittance and an aged solar reflectance when complying with the requirements of Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)H or 150.2(b)2. SRI calculations shall be based on moderate wind velocity of 2 – 6 meters per second. The SRI shall be calculated based on the aged reflectance value of the roofing products.

- 4. Liquid applied roof coatings applied to low-sloped roofs in the field as the top surface of a roof covering shall:

A. Be applied across the entire roof surface to meet the dry mil thickness or coverage recommended by the coating manufacturer, taking into consideration the substrate on which the coating is applied, and

B. Meet the minimum performance requirements listed in Table 110.8-B or the minimum performance requirements of ASTM C 836, D 3468, D 6083 or D 6694, whichever are appropriate to the coating material.

Exception 1 to Section 110.8(i)4B: Aluminum-pigmented asphalt roof coatings shall meet the requirements of ASTM D 2824 or ASTM D 6848 and be installed as specified by ASTM D 3805.

Exception 2 to Section 110.8(i)4B: Cement-based roof coatings shall contain a minimum of 20 percent cement and shall meet the requirements of ASTM C 1583, ASTM D 822 and ASTM D 5870.

- (j) **Radiant barrier.** A radiant barrier shall have an emittance of 0.05 or less, tested in accordance with ASTM C 1371 or ASTM E 408, and shall be certified to the Department of Consumer Affairs as required by Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.

**TABLE 110.8-C
MINIMUM PERFORMANCE REQUIREMENTS FOR LIQUID APPLIED ROOF COATINGS**

PHYSICAL PROPERTY	ASTM TEST PROCEDURE	REQUIREMENT
Initial percent elongation (break)	D 2370	Minimum 200% 73°F (23°C)
Initial percent elongation (break) or initial flexibility	D 2370 D 522, Test B	Minimum 60% 0°F (-18°C) Minimum pass 1" mandrel 0°F (-18°C)
Initial tensile strength (maximum stress)	D 2370	Minimum 100 psi (1.38 Mpa) 73°F (23°C)
Initial tensile strength (maximum stress) or initial flexibility	D 2370 D 522, Test B	Minimum 200 psi (2.76 Mpa) 0°F (-18°C) Minimum pass 1" mandrel 0°F (-18°C)
Final percent elongation (break) after accelerated weathering 1000 h	D 2370	Minimum 100% 73°F (23°C)
Final percent elongation (break) after accelerated weathering 100 h or flexibility after accelerated weathering 100 h	D 2370 D 522, Test B	Minimum 40% 0°F (-18°C) Minimum pass 1" mandrel 0°F (-18°C)
Permeance	D 1653	Maximum 50 perms
Accelerated weathering 1000 h	D 4798	No cracking or checking ¹

1. Any cracking or checking visible to the eye fails the test procedure.

**SECTION 110.9
MANDATORY REQUIREMENTS FOR
LIGHTING CONTROL DEVICES AND SYSTEMS,
BALLASTS AND LUMINAIRES**

(a) All lighting control devices and systems, ballasts and luminaires subject to the requirements of Section 110.9 shall meet the following requirements:

1. Shall be installed only if the lighting control device or system, ballast or luminaire complies with all of the applicable requirements of Section 110.9.
2. Lighting controls may be individual devices (Self-Contained lighting control) or systems (Lighting control systems) consisting of two or more components.
3. Self-Contained lighting controls, as defined in Section 100.1, shall be certified by the manufacturer as required by the Title 20 Appliance Efficiency Regulations.
4. Lighting control systems, as defined in Section 100.1, shall be a fully functional lighting control system complying with the applicable requirements in Section 110.9(b) and shall meet the lighting control installation requirements in Section 130.4.
5. If indicator lights are integral to a lighting control system, they shall consume no more than one watt of power per indicator light.

(b) All installed lighting control systems listed in Section 110.9(b) shall comply with the requirements listed below; and all components of the system considered together as installed shall meet all applicable requirements for the application for which they are installed as required in Sections 130.0 through 130.5, Sections 140.6 through 140.8, Section 141.0, and Section 150.0(k).

1. Time-switch lighting controls.

A. **Automatic time-switch controls** shall meet all requirements for automatic time switch control devices in the Title 20 Appliance Efficiency Regulations.

B. **Astronomical time-switch controls** shall meet all requirements for astronomical time-switch control devices in the Title 20 Appliance Efficiency Regulations.

C. **Multilevel astronomical time-switch controls**, in addition to meeting all of the requirements for astronomical time-switch controls, shall include at least two separately programmable steps per zone.

D. **Outdoor astronomical time-switch controls**, in addition to meeting all of the requirements for astronomical time-switch controls, shall have setback functions that allow the lighting on each controlled channel to be switched or dimmed to lower levels. The set back functions shall be capable of being programmed by the user for at least one specific time of day.

2. Daylighting controls.

A. **Automatic daylight controls** shall meet all requirements for automatic daylight control devices in the Title 20 Appliance Efficiency Regulations.

B. **Photo controls** shall meet all requirements for photo control devices in the Title 20 Appliance Efficiency Regulations.

3. **Dimmers** shall meet all requirements for dimmer control devices in the Title 20 Appliance Efficiency Regulations.

4. **Occupant sensing controls:** Occupant, motion and vacancy sensor controls shall meet the following requirements:

A. **Occupant sensors** shall meet all applicable requirements for occupant sensor control devices in the Title 20 Appliance Efficiency Regulations.

B. **Motion sensors** shall meet all applicable requirements for motion sensor controls devices in the Title 20 Appliance Efficiency Regulations.

C. **Vacancy sensors** shall meet all applicable requirements for vacancy sensor controls devices in the Title 20 Appliance Efficiency Regulations.

D. **Partial-ON sensors** shall meet all applicable requirements for partial on sensing devices in the Title 20 Appliance Efficiency Regulations.

E. **Partial-OFF sensors** shall meet all applicable requirements for partial off sensing devices in the Title 20 Appliance Efficiency Regulations.

Exception to Section 110.9(b)4: Occupant sensing control systems may consist of a combination of single or multi-level occupant, motion or vacancy sensor controls, provided that components installed to comply with manual-on requirements shall not be capable of conversion by the user from manual-on to automatic-on functionality.

5. **Part-night outdoor lighting controls**, as defined in Section 100.1, shall meet all of the following requirements:

A. Have sunrise and sunset prediction accuracy within +/- 15 minutes and timekeeping accuracy within five minutes per year; and

B. Have the ability to setback or turn off lighting at night as required in Section 130.2(c), by means of a programmable timeclock or motion sensing device; and

C. When controlled with a timeclock, shall be capable of being programmed to allow the setback or turning off of the lighting to occur from any time at night until any time in the morning, as determined by the user.

(c) **Track lighting integral current limiter.** An integral current limiter for line-voltage track lighting shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall be certified to the Energy Commission as meeting all of the applicable requirements in Section 110.9(c); and

2. Shall comply with the lighting control installation requirements in accordance with Section 130.4; and

3. Shall be manufactured so that the current limiter housing is used exclusively on the same manufacturer's track for which it is designed; and

4. Shall be designed so that the current limiter housing is permanently attached to the track so that the system will be irreparably damaged if the current limiter housing were to be removed after installation into the track. Methods of attachment may include but are not limited to one-way barbs, rivets and one-way screws; and

5. Shall employ tamper resistant fasteners for the cover to the wiring compartment; and

6. Shall have the identical volt-ampere (VA) rating of the current limiter as installed and rated for compliance with Part 6 clearly marked as follows; and

A. So that it is visible for the building officials' field inspection without opening coverplates, fixtures or panels; and

B. Permanently marked on the circuit breaker; and

C. On a factory-printed label that is permanently affixed to a nonremovable base-plate inside the wiring compartment.

7. Shall have a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring or bypassing the device; and

8. Each electrical panel from which track lighting integral current limiters are energized shall have a factory printed label permanently affixed and prominently located, stating the following: "NOTICE: Current limiting devices installed in track lighting integral current limiters connected to this panel shall only be replaced with the same or lower amperage. Adding track or replacement of existing current limiters with higher continuous ampere rating will void the track lighting integral current limiter certification, and will require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards."

(d) **Track lighting supplementary overcurrent protection panel.** A Track Lighting Supplementary Overcurrent Protection Panel shall be used only for line-voltage track lighting and shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall comply with the Lighting Control Installation requirements in accordance with Section 130.4; and

2. Shall be listed as defined in Section 100.1; and

3. Shall be used only for line voltage track lighting. No other lighting or building power shall be used in a Supplementary Overcurrent Protection Panel used to determine input wattage for track lighting; and

4. Be permanently installed in an electrical equipment room, or permanently installed adjacent to the lighting panel board providing supplementary overcurrent protection for the track lighting circuits served by the supplementary over current protection pane; and

5. Shall have a permanently installed label that is prominently located stating the following: "NOTICE: This Panel for Track Lighting Energy Code Compliance Only." The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other overcurrent protective device shall be added to this panel. Adding to, or replacement of, existing overcurrent protective device(s) with higher continuous ampere rating will void the panel listing and require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards.

(m) **Residential high efficacy light emitting diode (LED) lighting.** To qualify as high efficacy for compliance with the residential lighting Standards in Section 150.0(k), a residential

LED luminaire or LED light engine shall be certified to the Energy Commission according to Reference Joint Appendix JA-8. LED lighting not certified to the Energy Commission shall be classified as low efficacy for compliance with Section 150.0(k). Nonresidential LED lighting is not required to be certified to the Energy Commission.

(f) **Ballasts for residential recessed luminaires.** To qualify as high efficacy for compliance with Section 150.0(k), any compact fluorescent lamp ballast in a residential recessed luminaire shall meet all of the following conditions:

1. Be rated by the ballast manufacturer to have a minimum rated life of 30,000 hours when operated at or below a specified maximum case temperature. This maximum ballast case temperature specified by the ballast manufacturer shall not be exceeded when tested in accordance to UL 1598 Section 19.15; and
2. Have a ballast factor of not less than 0.90 for nondimming ballasts and a ballast factor of not less than 0.85 for dimming ballasts.

SECTION 110.10 MANDATORY REQUIREMENTS FOR SOLAR READY BUILDINGS

(a) Covered occupancies.

1. **Single-family residences.** Single-family residences located in subdivisions with ten or more single-family residences and where the application for a tentative subdivision map for the residences has been deemed complete, by the enforcement agency, on or after January 1, 2014, shall comply with the requirements of Sections 110.10(b) through 110.10(e)
2. **Low-rise multifamily buildings.** Low-rise multifamily buildings shall comply with the requirements of Sections 110.10(b) through 110.10(d).
3. **Hotel/motel occupancies and high-rise multifamily buildings.** Hotel/motel occupancies and high-rise multifamily buildings with ten stories or fewer shall comply with the requirements of Sections 110.10(b) through 110.10(d).
4. **All other nonresidential buildings.** All other nonresidential buildings with three stories or fewer shall comply with the requirements of Sections 110.10(b) through 110.10(d).

(b) Solar zone.

1. **Minimum area.** The solar zone shall have a minimum total area as described below. The solar zone shall comply with access, pathway, smoke ventilation and spacing requirements as specified in Title 24, Part 9 or other Parts of Title 24 or in any requirements adopted by a local jurisdiction. The solar zone total area shall be comprised of areas that have no dimension less than five feet and are no less than 80 square feet each for buildings with roof areas less than or equal to 10,000 square feet or no less than 160 square feet each for buildings with roof areas greater than 10,000 square feet.

A. **Single-family residences.** The solar zone shall be located on the roof or overhang of the building and have a total area no less than 250 square feet.

Exception 1 to Section 110.10(b)1A: Single-family residences with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than 1000 watts.

Exception 2 to Section 110.10(b)1A: Single-family residences with a permanently installed domestic solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.50.

Exception 3 to Section 110.10(b)1A: Single-family residences with three stories or more and with a total floor area less than or equal to 2000 square feet and having a solar zone total area no less than 150 square feet.

Exception 4 to Section 110.10(b)1A: Single-family residences located in climate zones 8-14 and the Wildland-Urban Interface Fire Area as defined in Title 24, Part 2 and having a whole house fan and having a solar zone total area no less than 150 square feet.

Exception 5 to Section 110.10(b)1A: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 110 degrees and 270 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

Exception 6 to Section 110.10(b)1A: Single-family residences having a solar zone total area no less than 150 square feet and where all thermostats comply with Reference Joint Appendix JA5 and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.

Exception 7 to Section 110.10(b)1A: Single-family residences meeting the following conditions:

- A. All thermostats comply with Reference Joint Appendix JA5 and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.
- B. All applicable requirements of Section 150.0(k), except as required below:
 - i. All permanently installed indoor lighting is high efficacy as defined in Table 150.0-A or

150.0-B and is installed in kitchens, bathrooms, utility rooms and garages at a minimum.

- ii. All permanently installed lighting in bathrooms is controlled by a vacancy sensor.

Exception to Exception 7Bii: One high-efficacy luminaire as defined in Table 150.0-A or 150.0-B with total lamp wattage rated to consume no greater than 26 watts of power is not required to be controlled by a vacancy sensor.

- iii. Every room which does not have permanently installed lighting has at least one switched receptacle installed.
- iv. Permanently installed night lights complying with Section 150.0(k)1E are allowed.
- v. Lighting integral to exhaust fans complying with Section 150.0(k)1F is allowed. All permanently installed outdoor lighting is high efficacy as defined in Table 150.0-A or 150.0-B and is
- vi. Controlled as required in Section 150.0(k)9Ai and iii.

B. Low-rise and high-rise multifamily buildings, hotel/motel occupancies and nonresidential buildings. The solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building or on covered parking installed with the building project and have a total area no less than 15 percent of the total roof area of the building excluding any skylight area.

Exception 1 to Section 110.10(b)1B: Buildings with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than one watt per square foot of roof area.

Exception 2 to Section 110.10(b)1B: Buildings with a permanently installed domestic solar water-heating system complying with Section 150.1(c)8Ciii.

Exception 3 to Section 110.10(b)1B: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 110 degrees and 270 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

Exception 4 to Section 110.10(b)1B: Low-rise and high-rise multifamily buildings meeting the following conditions:

- A. All thermostats in each dwelling unit comply with Reference Joint Appendix JA5 and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.
- B. All applicable requirements of Section 150.0(k), except as required below:

- i. All permanently installed indoor lighting in each dwelling unit is high efficacy as defined in Table 150.0-A or 150.0-B and is installed in kitchens, bathrooms, utility rooms and private garages at a minimum.
- ii. All permanently installed lighting in bathrooms is controlled by a vacancy sensor.

Exception to Exception 4Bii: One high-efficacy luminaire as defined in Table 150.0-A or 150.0-B with total lamp wattage rated to consume no greater than 26 watts of power is not required to be controlled by a vacancy sensor.

- iii. Every room which does not have permanently installed lighting has at least one switched receptacle installed.
- iv. Permanently installed night lights complying with Section 150.0(k)1E are allowed.
- v. Lighting integral to exhaust fans complying with Section 150.0(k)1F is allowed. All permanently installed outdoor lighting for private patios, entrances, balconies and porches is high efficacy as defined in Table 150.0-A or 150.0-B; and
- vi. Is controlled as required in Section 150.0(k)9Ai and iii.

Exception 5 to Section 110.10(b)1B: Buildings where the roof is designed and approved to be used for vehicular traffic or parking or for a heliport.

- 2. **Orientation.** All sections of the solar zone located on steep-sloped roofs shall be oriented between 110 degrees and 270 degrees of true north.

3. **Shading.**

A. No obstructions, including but not limited to, vents, chimneys, architectural features and roof mounted equipment, shall be located in the solar zone.

B. Any obstruction, located on the roof or any other part of the building that projects above a solar zone shall be located at least twice the distance, measured in the horizontal plane, of the height difference between the highest point of the obstruction and the

horizontal projection of the nearest point of the solar zone, measured in the vertical plane.

Exception to Section 110.10(b)3: Any roof obstruction, located on the roof or any other part of the building, that is oriented north of all points on the solar zone.

4. Structural design loads on construction documents.

For areas of the roof designated as solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

Note: Section 110.10(b)4 does not require the inclusion of any collateral loads for future solar energy systems.

(c) Interconnection pathways.

1. The construction documents shall indicate a location for inverters and metering equipment and a pathway for routing of conduit from the solar zone to the point of interconnection with the electrical service. For single-family residences the point of interconnection will be the main service panel.
2. The construction documents shall indicate a pathway for routing of plumbing from the solar zone to the water-heating system.

(d) **Documentation.** A copy of the construction documents or a comparable document indicating the information from Sections 110.10(b) through 110.10(c) shall be provided to the occupant.

(e) Main electrical service panel.

1. The main electrical service panel shall have a minimum busbar rating of 200 amps.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation.

A. **Location.** The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.

B. **Marking.** The reserved space shall be permanently marked as “For Future Solar Electric.”