

SUBCHAPTER 2

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

SECTION 110 – SYSTEMS AND EQUIPMENT—GENERAL

Sections 111 through 119 establish requirements for ~~the~~manufacturing~~ing~~, construction, and installation of certain systems, equipment and building components that are installed in buildings regulated by Title 24, Part 6. Systems, equipment and building components listed below may be installed only if:

- (a) The manufacturer has certified that the system, equipment or building component complies with the applicable manufacturing~~ing~~ provisions of Sections 111 through 119; and
- (b) The system, equipment or building component complies with the applicable installation provisions of Sections 111 through 119.

No system, equipment or building component covered by the provisions of Sections 111 through 119, that is not certified or that fails to comply with the applicable installation requirements, may be installed in a building regulated by Title 24, Part 6.

The systems, equipment and building components covered are:

Appliances regulated by the Appliance Efficiency Regulations (Section 111).

Other space-conditioning equipment (Section 112).

Other service water-heating systems and equipment (Section 113).

Pool and spa heating systems and equipment (Section 114).

Gas appliances (Section 115).

Doors, windows, and fenestration products (Section 116).

Joints and other openings (Section 117).

Insulation and Cool Roofs (Section 118).

Lighting control devices (Section 119).

SECTION 111 – MANDATORY REQUIREMENTS FOR APPLIANCES REGULATED BY THE APPLIANCE EFFICIENCY REGULATIONS

Any appliance for which there is a California standard established in the Appliance Efficiency Regulations may be installed only if the manufacturer has certified to the commission, as specified in those regulations, that the appliance complies with the applicable standard for that appliance. See Appendix 1-A for availability of directories of certified appliances.

SECTION 112 – 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 that the equipment complies with all the applicable requirements of this section.

- (a) **Efficiency.** Equipment shall meet the applicable requirements TABLE 112-A through TABLE 112-M, subject to the following:

~~SECTION 110 – SYSTEMS AND EQUIPMENT—GENERAL~~~~SECTION 112 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT~~~~SECTION 115 – NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, AND POOL AND SPA HEATERS: PILOT LIGHTS PROHIBITED~~~~SECTION 112 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT~~

1. If more than one standard is listed for any equipment in TABLE 112-A through TABLE 112-M, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in TABLE 112-A through TABLE 112-M, 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.

EXCEPTION to Section 112 (a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550 test conditions of 44°F leaving chilled water temperature and 85°F entering condenser water temperature shall have a minimum full load COP rating as shown in TABLE 112-H, TABLE 112-I, and TABLE 112-J, and a minimum NPLV rating as shown in TABLE 112-K, TABLE 112-L, and TABLE 112-M. The table values are only applicable over the following full load design ranges:

Leaving Chiller Water Temp.	40 to 48°F
Entering Condenser Water Temp.	75 to 85°F
Condensing Water Temp. Rise	5 to 15°F

- (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 to Section 112 (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.

- (c) **Thermostats¹.** All unitary heating and/or cooling systems including heat pumps that are not controlled by a central energy management control system (EMCS) shall have a Programmable Communicating Thermostat (PCT) that is certified by the manufacturer to the Energy Commission to meet the requirements of Subsections 112(c)(1) and 112(c)(2) below:

1. **Setback Capabilities.** All PCTs shall have a clock mechanism that allows the building occupant to program the temperature set points for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 112(b).
2. **Communicating Capabilities.** All PCTs shall be distributed with a non-removable Radio Data System (RDS) communications device that is compatible with the default statewide DR communications system, which can be used by utilities to send price and emergency signals. PCTs shall be capable of receiving and responding to the signals indicating price and emergency events as follows.

- A. **Price Events.** The PCT shall be shipped with default price-event offsets of +4°F for cooling and -4°F for heating enabled; however, customers shall be able to change the offsets and thermostat settings at any time during price events. Upon receiving a price-event signal, the PCT shall adjust the thermostat setpoint by the number of degrees indicated in the offset for the duration specified in the signal of the price event. The PCT shall also be equipped with the capability to allow customers to define setpoints for heating and cooling in response to price signals as an alternative to temperature-offsetting response, as described in Reference Joint Appendix 5.

B. Emergency Events. Upon receiving an emergency signal, the PCT shall respond to commands contained in the emergency signal, including changing the setpoint by any number of degrees or to a specific temperature setpoint. The PCT shall not allow customer changes to thermostat settings during emergency events.

3. Other Required Capabilities. PCTs shall also have the following capabilities. Technical detail of items A through E below shall be included in Reference Joint Appendix 5:

A. Include at least one industry standard expansion/communication port. Insertion of a utility-specific communications module shall disable the default statewide communications hardware built in to the PCT unless the utility module is removed or is no longer receiving a signal.

B. Provide user information regarding communications system connection status, type of event (price or emergency), and other maintenance-related information. This information shall be on the standard PCT display, using a Liquid Crystal Display, standalone indicator using Light Emitting Diodes, or other means.

C. At a minimum, standardize terminal mapping of terminal numbers 1-9. This approach must include 24 volt power supply, both analog and digital PCTs, and must support heat pumps with resistance heat strips and reversing valve in both residential and small commercial packaged units.

D. Include the capability to randomize, over a 30-minute period after the end of an event, the time at which the thermostat returns to the programmed setpoint.

E. Through user input be capable of addressability at the substation level or finer including individual PCT.

EXCEPTION 1 to Section 112(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps need not comply with this requirement. Additionally, room air-conditioner heat pumps need not comply with Section 112 (b). Under performance method of compliance, the resulting increase in energy use due to elimination of the setback thermostat shall be factored into the compliance analysis in accordance with a method prescribed by the executive director.

EXCEPTION 2 to Section 112(c): Other devices within the heating and cooling system, other communications systems or methods, or utility specific devices determined to be capable of providing equivalent demand response functionality described in Section 112(c) that are approved by the Executive Director.

(ed) Gas- and Oil-Fired Furnace Standby Loss Controls. Gas-fired and oil-fired forced air furnaces with input ratings $\geq 225,000$ Btu/h 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/h, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75% of the input rating

TABLE 112-A^[ce2] ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS²

Equipment Type	Size Category	Efficiency ^a		Test Procedure
		Before 1/1/2010	After 1/1/2010	
Air Conditioners, Air Cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	10.3 EER ^b	11.2 EER ^b	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	9.7 EER ^b	11.0 EER ^b	ARI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	9.5 EER ^b and 9.7 IPLV ^b	10.0 EER ^b and 9.7 IPLV ^b	
	≥ 760,000 Btu/h	9.2 EER ^b and 9.4 IPLV ^b	9.7 EER ^b and 9.4 IPLV ^b	
Air Conditioners, Water and Evaporatively Cooled				ARI 210/240
	> 240,000 Btu/h	11.0 EER ^b and 10.3 IPLV ^b		ARI 340/360
Condensing Units, Air Cooled	≥ 135,000 Btu/h	10.1 EER and 11.2 IPLV		ARI 365
Condensing Units, Water or Evaporatively Cooled	≥ 135,000 Btu/h	13.1 EER and 13.1 IPLV		

^a IPLVs are only applicable to equipment with capacity modulation.

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

TABLE 112-B UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS³

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency ^a		Test Procedure
			Before 1/1/2010	After 1/1/2010	
Air Cooled (Cooling Mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.1 EER ^b	11.0	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h		9.3 EER ^b	10.6	
	≥ 240,000 Btu/h		9.0 EER ^b and 9.2 IPLV ^b	9.5 EER ^b and 9.2 IPLV ^b	
Air Cooled (Heating Mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP	3.3 COP	ARI 210/240
	≥ 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.1 COP	3.2 COP	ARI 340/360

^a IPLVs and Part load rating conditions are applicable only to equipment with capacity modulation.

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

TABLE 112-C AIR-COOLED GAS-ENGINE HEAT PUMPS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency	Test Procedure
Air-Cooled Gas-Engine Heat Pump (Cooling Mode)	All Capacities	95° F db Outdoor Air	0.60 COP	ANSI Z21.40.4

Air-Cooled Gas-Engine Heat Pump (Heating Mode)	All Capacities	47° F db/43 F wb OutdoorAir	0.72 COP	ANSI Z21.40.4
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TABLE 112-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency	Test Procedure
Air Cooled, With Condenser, Electrically Operated	< 150 Tons	2.80 COP	ARI 550/590
	≥ 150 Tons	3.05 IPLV	
Air Cooled, Without Condenser, Electrically Operated	All Capacities	3.10 COP 3.45 IPLV	
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All Capacities	4.20 COP 5.05 IPLV	ARI 550/590
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	< 150 Tons	4.45 COP 5.20 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons	4.90 COP 5.60 IPLV	
	≥ 300 Tons	5.50 COP	
	€	6.15 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	5.00 COP 5.25 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons	5.55 COP 5.90 IPLV	
	≥ 300 Tons	6.10 COP	
	€	6.40 IPLV	
Air Cooled Absorption Single Effect	All Capacities	0.60 COP	ARI 560
Water Cooled Absorption Single Effect	All Capacities	0.70 COP	
Absorption Double Effect, Indirect-Fired	All Capacities	1.00 COP 1.05 IPLV	
	All Capacities	1.00 COP 1.00 IPLV	
Water Cooled Gas Engine Driven Chiller	All Capacities	1.2 COP 2.0 IPLV	

TABLE 112-E PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS^d

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Efficiency ^a	Test Procedure
PTAC (Cooling Mode) New Construction	All Capacities	95°F db Outdoor Air	12.5 - (0.213 x Cap/1000) ^a EER	ARI 310/380
PTAC (Cooling Mode) Replacements ^b			10.9 - (0.213 x Cap/1000) ^a EER	
PTHP (Cooling Mode) New Construction			12.3 - (0.213 x Cap/1000) ^a EER	
PTHP (Cooling Mode) Replacements ^b			10.8 - (0.213 x Cap/1000) ^a EER	
PTHP (Heating Mode) New Construction			3.2 - (0.026 x Cap/1000) ^a COP	
PTHP (Heating Mode) Replacements ^b			2.9 - (0.026 x Cap/1000) ^a COP	
SPVAC (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	9.0 EER	ARI 390
	>=65,000 Btu/h and <135,000 Btu/h		8.9 EER	
	>=135,000 Btu/h and <240,000 Btu/h		8.6 EER	
SPVHP (Cooling Mode)	<65,000 Btu/h		9.0 EER	
	>=65,000 Btu/h and <135,000 Btu/h		8.9 EER	
	>=135,000 Btu/h and <240,000 Btu/h		8.6 EER	
SPVHP (Heating Mode)	<65,000 Btu/h	47°F db / 43°F wb Outdoor Air	3.0 COP	
	>=65,000 Btu/h and <135,000 Btu/h		3.0 COP	
	>=135,000 Btu/h and <240,000 Btu/h		2.9 COP	

^a Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

^b 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 high and less than 42 inches wide[rh5].

TABLE 112-F BOILERS, GAS AND OIL FIRED – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency	Test Procedure
Boilers, Gas-Fired	>= 300,000 Btu/h and <= 2,500,000 Btu/h	Maximum Capacity	75% Et ^a	H.I. Htg Boiler Standard
Boilers, Oil-Fired	>= 300,000 Btu/h and <= 2,500,000 Btu/h	Maximum Capacity	78% Et ^a	

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~~SECTION 115 – NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, AND POOL AND SPA HEATERS: PILOT LIGHTS PROHIBITED~~
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			H.I. Htg Boiler
* Et = Thermal efficiency. See test procedure for detailed information.			

TABLE 112-G PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT^d

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required ^{a,b}	Test Procedure ^c
Propeller or Axial Fan <u>Open</u> Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75 °F wb Outdoor Air	≥ 38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan <u>Open</u> Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75 °F wb Outdoor Air	≥ 20.0 gpm/hp	CTI ATC-105 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	ARI 460

^a For purposes of this table, open cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.

^b 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.

^c ~~Cooling-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. ~~Factory-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% 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.

^d ~~The efficiencies for open cooling towers listed in Table 112-G are not applicable for closed-circuit cooling towers.~~

TABLE 112-H COPS FOR NON-STANDARD CENTRIFUGAL CHILLERS < 150 TONS

Centrifugal Chillers < 150 Tons								
COP _{std} = 5.0								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required COP					
46	75	29	5.58	5.83	6.03	6.32	6.54	6.70
45	75	30	5.50	5.74	5.92	6.19	6.38	6.53
44	75	31	5.42	5.65	5.82	6.07	6.24	6.37
43	75	32	5.35	5.57	5.72	5.95	6.11	6.23
42	75	33	5.27	5.49	5.64	5.85	6.00	6.11
41	75	34	5.19	5.41	5.56	5.75	5.89	5.99
46	80	34	5.19	5.41	5.56	5.75	5.89	5.99
40	75	35	5.11	5.33	5.48	5.67	5.79	5.88
45	80	35	5.11	5.33	5.48	5.67	5.79	5.88
44	80	36	5.03	5.26	5.40	5.58	5.70	5.79
43	80	37	4.94	5.18	5.32	5.50	5.62	5.70
42	80	38	4.84	5.10	5.25	5.43	5.53	5.61
41	80	39	4.73	5.01	5.17	5.35	5.46	5.53
46	85	39	4.73	5.01	5.17	5.35	5.46	5.53
40	80	40	4.62	4.92	5.09	5.27	5.38	5.45
45	85	40	4.62	4.92	5.09	5.27	5.38	5.45
44	85	41	4.49	4.82	5.00	5.20	5.30	5.38
43	85	42	4.35	4.71	4.91	5.12	5.23	5.30
42	85	43	4.19	4.59	4.81	5.03	5.15	5.22
41	85	44	4.02	4.46	4.70	4.94	5.06	5.14
40	85	45	3.84	4.32	4.58	4.84	4.98	5.06
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68

^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)

^b Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)

$K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$

where X = Condenser DT + LIFT

$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-I COPS FOR NON-STANDARD CENTRIFUGAL CHILLERS > 150 TONS, ≤ 300 TONS

Centrifugal Chillers > 150 Tons, ≤ 300 Tons								
COP _{std} = 5.55								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required COP					
46	75	29	6.17	6.44	6.66	6.99	7.23	7.40
45	75	30	6.08	6.34	6.54	6.84	7.06	7.22
44	75	31	6.00	6.24	6.43	6.71	6.9	7.05
43	75	32	5.91	6.15	6.33	6.58	6.76	6.89
42	75	33	5.83	6.07	6.23	6.47	6.63	6.75
41	75	34	5.74	5.98	6.14	6.36	6.51	6.62
46	80	34	5.74	5.98	6.14	6.36	6.51	6.62
40	75	35	5.65	5.90	6.05	6.26	6.40	6.51
45	80	35	5.65	5.90	6.05	6.26	6.40	6.51
44	80	36	5.56	5.81	5.97	6.17	6.30	6.40
43	80	37	5.46	5.73	5.89	6.08	6.21	6.30
42	80	38	5.35	5.64	5.80	6.00	6.12	6.20
41	80	39	5.23	5.54	5.71	5.91	6.03	6.11
46	85	39	5.23	5.54	5.71	5.91	6.03	6.11
40	80	40	5.10	5.44	5.62	5.83	5.95	6.03
45	85	40	5.10	5.44	5.62	5.83	5.95	6.03
44	85	41	4.96	5.33	5.55	5.74	5.86	5.94
43	85	42	4.81	5.21	5.42	5.66	5.78	5.86
42	85	43	4.63	5.08	5.31	5.56	5.69	5.77
41	85	44	4.45	4.93	5.19	5.46	5.60	5.69
40	85	45	4.24	4.77	5.06	5.35	5.50	5.59
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68
^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F) ^b Condenser DT = Leaving Condenser Water Temperature (°F) - Entering Condenser Water Temperature (°F) $K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$ where X = Condenser DT + LIFT $COP_{adj} = K_{adj} * COP_{std}$								

TABLE 112-J COPS FOR NON-STANDARD CENTRIFUGAL CHILLERS > 300 TONS

Centrifugal Chillers > 300 Tons								
COP _{std} = 6.1								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required COP					
46	75	29	6.80	7.11	7.35	7.71	7.97	8.16
45	75	30	6.71	6.99	7.21	7.55	7.78	7.96
44	75	31	6.61	6.89	7.09	7.40	7.61	7.77
43	75	32	6.52	6.79	6.98	7.26	7.45	7.60
42	75	33	6.43	6.69	6.87	7.13	7.31	7.44
41	75	34	6.33	6.60	6.77	7.02	7.18	7.30
46	80	34	6.33	6.60	6.77	7.02	7.18	7.30
40	75	35	6.23	6.50	6.68	6.91	7.06	7.17
45	80	35	6.23	6.50	6.68	6.91	7.06	7.17
44	80	36	6.13	6.41	6.58	6.81	6.95	7.05
43	80	37	6.02	6.31	6.49	6.71	6.85	6.94
42	80	38	5.90	6.21	6.40	6.61	6.75	6.84
41	80	39	5.77	6.11	6.30	6.52	6.65	6.74
46	85	39	5.77	6.11	6.30	6.52	6.65	6.74
40	80	40	5.63	6.00	6.20	6.43	6.56	6.65
45	85	40	5.63	6.00	6.20	6.43	6.56	6.65
44	85	41	5.47	5.87	6.10	6.33	6.47	6.55
43	85	42	5.30	5.74	5.98	6.24	6.37	6.46
42	85	43	5.11	5.60	5.86	6.13	6.28	6.37
41	85	44	4.90	5.44	5.72	6.02	6.17	6.27
40	85	45	4.68	5.26	5.58	5.90	6.07	6.17
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68
^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F) ^b Condenser DT = Leaving Condenser Water Temperature (°F) - Entering Condenser Water Temperature (°F) $K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$ where X = Condenser DT + LIFT $COP_{adj} = K_{adj} * COP_{std}$								

TABLE 112-K IPLV/NPLV FOR NON-STANDARD CENTRIFUGAL CHILLERS < 150 TONS

Centrifugal Chillers < 150 Tons								
IPLVstd = 5.25								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required IPLV/NPLV					
			46	75	29	5.84	6.10	6.30
45	75	30	5.75	6.00	6.19	6.47	6.68	6.83
44	75	31	5.67	5.91	6.08	6.34	6.53	6.67
43	75	32	5.59	5.82	5.99	6.23	6.39	6.52
42	75	33	5.51	5.74	5.90	6.12	6.27	6.39
41	75	34	5.43	5.66	5.81	6.02	6.16	6.26
46	80	34	5.43	5.66	5.81	6.02	6.16	6.26
40	75	35	5.35	5.58	5.73	5.93	6.06	6.15
45	80	35	5.35	5.58	5.73	5.93	6.06	6.15
44	80	36	5.26	5.50	5.65	5.84	5.96	6.05
43	80	37	5.16	5.42	5.57	5.76	5.87	5.96
42	80	38	5.06	5.33	5.49	5.67	5.79	5.87
41	80	39	4.95	5.24	5.41	5.60	5.71	5.78
46	85	39	4.95	5.24	5.41	5.60	5.71	5.78
40	80	40	4.83	5.14	5.32	5.52	5.63	5.70
45	85	40	4.83	5.14	5.32	5.52	5.63	5.70
44	85	41	4.69	5.04	5.25 ^c	5.43	5.55	5.62
43	85	42	4.55	4.93	5.13	5.35	5.47	5.54
42	85	43	4.38	4.80	5.03	5.26	5.38	5.46
41	85	44	4.21	4.67	4.91	5.17	5.30	5.38
40	85	45	4.01	4.52	4.79	5.06	5.20	5.29
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68

^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)

^b Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)

^c All values shown are NPLV except at conditions of 3 gpm/ton and 41 °F LIFT which is IPLV.

$$K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$$

where X = Condenser DT + LIFT

$$COP_{adj} = K_{adj} * COP_{std}$$

TABLE 112-L IPLV/NPLV FOR NON-STANDARD CENTRIFUGAL CHILLERS > 150 TONS, < 300 TONS

Centrifugal Chillers > 150 Tons, < 300 Tons								
IPLV _{std} = 5.9								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required IPLV/NPLV					
			46	75	29	6.58	6.87	7.11
45	75	30	6.49	6.76	6.98	7.30	7.53	7.70
44	75	31	6.40	6.66	6.86	7.15	7.36	7.52
43	75	32	6.31	6.56	6.75	7.02	7.21	7.35
42	75	33	6.22	6.47	6.65	6.90	7.07	7.20
41	75	34	6.13	6.38	6.55	6.79	6.95	7.06
46	80	34	6.13	6.38	6.55	6.79	6.95	7.06
40	75	35	6.03	6.29	6.46	6.68	6.83	6.94
45	80	35	6.03	6.29	6.46	6.68	6.83	6.94
44	80	36	5.93	6.20	6.37	6.58	6.72	6.82
43	80	37	5.82	6.11	6.28	6.49	6.62	6.72
42	80	38	5.71	6.01	6.19	6.40	6.53	6.62
41	80	39	5.58	5.91	6.10	6.31	6.44	6.52
46	85	39	5.58	5.91	6.10	6.31	6.44	6.52
40	80	40	5.44	5.80	6.00	6.22	6.35	6.43
45	85	40	5.44	5.80	6.00	6.22	6.35	6.43
44	85	41	5.29	5.68	5.90 ^c	6.13	6.26	6.34
43	85	42	5.13	5.55	5.79	6.03	6.16	6.25
42	85	43	4.94	5.41	5.67	5.93	6.07	6.16
41	85	44	4.74	5.26	5.54	5.82	5.97	6.07
40	85	45	4.52	5.09	5.40	5.71	5.87	5.97
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68

^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)

^b Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)

^c All values shown are NPLV except at conditions of 3 gpm/ton and 41 °F LIFT which is IPLV.

$$K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$$

where X = Condenser DT + LIFT

$$COP_{adj} = K_{adj} * COP_{std}$$

TABLE 112-M IPLV/NPLV FOR NON-STANDARD CENTRIFUGAL CHILLERS > 300 TONS

Centrifugal Chillers > 300 Tons								
IPLV _{std} = 6.4								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	Required IPLV/NPLV					
46	75	29	7.15	7.47	7.72	8.10	8.37	8.58
45	75	30	7.05	7.35	7.58	7.93	8.18	8.36
44	75	31	6.95	7.23	7.45	7.77	8.00	8.16
43	75	32	6.85	7.13	7.33	7.63	7.83	7.98
42	75	33	6.75	7.03	7.22	7.49	7.68	7.82
41	75	34	6.65	6.93	7.12	7.37	7.55	7.67
46	80	34	6.65	6.93	7.12	7.37	7.55	7.67
40	75	35	6.55	6.83	7.01	7.26	7.42	7.54
45	80	35	6.55	6.83	7.01	7.26	7.42	7.54
44	80	36	6.44	6.73	6.92	7.15	7.30	7.41
43	80	37	6.32	6.63	6.82	7.05	7.19	7.30
42	80	38	6.20	6.53	6.72	6.95	7.09	7.19
41	80	39	6.06	6.42	6.62	6.85	6.99	7.08
46	85	39	6.06	6.42	6.62	6.85	6.99	7.08
40	80	40	5.91	6.30	6.52	6.76	6.89	6.98
45	85	40	5.91	6.30	6.52	6.76	6.89	6.98
44	85	41	5.75	6.17	6.40 ^c	6.66	6.79	6.89
43	85	42	5.57	6.03	6.28	6.55	6.70	6.79
42	85	43	5.37	5.88	6.16	6.44	6.59	6.69
41	85	44	5.15	5.71	6.01	6.33	6.49	6.59
40	85	45	4.91	5.53	5.86	6.20	6.37	6.48
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68

^a LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)

^b Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)

^c All values shown are NPLV except at conditions of 3 gpm/ton and 41 °F LIFT which is IPLV.

$$K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$$

where X = Condenser DT + LIFT

$$COP_{adj} = K_{adj} * COP_{std}$$

SECTION 113 – 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 9 of the ASHRAE Handbook, HVAC Applications Volume.
- EXCEPTION to Section 113 (a) 1:** Residential occupancies.
- (b) **Efficiency.** Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 111, 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. **Pumps for circulating systems.** Circulating service water-heating systems shall have a control capable of automatically turning off the circulating pump when hot water is not required.

EXCEPTION to Section 113 (c) 2: Water heating systems serving a single dwelling unit.

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 and

Hotel/Motel 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. 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.

- 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 boiler 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

inches—76. **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 113 (c) 5: Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

SECTION 114 – MANDATORY REQUIREMENTS FOR POOL AND SPA ~~HEATING~~ 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 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 114 (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 114 (a) 4: Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.

5. **Pilot light.** No pilot light.

- (b) **Installation.** Any pool or spa ~~heating~~ system or equipment shall be installed with all of the following:⁵

1. **Piping.** At least 36 inches of pipe shall be installed between the filter and the heater or built-in or built-up connections 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.

~~**EXCEPTION to Section 114 (b) 2:** Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.~~

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 the pool water circulation control system that will allow all ~~The circulation pump shall have a time switch that allows the pumps to be set or programmed~~ to run during the ~~in the~~ off-peak electric demand period, and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

~~**EXCEPTION to Section 114 (b) 3:** Where applicable public health standards require on peak operation.~~

SECTION 115 – 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 115 (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.

End Notes

The following notes are an explanation of the changes that have been made. These notes are not part of the Standard.

¹ These are the new PCT requirements per CEC DR team recommendations.

² This table is updated to be in agreement with Table 6.8.1A of ASHRAE 90.1-2007 as modified by Addendum G.

³ This table is updated to be in agreement with Table 6.8.1B of ASHRAE 90.1-2007 as modified by Addendum G.

⁴ This table is updated to be in agreement with Table 6.8.1D of ASHRAE 90.1-2007 as modified by Addendum B.

⁵ Davis Energy Group CASE initiative