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HVAC Equipment Efficiency

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Acknowledgements

California Statewide Codes and Standards Team

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Background

Federal Law (42USC 6313(a)(6)(A))

- Triggered when ASHRAE 90.1 is amended
- DOE determination within 18 months
- States can adopt ASHRAE 90.1 before DOE determination
- Tables 110.2A through 110.2K
- Not Subject to Cost Effectiveness

Background

Equipment subject to this requirement:

- Small, Large and Very Large Commercial Package Air Conditioning and Heating Equipment
- Single Package Vertical Air Conditioners and Heat Pumps
- Packaged Terminal Air Conditioners and Heat Pumps
- Warm-Air Furnaces
- Commercial Packaged Boilers
- Storage Water Heaters, Instantaneous Water Heaters, and Unfired Hot Water Storage Tanks

Proposed Code Change

Equipment	Equipment Category	Proposed Change to Efficiency
Single Package Vertical Air Conditioners (SPVAC)	Both weatherized and non-weatherized space constrained	**Update EER and COP for weatherized units <65,000 Btu/h**
Single Package Vertical Heat Pumps (SPVHP) - cooling & heating mode	Both weatherized and non-weatherized space constrained	**Update EER and COP for weatherized units <65,000 Btu/h**
Cooling Towers	Propeller or axial fan closed-circuit	**Update gpm/hp to efficiency levels in ASHRAE 90.1-2016**
VRF air conditioners	Air cooled	**Update IEER to efficiency levels in ASHRAE 90.1-2016 being adopted after 1/1/2017**
VRF heat pumps- cooling mode	Air Cooled	**Update IEER to efficiency levels in ASHRAE 90.1-2016 being adopted after 1/1/2017**
VRF heat pumps- cooling mode	Water-Source	**Update IEER to efficiency levels in ASHRAE 90.1-2016 being adopted after 1/1/2018 and insert requirements for EER and IEER for ≥ 240,000 Btu/h size category**
VRF heat pumps- heating mode	Water-Source	**Update COP to efficiency levels in ASHRAE 90.1-2016 being adopted after 1/1/2018 and insert requirements for COP for <65,000 Btu/h and ≥ 240,000 Btu/h size category**

Energy Analysis

- Changes in efficiency only affect closed circuit cooling towers and SPVAC/SPVHP
- Prototypes selected are buildings with the highest use rate for these systems

Prototype ID	Occupancy Type (Residential, Retail, Office, etc.)	Area (ft_2)	Number of Stories	Statewide New Construction Area (million ft_2)
Prototype 1	High-Rise Res (cooling tower)	93,632	10	**0.9**
Prototype 2	Small Schools (SPVAC/SPVHP)	24,413	1	**3.1/7.6**

Energy Savings

Climate Zone	First-Year Electricity Savings (GWh) New Construction	First-Year Electricity Savings (GWh) Alterations	First-Year Peak Electrical Demand Reduction (MW) New Construction	First-Year Peak Electrical Demand Reduction (MW) Alterations
1	0.01	0.02	6.84×10^{-3}	1.94E-02
2	0.05	0.15	3.52×10^{-2}	1.12E-01
3	0.11	0.36	1.21×10^{-1}	4.07E-01
4	0.10	0.33	7.77×10^{-2}	2.51E-01
5	0.01	0.04	1.53×10^{-2}	4.95E-02
6	0.10	0.46	8.46×10^{-2}	3.77E-01
7	0.09	0.25	1.11×10^{-1}	3.04E-01
8	0.18	0.79	1.20×10^{-1}	5.15E-01
9	0.22	0.81	1.14×10^{-1}	4.27E-01
10	0.34	0.96	2.16×10^{-1}	6.04E-01
11	0.11	0.28	4.89×10^{-2}	1.31E-01
12	0.34	0.96	1.88×10^{-1}	5.26E-01
13	0.24	0.65	1.02×10^{-1}	2.81E-01
14	0.07	0.21	3.47×10^{-2}	1.00E-01
15	0.12	0.29	8.66×10^{-2}	2.10E-01
16	0.06	0.18	3.88×10^{-2}	1.13E-01
TOTAL	2.15	6.74	1.40	4.43
	8.89 GWh		**5.83 MW**	

Proposed Code Language

Table 110.2 – A Electrically Operated Unitary Air Conditioners and Condensing Units				
Equipment Type	Size Category	Efficiency		Test Procedure
		~~Before 1/1/2016~~	~~After 1/1/2016~~	
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	~~11.2 EER~~ ~~11.4 IEER~~	11.2 EER 12.9 IEER	ANSI/AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	~~11.0 EER~~ ~~11.2 IEER~~	11.0 EER 12.4 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	~~10.0 EER~~ ~~10.1 IEER~~	10.0 EER 11.6 IEER	
	≥ 760,000 Btu/h	~~9.7 EER~~ ~~10.1 IEER~~	9.7 EER 11.2 IEER	
Air conditioners, water cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	~~12.1 EER~~ ~~12.3 IEER~~	12.1 EER 13.9 IEER	ANSI/AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	~~12.5 EER~~ ~~12.5 IEER~~	12.5 EER 13.9 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	~~12.4 EER~~ ~~12.6 IEER~~	12.4 EER 13.6 IEER	
	≥ 760,000 Btu/h	~~12.2 EER~~ ~~12.4 IEER~~	12.2 EER 13.5 IEER	

Proposed Code Language

Table 110.2 – B Unitary and Applied Heat Pumps

Equipment Type	Size Category	Efficiency [a, b]		Test Procedure
		~~Before 1/1/2016~~	~~After 1/1/2016~~	
Air Cooled (Cooling Mode), both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	~~11.0 EER~~ ~~11.2 IEER~~	11.0 EER 12 .2 IEER	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	~~10.6 EER~~ ~~10.7 IEER~~	10.6 EER 11.6 IEER	
	≥ 240,000 Btu/h	~~9.5EER~~ ~~9.6IEER~~	9.5 EER 10.6 IEER	

Proposed Code Language

Table 110.2 – E Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

Equipment Type	Size Category	Rating Condition	Efficiency [a, b]	Test Procedure
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb Outdoor Air	~~10.0 EER~~ 11.0 EER	ANSI/AHRI 390
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb Outdoor Air	~~10.0 EER~~ 11.0 EER	
SPVHP (heating mode)	< 65,000 Btu/h	95°F db/ 75°F wb Outdoor Air	~~3.0 COP~~ 3.3 COP	

Proposed Code Language

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 RS
Centrifugal fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥ 20.0 gpm/hp	
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~~ ≥ 16.1 gpm/hp	
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	≥ 7.0 gpm/hp	

Proposed Code Language

Table 110.2 – H Electrically Operated Variable Refrigerant Flow Air Conditioners

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [a]
VRF Air Conditioners, Air Cooled	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	ANSI/AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.2 EER ~~13.1 IEER [b]~~ 15.5 IEER [b]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER ~~12.9 IEER [b]~~ 14.9 IEER [b]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.0 EER ~~11.6 IEER [b]~~ 13.9 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 specified by ANSI/AHRI 1230 test procedures.

Proposed Code Language

Table 110.2 I Electrically Operated Variable Refrigerant Flow Air to Air and Applied Heat Pumps

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System a	11.0 EER ~~12.9 IEER~~ [c] 14.6 IEER [c]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	10.6 EER ~~12.3 IEER~~ [c] 13.9 IEER [c]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	9.5 EER ~~11.0 IEER~~ [c] 12.7 IEER [c]	
VRF Water source (cooling mode)	<65,000 Btu/h	All	VRF Multi-split systems [a] 86ºF entering water	12.0 EER 15.8 IEER [c]	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System [a] 86ºF entering water	12.0 EER 15.8 IEER [c]	
	≥135,000 Btu/h	All	VRF Multi-split System [a] 86ºF entering water	10.0 EER 13.8 IEER [c]	
	≥240,000 Btu/h	All	VRF Multi-split System [a] 86ºF entering water	10.0 EER 12.0 IEER	

Proposed Code Language

Continued: **Table 110.2 I Electrically Operated Variable Refrigerant Flow Air to Air and Applied Heat Pumps**

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	**Test Procedure [b]**
VRF Water source (heating mode)	<65,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	4.3 COP	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	~~4.2 COP~~ 4.3 COP	
	≥135,000 Btu/h and <240,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	~~3.9 COP~~ 4.0 COP	
	≥240,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	3.9 COP	

a Deduct 0.2 from the required EERs and IEERs for Variable Refrigerant Flow (VRF) Multi-split 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 specified by ANSI/AHRI 1230 test procedures.

Proposed Code Language

Table 110.2 – J Warm-Air Furnaces and Combination Warm-Air Furnaces/Air Conditioning Units, Warm-Air Duct Furnaces and Unit Heaters

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[b]	78% AFUE or 80% Et	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h	Maximum Capacity[b]	80% Et	Section 2.39, Thermal Efficiency, ANSIZ21.47
Warm-Air Furnace, oil-Fired	< 225,000 Btu/h	Maximum Capacity[b]	78% AFUE or 80% Et	DOE 10 CFR Part 430 or Section 42, Combustion,
	≥ 225,000 Btu/h	Maximum Capacity[b]	81% Et	Section 42, Combustion, UL 727
Warm-Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[b]	80% Ec	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[b]	80% Ec	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[b]	81% Ec	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~~ the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 (3-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.
d Et= 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 Ec= combustion efficiency (100% less flue losses). See test procedure for detailed discussion.
f Units must also include interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

Questions?

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