



**BSR/ASHRAE/IES Addendum y
to ANSI/ASHRAE/IES Standard 90.1-2019**

Public Review Draft

Proposed Addendum y to Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings

**First Public Review (November 2020)
(Draft Shows Proposed Changes to Current Standard)**

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FOREWORD

This proposed addendum makes revisions to table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages Minimum Efficiency Requirements for the following 4 groups of changes;

Change Group 1 - Heating Duty Minimum Efficiency Compliance

Background

Table 6.8.1-16 was introduced into ASHRAE 90.1-2019 to define the requirements for the new emerging chiller application that can provide heating and also simultaneous cooling and heating and offer opportunities for systems related energy savings and to support electrification. In the table both cooling operation minimum efficiencies as well as heating operation minimum efficiencies are defined. For heating duty Table 6.8.1-16 defines minimum *efficiency* requirements for heating fluid rating temperatures at 4 different hot fluid rating conditions, which are based on the reference AHRI 550/590(IP) and AHRI 551/591(SI) standard. Note the SI standard is a hard metric standard and the rating conditions are slightly different than the IP rating conditions. AHRI is in the process of revisions to the AHRI 550/590 (IP) and AHRI 551/591 (SI) standard and the AHRI 550/590 (IP) has been published and the AHRI 551/591 (SI) is in the final stages of publication. Shown below is the revised rating condition table 4

Operating Category	Conditions	Cooling Mode Heat Rejection Heat Exchanger															
		Cooling Mode Evaporator ²			Tower (Water Conditions) ³			Heat/Recovery (Water Conditions) ⁴		Evaporatively-cooled Entering Temperature ^{5,7}		Air-cooled (AC) Entering Temperature ^{5,7}		Without Condenser			
		Entering Temperature, °F	Leaving Temperature, °F	Flow Rate, gpm/ton ⁶	Entering Temperature, °F	Leaving Temperature, °F	Flow Rate, gpm/ton ⁶	Entering Temperature, °F	Leaving Temperature, °F	Dry-Bulb, °F	Wet-Bulb, °F	Dry-Bulb, °F	Wet-Bulb, °F	Air-cooled Refrigerant Temperature		Water & Evaporatively Cooled Refrigerant Temperature	
														SDT, °F	LIQ, °F	SDT, °F	LIQ, °F
All Cooling	Standard	54.00	44.00	Note - 8	85.00	94.30	Note - 10	--	--	95.00	75.00	95.00	--	125.00	105.00	105.00	98.00
AC Heat Pump High Heating ⁸	Low	--	105.00	Note - 1	--	--	--	--	--	--	--	47.00	43.00	--	--	--	--
	Medium	--	120.00	Note - 1	--	--	--	--	--	--	--	47.00	43.00	--	--	--	--
	High	--	140.00	Note - 1	--	--	--	--	--	--	--	47.00	43.00	--	--	--	--
AC Heat Pump Low Heating ⁸	Low	--	105.00	Note - 1	--	--	--	--	--	--	--	17.00	15.00	--	--	--	--
	Medium	--	120.00	Note - 1	--	--	--	--	--	--	--	17.00	15.00	--	--	--	--
	High	--	140.00	Note - 1	--	--	--	--	--	--	--	17.00	15.00	--	--	--	--
Water Cooled Heating	Low	--	44.00	Note - 8	--	--	--	95.00	105.00	--	--	--	--	--	--	--	--
	Medium	--	44.00	Note - 8	--	--	--	105.00	120.00	--	--	--	--	--	--	--	--
	High	--	44.00	Note - 8	--	--	--	120.00	140.00	--	--	--	--	--	--	--	--
	Boost	--	65.00	Note - 8	--	--	--	120.00	140.00	--	--	--	--	--	--	--	--
Heat Recovery	Low	--	44.00	Note - 8	75.00	--	Note - 9	95.00	105.00	40.00	38.00	40.00	38.00	--	--	--	--
	Medium	--	44.00	Note - 8	75.00	--	Note - 9	105.00	120.00	40.00	38.00	40.00	38.00	--	--	--	--
	Hot Water 1	--	44.00	Note - 8	75.00	--	Note - 9	90.00	140.00	40.00	38.00	40.00	38.00	--	--	--	--
	Hot Water 2	--	44.00	Note - 8	75.00	--	Note - 9	120.00	140.00	40.00	38.00	40.00	38.00	--	--	--	--

The standard defines the following full load heating *efficiency* metrics:

- **Heating Coefficient of Performance (COP_H) W/W** – This metric is intended for use in heating where there is no simultaneous cooling and heating like an air cooled heat pump or a water source 2 pipe system. This metric is full load standard rating conditions and there is currently no part load or annualized metric.

$$COP_H = \frac{Q_{cd}}{K3 \times W_{input}} \quad (\text{Note that } K3 \text{ is a conversion constant} = 3412)$$

- The *Heat Recovery Coefficient of Performance (COP_{HR})* W/W – This metric is intended for heat recovery chillers which can be single bundle condensers or double bundle condensers where there is simultaneous cooling and heating. The metric is for full load at standard rating conditions with 100% of the heat or rejection going to heating and not to a tower or external building heat rejection device. There is currently no part load or annualized metric.

$$COP_{HR} = \frac{Q_{ev} + Q_{hrc}}{K3 \times W_{input}} \quad (\text{Note that } K3 \text{ is a conversion constant} = 3412)$$

- The *Simultaneous Heating and Cooling Coefficient of Performance (COP_{SHC})* – This metric is intended for applications where there is a cooling load and a simultaneous heating load which can occur in large buildings where there is an interior cooling load and a perimeter heating load. These type of unit is sometimes used as a lead chiller in multiple chiller applications for perimeter heating or to support VAV reheat. There is currently no part load or annualized metric. Essential it is the same metric as COP_{HR} but AHRI choose to use a different name.

- $COP_{SHC} = \frac{Q_{ev} + Q_{hrc}}{K3 \times W_{input}} \quad (\text{Note that } K3 \text{ is a conversion constant} = 3412)$

The actual chiller that would meet these heating rating conditions would likely be different products and have different compression, heat exchangers, and refrigerant and would be configured for the intended application conditions. Compliance with all four standard rating heating conditions and metrics does not make sense and is not practical, but the Table 6.8.1-16 and ASHRAE/IES 90.1-2019 is not clear as to what compliance requirements are for the multiple heating rating conditions and metrics. The original intent of the table was not to require compliance with all four heating *efficiency* requirements but was not clarified in the standard or table footnotes.

Also, for the air source products the standard and Table 6.8.1-16 is not clear regarding the air source heat pump requirements for compliance with the 47 °F and 17 °F heating rating conditions. The intent was that compliance with both 47 °F and 17 °F is required. This is similar to air source heat pumps covered in Table 6.8.1-2.

An official interpretation, IC 90.1-2019-1, was approved on June, 1 2019 to clarify the compliance with the minimum *efficiency* requirements for the heating rating conditions of 105 °F, 120 °F, 140 °F, and 140 °F boost as well as the air cooled source temperature heating rating conditions.. The official interpretation clarified that only compliance with one rating condition and *efficiency* are required. It also clarified that both the 47 °F and 17 °F source temperature *efficiency* requirements must be complied with.

The following is the official interpretation responses.

Interpretation No.1: For heat pumps the 4 heating rating conditions of 105 °F, 120 °F, 140 °F, and 140 °F boost, only compliance with one rating condition and *efficiency* are required. The cooling requirement must be met.

Question No.1: Is this interpretation correct?

Answer No.1: Yes

Interpretation No.2: For air-source products there is a rating and *efficiency* metric at 47 °F and 17 °F ambient source temperatures. Compliance with both heating efficiencies is required. The cooling requirement must be met.

Question No.2: Is this interpretation correct?

Answer No.2: Yes

Change Group 2 - Air Source Heat Pump 17 °F rating *efficiency* requirements

In the table for air source heat pumps there is a 47 °F rating and a 17 °F rating. Both *efficiency* ratings were instantaneous *efficiency* ratings and did not include the impact of defrost which is typically referred to as degradation. The table is not clear if the metrics are instantaneous or degraded with the impact of defrost. The typical rating approach and the requirements of AHRI 550/590 is that the ratings include the impact of defrost. Typically, there is no defrosting that is needed at 47 °F but at 17 °F defrost does occur. To be consistent with other *efficiency* requirements for heat pumps, as part of this addendum we will adjust the instantaneous *efficiency* of the 17 °F minimum *efficiency* by -9% which is the typical degradation for air source heat pumps operating at 17 °F

Change Group 3 – New AHRI 550/590 and AHRI 551/591 Standard

A noted AHRI has updated the chiller standard AHRI 550/590 (IP) and AHRI 551/591 (SI) from the 2018 version to the 2020 version. This involved some changes to the rating table 1 rating conditions which are now documented in the 2020 version table 4. This requires adjustment to the table 6.8.1-16 which will be included in this addendum.

Change Group 4 - Miscellaneous Other Changes

In the original table development the cooling efficiencies were reduced by 5% to account for use of additional hardware for heating operation including accumulators, 4-way valves and for compressors and heat exchanger and compressor optimized for heating operation. For the power per capacity metrics (kW/ton) the *efficiency* were first converted to Btu/W-h and then decreased by 5% and then converted back to kW/ton. There are some conversion errors so these are being corrected by this addendum

Also in the table as part of an ISC change, cooling efficiencies were added, but for air cooled chillers the <150 ton and ≥150 ton rows have different cooling *efficiency* so this needs to be clarified in the table. The heating efficiencies for the two categories are the same.

There also are some italics that were missed in the publication and these will be corrected. In addition some notes are being updated to clarify the requirements for the heating performance.

To allow for use of other source fluids the reference to water cooled is being changed to fluid cooled. This was partially done in section 6.4.1.2.2 but not consistently in the table and requirements of chapter 6.

Cost Effectiveness

This addendum is just making editorial and requirement clarification corrections to the table 6.8.1-16, so cost effectiveness is not impacted.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum y to 90.1-2019

Update the reference in the IP Standard

AHRI 550/590-2018~~2020~~ Performance Rating of Water-Chilling and Heat-Pump Water Heating Packages Using the Vapor Compression Cycle

Update the reference in the SI Standard

AHRI 551/591-2018~~2020~~ Performance Rating of Water-Chilling and Heat-Pump Water Heating Packages Using the Vapor Compression Cycle

Make the following changes to the IP table 6.8.1-16

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements

Equipment Type	Size Category ton _r	Cooling-only Operation Cooling Efficiency ^{a,d,e,i} Air Source (EER (FL/PLV-IPLV), Btu/W-h Water Fluid-Source Power Input per Capacity (FL/IPLV) kW/ton _r)		Heating Operation Efficiency ^{e,s,j}												Test Procedure								
				Heat Pump Heating Full Load Heating Efficiency ^{g,h,i} (COP _h COP _h) ^{b,1h} , W/W				Heat Recovery Chiller Full-Load Efficiency (COP _{HR}) ^{b,c,r} , W/W				Heat Recovery Heating Full-Load Efficiency (COP _{HR}) ^{b,c,j} , W/W												
				Entering/Leaving Heating Water Fluid Temperature				Simultaneous Cooling and Heating Full-Load Efficiency ^{g,h,i} (COP _{SHC} COP _{SHC}) ^{b,l} , W/W				Entering/Leaving Heating Water Fluid Temperature												
				Path A		Path B		Low		Medium		High		Boost			Low		Medium		Hot Water 1		Hot Water 2	
				95°F/105°F		105°F/120°F		120°F/140°F		120°F/140°F		95°F/105°F		105°F/120°F			120°F/140°F		95°F/105°F		105°F/120°F		90°F/140°F	
Air_Source	All sizes <150	≥9.595 FL ≥13.02 IPLV-IP IPLV-IP	≥9.215 FL ≥15.01 IPLV-IP IPLV-IP	47 db 43 wb ⁴	≥3.290	≥2.770	≥2.310	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	AHRI 550/590				
				17 db 15 wb ⁴	≥2.230 2.029	≥1.950 1.775	≥1.630 1.483	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA					
	≥150	≥9.595 FL ≥13.30 IPLV-IP IPLV-IP	≥9.215 FL ≥15.30 IPLV-IP IPLV-IP	47 db 43 wb ^d	≥3.290	≥2.770	≥2.310	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA			
				17 db 15 wb ^d	≥2.029	≥1.775	≥1.483	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA			
Water Fluid-Source electrically operated positive displacement	< 75	≤0.7885 FL ≤0.6316 IPLV-IP IPLV-IP	≤0.7875 FL ≤0.5145 IPLV-IP IPLV-IP	54/44 ^{ek}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	NA	NA	NA	AHRI 550/590				
				75/65 ^{ek}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	NA	NA	NA					
	≥75 and <150	≤0.7579 FL ≤0.5895 IPLV-IP IPLV-IP	≤0.7140 FL ≤0.4620 IPLV-IP IPLV-IP	54/44 ^{ek}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	NA	NA	NA		NA			
				75/65 ^{ek}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	NA	NA	NA					
	≥150 and <300	≤0.6947 FL ≤0.5684 IPLV-IP IPLV-IP	≤0.7140 FL ≤0.4620 IPLV-IP IPLV-IP	54/44 ^{ek}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	NA	NA	NA		NA			
				75/65 ^{ek}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	NA	NA	NA					
	≥300 and <600	≤0.6421 FL ≤0.5474 IPLV-IP IPLV-IP	≤0.6563 FL ≤0.4305 IPLV-IP IPLV-IP	54/44 ^{ek}	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	NA	≥8.900	≥6.980	≥5.500	≥5.000	NA	NA	NA		NA			
				75/65 ^{ek}	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	NA	NA	NA					
≥600	≤0.5895 FL ≤0.5263 IPLV-IP IPLV-IP	≤0.6143 FL ≤0.3990 IPLV-IP IPLV-IP	54/44 ^{ek}	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	NA	≥8.900	≥6.980	≥5.500	≥5.000	NA	NA	NA	NA					
			75/65 ^{ek}	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	NA	NA	NA						

- a. Cooling only rating conditions are standard rating conditions defined in AHRI 550/590 Table 44, except for fluid-cooled centrifugal chillers which can adjust cooling efficiency for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 44 and includes the impact of defrost for air source heating ratings
- c. For water cooled fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- d. For cooling operation compliance with both the FL and IPLV is required, but only compliance with Path A or Path B cooling efficiency is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating efficiency is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- g. For air-source heat pumps compliance with both the 47°F and 17°F heating source outdoor air temperature (OAT) rating efficiency is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- dl. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- em. Source-water entering and-leaving water fluid temperature

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum Efficiency Requirements (continued)

Equipment Type	Size Category	Cooling-only Operation Cooling Efficiency $Efficiency_{d,e,i}$ Air Source (EER (FL/IPLV/IPLV), Btu/W-h Water Fluid-Source Power Input per Capacity (FL/IPLV) kW/ton _r		Heating Operation Efficiency $Efficiency_{e,j}$												Test Procedure	
				Heating Source Conditions (Entering/leaving water fluid) or OAT (db/wb) $_{em}$ °F	Heat Pump Heating Full Load Heating Efficiency $Efficiency_{e,j}$ (COP_H COP_H) ^{b,d,h} , W/W				Heat Recovery Chiller Full-Load Efficiency (COP_{HR}) ^{b,e,i} , W/W				Heat Recovery Heating Full-Load Efficiency (COP_{SHC}) ^{b,c,j} , W/W				
					Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Fluid Temperature				
					Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1		Hot Water 2
					95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	90°F/140°F		120°F/140°F
Water Fluid-source electrically operated centrifugal	< 75	≤0.6421 FL ≤0.5789 IPLV-IP IPLV-IP	≤0.7316 FL ≤0.4632 IPLV-IP-IPLV-IP	54/44 ^{el}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	AHRI 550/590
				75/65 ^{el}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥75 and <150	≤0.5895 FL ≤0.5474 IPLV-IP IPLV-IP	≤0.6684 FL ≤0.4211 IPLV-IP-IPLV-IP	54/44 ^{el}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
				75/65 ^{el}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥150 and <300	≤0.5895 FL ≤0.5263 IPLV-IP IPLV-IP	≤0.6263 FL ≤0.4105 IPLV-IP-IPLV-IP	54/44 ^{el}	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
				75/65 ^{el}	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥300 and <600	≤0.5895 FL ≤0.5263 IPLV-IP IPLV-IP	≤0.6158 FL ≤0.4000 IPLV-IP-IPLV-IP	54/44 ^{el}	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	≥NA	≥8.900	≥6.980	≥5.500	≥5.000	
				75/65 ^{el}	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	
	≥600	≤0.5895 FL ≤0.5263 IPLV-IP IPLV-IP	≤0.6158 FL ≤0.4000 IPLV-IP-IPLV-IP	54/44 ^{el}	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	NA	≥8.900	≥6.980	≥5.500	≥5.000	
				75/65 ^{el}	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	

- a. Cooling only rating conditions are standard rating conditions defined in AHRI 550/590 Table 44, except for fluid-cooled centrifugal chillers which can adjust cooling efficiency for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 44 and includes the impact of defrost for air source heating ratings

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- c. For ~~water cooled~~ fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the ~~COP_{HR}~~ COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of ~~Table 6.8.1-3~~
- d. For cooling operation compliance with both the FL and IPLV is required, but only compliance with path A or Path B cooling *efficiency* is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating *efficiency* is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- g. For air-source heat pumps compliance with both the 47°F and 17°F heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- dl. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- em. ~~Source-water entering and-leaving water~~ fluid temperature

Make the following changes to the SI table 6.8.1-16

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements

Equipment Type	Size Category kW	Cooling-only Operation Cooling Efficiency ^{a,d,e,i} (Air Source COP, FL/IPLV/IPLV-W/W) Water Fluid-Source Power Input per Capacity (FL-IPLV/IPLV) W/W		Heating Operation Efficiency ^{e,j}														Test Procedure
				Heating Source Conditions (Entering/leaving water fluid) or OAT (db/wb) ΔT °C	Heat Pump Heating Full Load Heating Efficiency ^e (COP_H) ^{b,i,h} , W/W				Heat Recovery Chiller Full-Load Efficiency (COP_{HR}) ^{b,c,r} , W/W				Heat Recovery Heating Full-Load Efficiency (COP_{HR}) ^{b,c,r} , W/W					
					Simultaneous Cooling and Heating Full-Load Efficiency ^e (COP_{SHC}) ^{b,d} , W/W				Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Fluid Temperature					
					Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Fluid Temperature					
					Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1	Hot Water 2		
35°C/40°C	42°C/50°C	50°C/60°C	50°C/60°C	35°C/40°C	42°C/50°C	50°C/60°C	50°C/60°C	35°C/40°C	42°C/50°C	32°C/60°C	50°C/60°C							
Air-Source	All-sizes <150	All-sizes <528 kW	≥2.836 FL ≥3.846 IPLV-SH/IPLV-SI	8.0 db ^d 6.0 wb	≥3.250	≥2.720	≥3.330	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	AHRI 551/591
				-8.0 db ^d -9.0 wb	≥2.250 2.048	≥1.920 1.747	≥1.640 1.492	NA	NA	NA	NA	NA	NA	NA	NA	NA		
	≥150	≥528 kW	≥2.836 FL ≥3.930 IPLV-SH/IPLV-SI	8.0 db ^d 6.0 wb	≥3.250	≥2.720	≥3.330	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
				-8.0 db ^d -9.0 wb	≥2.048	≥1.747	≥1.492	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Water Fluid-Source electrically operated positive displacement	< 75	< 264	≥4.659 4.459 FL ≥5.574 IPLV-SH/IPLV-SI	4.2/7 ^{e,l}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	AHRI 551/591	
				24/19 ^{e,l}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA		
	≥75 and <150	≥264 and <528	≥4.645 FL ≥5.972 IPLV-SH/IPLV-SI	4.2/7 ^{e,l}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390		
				24/19 ^{e,l}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA		
	≥150 and <300	≥528 and <1055	≥5.067 FL ≥6.193 IPLV-SH/IPLV-SI	4.2/7 ^{e,l}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390		
				24/19 ^{e,l}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA		
	≥300 and <600	≥1055 and <2110	≥5.482 FL ≥6.432 IPLV-SH/IPLV-SI	4.2/7 ^{e,l}	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960		
				24/19 ^{e,k}	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA		
≥600	≥2110	≥5.072 5.972 FL ≥6.689 IPLV-SH/IPLV-SI	4.2/7 ^{e,l}	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960			
			24/19 ^{e,l}	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA			

- Cooling only rating conditions are standard rating conditions defined in AHRI 550/590 Table 44, except for fluid-cooled centrifugal chillers which can adjust cooling efficiency for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 44 and includes the impact of defrost for air source heating ratings
- For water cooled fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- For cooling operation compliance with both the FL and IPLV is required, but only compliance with path A or Path B cooling efficiency is required.
- For units that operate in both cooling and heating compliance with both the cooling and heating efficiency is required.
- For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- For air-source heat pumps compliance with both the 8°C and -8°C heating source outdoor air temperature (OAT) rating efficiency is required for heating.
- For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.

- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- dl. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- em. Source–water entering and leaving water fluid temperature

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements (*continued*)

Equipment Type	Size Category kW/kW	Cooling-only Operation Cooling Efficiency $Efficiency_{a,d,e,j}$ (Air Source COP, FL/PLV/IPLV-W/W) Water Fluid-Source Power Input per Capacity (FL/PLV/IPLV) W/W		Heating Operation Efficiency $Efficiency_{c,d}$												Test Procedure					
				Heating Source Conditions (Entering/leaving water/fluid) or OAT (db/wb) t_{em} °C	Heat Pump Heating Full Load Heating Efficiency $Efficiency_{c,d}$ (COP_H / COP_H) ^{b,f,h} , W/W				Heat Recovery Chiller Full-Load Efficiency (COP_{HR}) ^{b,c,e} , W/W				Simultaneous Cooling and Heating Full-Load Efficiency (COP_{SHC} / COP_{SHC}) ^{b,d} , W/W				Heat Recovery Heating Full-Load Efficiency (COP_{HR}) ^{b,c} , W/W				
					Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Water Fluid Temperature				Entering/Leaving Heating Fluid Temperature								
					Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1		Hot Water 2				
				35°C/ 40°C	42°C/ 50°C	50°C/ 60°C	50°C/ 60°C	35°C/ 40°C	42°C/ 50°C	50°C/ 60°C	50°C/ 60°C	35°C/ 40°C	42°C/ 50°C	32°C/ 60°C	50°C/ 60°C						
Water Fluid-source electrically operated centrifugal	< 264	≥5.482 FL ≥6.081 IPLV-SH/PLV-SI	≥4.812 FL ≥7.601 IPLV-SH/PLV-SI	12/7 ^{el}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	AHRI 551/591				
				24/19 ^{el}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA					
	≥264 and <528	≥5.482 FL ≥6.081 IPLV-SH/PLV-SI	≥5.267 FL ≥6.364 8.361 IPLV-SH/PLV-SI	12/7 ^{el}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390					
				24/19 ^{el}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA					
	≥528 and <1055	≥5.972 FL ≥6.432 IPLV-SH/PLV-SI	≥5.621 FL ≥8.567 8.576 IPLV-SH/PLV-SI	12/7 ^{el}	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390					
				24/19 ^{el}	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA					
	≥1055 and <2110	≥5.972 FL ≥6.689 IPLV-SH/PLV-SI	≥5.717 FL ≥8.801 IPLV-SH/PLV-SI	12/7 ^{el}	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960					
				24/19 ^{ek}	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA					
≥2110	≥5.972 FL ≥6.689 IPLV-SH/PLV-SI	≥5.717 FL ≥8.801 IPLV-SH/PLV-SI	12/7 ^{el}	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960						
			24/19 ^{el}	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA						

- a. Cooling only rating conditions are standard rating conditions defined in AHRI 550/590 Table 44, except for fluid-cooled centrifugal chillers which can adjust cooling efficiency for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 44 and includes the impact of defrost for air source heating ratings
- c. For water cooled fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- d. For cooling operation compliance with both the FL and IPLV is required, but only compliance with path A or Path B cooling efficiency is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating efficiency is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- g. For air-source heat pumps compliance with both the 8°C and -8°C heating source outdoor air temperature (OAT) rating efficiency is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.

- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
 dl. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
 em. Source-water-entering and-leaving water fluid temperature

REFERENCE ONLY: No other addenda have been released that is impacting table 6.8.1-16. Shown below is a clean version incorporating the changes above.

Make the following changes to the IP Table 6.8.1-16

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements

Equipment Type	Size Category ton _R	Cooling Operation <i>Efficiency</i> ^{a,d,e,j}		Heating Operation <i>Efficiency</i> ^{e,j}												Test Procedure	
		Air Source (EER (FL/IPLV), Btu/W-h)		Heating Source Conditions (leaving fluid) or OAT (db/wb) ^{g,m} °F	Heat Pump Heating Full Load Heating <i>Efficiency</i> (<i>COP_H</i>) ^{b,f,h} , W/W				Simultaneous Cooling and Heating Full-Load <i>Efficiency</i> (<i>COP_{SHC}</i>) ^{b,i} , W/W				Heat Recovery Heating Full-Load <i>Efficiency</i> (<i>COP_{HR}</i>) ^{b,c,j} , W/W				
		Fluid-Source Power Input per Capacity (FL/IPLV) kW/ton _R			Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				
		Path A	Path B		Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1		Hot Water 2
		95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	90°F/140°F	120°F/140°F				
Air-Source	<150	≥9.595 FL ≥13.02 IPLV.IP	≥9.215 FL ≥15.01 IPLV.IP	47 db 43 wb ^{di}	≥3.290	≥2.770	≥2.310	NA	NA	NA	NA	NA	NA	NA	NA	NA	AHRI 550/590
				17 db 15 wb ^{di}	≥2.029	≥1.775	≥1.483	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	≥150	≥9.595 FL ≥13.30 IPLV.IP	≥9.215 FL ≥15.30 IPLV.IP	47 db 43 wb ^d	≥3.290	≥2.770	≥2.310	NA	NA	NA	NA	NA	NA	NA	NA	NA	
				17 db 15 wb ^d	≥2.029	≥1.775	≥1.483	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Fluid-Source electrically operated positive displacement	< 75	≤0.7895 FL ≤0.6316 IPLV.IP	≤0.8211 FL ≤0.5263 IPLV.IP	44 ^k	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	AHRI 550/590
				65 ^k	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥75 and <150	≤0.7579 FL ≤0.5895 IPLV.IP	≤0.7895 FL ≤0.5158 IPLV.IP	44 ^k	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
				65 ^k	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥150 and <300	≤0.6947 FL ≤0.5684 IPLV.IP	≤0.7158 FL ≤0.4632 IPLV.IP	44 ^k	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
				65 ^k	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥300 and <600	≤0.6421 FL ≤0.5474 IPLV.IP	≤0.6579 FL ≤0.4316 IPLV.IP	44 ^k	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	NA	≥8.900	≥6.980	≥5.500	≥5.000	
				65 ^k	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	
	≥600	≤0.5895 FL ≤0.5263 IPLV.IP	≤0.6158 FL ≤0.4000 IPLV.IP	44 ^k	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	A	≥8.900	≥6.980	≥5.500	≥5.000	
				65 ^k	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	

- a. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 Table 4, except for fluid-cooled centrifugal chillers which can adjust cooling *efficiency* for nonstandard rating conditions using *K_{adj}* procedure in accordance with Section 6.4.1.2.1
 b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 4 and includes the impact of defrost for air source heating ratings

- c. For fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- d. For cooling operation compliance with both the FL and $IPLV$ is required, but only compliance with path A or Path B cooling *efficiency* is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating *efficiency* is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- g. For air-source heat pumps compliance with both the 47°F and 17°F heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- l. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- m. Source-leaving fluid temperature

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements (*continued*)

Equipment Type	Size Category ton _r	Cooling Operation <i>Efficiency</i> ^{a,d,e,j}		Heating Operation <i>Efficiency</i> ^{e,j}												Test Procedure	
		Air Source (EER FL/IPLV), Btu/W-h		Heating Source Conditions (leaving water) or OAT (db/wb) ^{g,m} °F	Heat Pump Heating Full Load Heating <i>Efficiency</i> (COP_H) ^{b,h} , W/W				Simultaneous Cooling and Heating Full-Load <i>Efficiency</i> (COP_{SHC}) ^{b,h} , W/W				Heat Recovery Heating Full-Load <i>Efficiency</i> (COP_{HR}) ^{b,c,j} , W/W				
		Fluid-Source Power Input per Capacity (FL/IPLV) kW/ton _r			Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				
		Path A	Path B		Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1		Hot Water 2
		95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	120°F/140°F	120°F/140°F	95°F/105°F	105°F/120°F	90°F/140°F	120°F/140°F				
Fluid-source electrically operated centrifugal	< 75	≤0.6421 FL	≤0.7316 FL	44 ¹	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	AHRI 550/590
		≤0.5789 <i>IPLV</i> .IP	≤0.4632 <i>IPLV</i> .IP	65 ¹	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥75 and <150	≤0.5895 FL	≤0.6684 FL	44 ⁴	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
		≤0.5474 <i>IPLV</i> .IP	≤0.4211 <i>IPLV</i> .IP	65 ¹	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥150 and <300	≤0.5895 FL	≤0.6263 FL	44 ⁴	≥4.640	≥3.680	≥2.680	NA	≥8.330	≥6.410	≥4.420	NA	≥8.330	≥6.410	≥4.862	≥4.420	
		≤0.5263 <i>IPLV</i> .IP	≤0.4105 <i>IPLV</i> .IP	65 ¹	NA	NA	NA	≥3.550	NA	NA	NA	≥6.150	NA	NA	NA	NA	
	≥300 and <600	≤0.5895 FL	≤0.6158 FL	44 ⁴	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	≥NA	≥8.900	≥6.980	≥5.500	≥5.000	
		≤0.5263 <i>IPLV</i> .IP	≤0.4000 <i>IPLV</i> .IP	65 ¹	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	
	≥600	≤0.5895 FL	≤0.6158 FL	44 ⁴	≥4.930	≥3.960	≥2.970	NA	≥8.900	≥6.980	≥5.000	NA	≥8.900	≥6.980	≥5.500	≥5.000	
		≤0.5263 <i>IPLV</i> .IP	≤0.4000 <i>IPLV</i> .IP	65 ¹	NA	NA	NA	≥3.900	NA	NA	NA	≥6.850	NA	NA	NA	NA	

- a. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 Table 4, except for fluid-cooled centrifugal chillers which can adjust cooling *efficiency* for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 4 and includes the impact of defrost for air source heating ratings
- c. For fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- d. For cooling operation compliance with both the FL and $IPLV$ is required, but only compliance with path A or Path B cooling *efficiency* is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating *efficiency* is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.

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- g. For air-source heat pumps compliance with both the 47°F and 17°F heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 550/590 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- l. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- m. Source-leaving fluid temperature

Make the following changes to the SI Table 6.8.1-16

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements

Equipment Type	Size Category kW	Cooling-Operation <i>Efficiency</i> ^{a,d,e,j} (Air Source COP, FL/ <i>IPLV</i> - W/W) Fluid-Source Power Input per Capacity (FL/ <i>IPLV</i>) W/W		Heating Operation <i>Efficiency</i> ^{e,j}													Test Procedure
				Heating Source Conditions (leaving water) or OAT (db/wb) ^{g,m} °C	Heat Pump Heating Full Load Heating <i>Efficiency</i> (<i>COP_H</i>) ^{b,f,h} , W/W				Simultaneous Cooling and Heating Full-Load <i>Efficiency</i> (<i>COP_{SHC}</i>) ^{b,i} , W/W				Heat Recovery Heating Full-Load <i>Efficiency</i> (<i>COP_{HR}</i>) ^{b,c} , W/W				
					Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature				
					Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium	Hot Water 1	Hot Water 2	
				35°C/40°C	42°C/50°C	50°C/60°C	50°C/60°C	35°C/40°C	42°C/50°C	50°C/60°C	50°C/60°C	35°C/40°C	42°C/50°C	32°C/60°C	50°C/60°C		
Air-Source	<150	<528 kW	≥2.836 FL ≥3.846 <i>IPLV</i> .SI	8.0 db ^h 6.0 wb	≥3.250	≥2.720	≥3.330	NA	NA	NA	NA	NA	NA	NA	NA	NA	AHRI 551/591
				-8.0 db ^h -9.0 wb	≥2.048	≥1.747	≥1.492	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	≥150	≥528 kW	≥2.836 FL ≥3.930 <i>IPLV</i> .SI	8.0 db ^d 6.0 wb	≥3.250	≥2.720	≥3.330	NA	NA	NA	NA	NA	NA	NA	NA	NA	
				-8.0 db ^d -9.0 wb	≥2.048	≥1.747	≥1.492	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Fluid-Source electrically operated positive displacement	< 75	< 264	≥4.459 FL ≥5.574 <i>IPLV</i> .SI	7 ^d	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	AHRI 551/591
				19 ^d	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA	
	≥75 and <150	≥264 and <528	≥4.645 FL ≥5.972 <i>IPLV</i> .SI	7 ^d	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	
				19 ^d	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA	
	≥150 and <300	≥528 and <1055	≥5.067 FL ≥6.193 <i>IPLV</i> .SI	7 ^d	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	
				19 ^d	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA	
	≥300 and <600	≥1055 and <2110	≥5.482 FL ≥6.432 <i>IPLV</i> .SI	7 ^d	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960	
				19 ^d	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA	
	≥600	≥2110	≥5.972 FL ≥6.689 <i>IPLV</i> .SI	7 ^d	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960	
				19 ^d	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA	

- Cooling rating conditions are standard rating conditions defined in AHRI 550/590 Table 4, except for fluid-cooled centrifugal chillers which can adjust cooling *efficiency* for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 4 and includes the impact of defrost for air source heating ratings
- For fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- For cooling operation compliance with both the FL and *IPLV* is required, but only compliance with path A or Path B cooling *efficiency* is required.
- For units that operate in both cooling and heating compliance with both the cooling and heating *efficiency* is required.
- For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- For air-source heat pumps compliance with both the 8°C and -8°C heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
- For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.

- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- l. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- m. Source-leaving fluid temperature

Table 6.8.1-16 Heat Pump and Heat Recovery Chiller Packages – Minimum *Efficiency* Requirements (*continued*)

Equipment Type	Size Category <i>kW</i>	Cooling Operation <i>Efficiency</i> ^{a,d,e,j} (Air Source COP, FL/IPLV- W/W) Fluid-Source Power Input per Capacity (FL/IPLV) W/W		Heating Operation <i>Efficiency</i> ^{c,i}												Test Procedure				
				Heat Pump Heating Full Load Heating <i>Efficiency</i> (COP_H) ^{b,f,h} , W/W				Simultaneous Cooling and Heating Full-Load <i>Efficiency</i> (COP_{SHC}) ^{b,i} , W/W				Heat Recovery Heating Full-Load <i>Efficiency</i> (COP_{HR}) ^{b,c} , W/W								
				Heating Source Conditions (leaving water) or OAT (db/wb) ^{g,m} °C				Entering/Leaving Heating Fluid Temperature				Entering/Leaving Heating Fluid Temperature					Entering/Leaving Heating Fluid Temperature			
				Path A	Path B	Low	Medium	High	Boost	Low	Medium	High	Boost	Low	Medium		Hot Water 1	Hot Water 2		
Fluid-source electrically operated centrifugal	< 264	≥5.482 FL ≥6.081 IPLV.SI	≥4.812 FL ≥7.601 IPLV.SI	7 ^l	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390	AHRI 551/591			
				19 ^l	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA				
	≥264 and <528	≥5.482 FL ≥6.081 IPLV.SI	≥5.267 FL ≥8.361 IPLV.SI	7 ^l	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390				
				19 ^l	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA				
	≥528 and <1055	≥5.972 FL ≥6.432 IPLV.SI	≥5.621 FL ≥8.576 IPLV.SI	7 ^l	≥4.760	≥3.610	≥2.660	NA	≥8.550	≥6.290	≥4.390	NA	≥8.550	≥6.290	≥4.829	≥4.390				
				19 ^l	NA	NA	NA	≥3.530	NA	NA	NA	≥6.100	NA	NA	NA	NA				
	≥1055 and <2110	≥5.972 FL ≥6.689 IPLV.SI	≥5.717 FL ≥8.801 IPLV.SI	7 ^l	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960				
				19 ^l	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA				
	≥2110	≥5.972 FL ≥6.689 IPLV.SI	≥5.717 FL ≥8.801 IPLV.SI	7 ^l	≥5.060	≥3.880	≥2.950	NA	≥9.140	≥6.850	≥4.960	NA	≥9.140	≥6.850	≥5.456	≥4.960				
				19 ^l	NA	NA	NA	≥3.870	NA	NA	NA	≥6.800	NA	NA	NA	NA				

- a. Cooling rating conditions are standard rating conditions defined in AHRI 550/590 Table 4, except for fluid-cooled centrifugal chillers which can adjust cooling *efficiency* for nonstandard rating conditions using K_{adj} procedure in accordance with Section 6.4.1.2.1
- b. Heating Full Load Rating conditions are at standard rating conditions defined in AHRI 550/590 Table 4 and includes the impact of defrost for air source heating ratings
- c. For fluid-source heat recovery chillers that have capabilities for heat rejection to a heat recovery condenser and a tower condenser the COP_{HR} applies to operation at full load with 100% heat recovery (no tower rejection). Units that only have capabilities for partial heat recovery shall meet the requirements of Table 6.8.1-3
- d. For cooling operation compliance with both the FL and IPLV is required, but only compliance with path A or Path B cooling *efficiency* is required.
- e. For units that operate in both cooling and heating compliance with both the cooling and heating *efficiency* is required.
- f. For applications where the equipment is installed to operate only in heating compliance only with the heating performance COP_H is required at standard rating conditions. Compliance with cooling performance is not required.
- g. For air-source heat pumps compliance with both the 8°C and -8°C heating source *outdoor air* temperature (OAT) rating *efficiency* is required for heating.
- h. For Heat Pump chillers applications where the cooling capacity is not being used for conditioning, compliance with the heating performance COP_H is required at only one of the heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling performance is required as defined in footnote a and d.
- i. For simultaneous cooling and heating chillers applications where there is simultaneous cooling and heating, compliance with the simultaneous cooling performance heat recovery COP_{SHC} at only one of the simultaneous cooling and heating AHRI 551/591 standard ratings conditions of Low, Medium, High, Boost. Compliance with the cooling only performance is required as defined in footnote a and d.
- j. For heat recovery heating chillers applications where there is simultaneous cooling and heating, compliance with the heating performance heat recovery COP_{HR} is required at only one of the heating AHRI 550/590 standard ratings conditions of Low, Medium, Hot Water 1 and Hot Water 2. Compliance with the cooling only performance is required as defined in footnote a and d.
- k. Chillers employing a freeze-protection fluid in accordance with Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table
- l. Outdoor air entering dry bulb (db) temperature and wet bulb (wb) temperature
- m. Source-leaving fluid temperature