



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

Public Review Draft

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

**Second Public Review (May 2021)
(Draft Shows Proposed Independent Substantive
Changes to Previous Public Review Draft)**

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FOREWORD

This 2nd public review ISC has been developed to make some phrasing and editorial changes to Addendum X which was circulated for comments in late 2020 and closed on 1/4/2021. There were some proposed wording and editorial changes that are being made to improve the readability and requirements.

In addition some additional changes have been requested by the SSPC 90.1 including elimination of the Kadj example as it is now felt example do not belong in the standard and should be in the User's Manual which is the case for Kadj. There is also a Kadj spreadsheet tool that is available for users of the standard.

The original scope of the addendum was to make some changes to the Kadj for centrifugal chillers and to expand the requirements for compliance for chillers with freeze project fluids/liquids. For details on these refer to the original first public review addendum.

One change, that was proposed in one of the comments from the first public review, is to change the word "fluid" used to describe the heat transfer substance that is used in condensers and evaporators to "liquid". The word "fluid" has been used in ASHRAE 90.1 since the 2004 version. But "fluid" is too general because it also could include air or any gas. Thus, it overlaps with and would technically also include "air-cooled" chillers, which was not the intent as air-cooled is separately covered in the requirements. Note that ASHRAE Standard 184-2016 refers to liquid-cooled, evaporatively-cooled, and air-cooled as the types of heat rejection in a refrigerant condenser (see Table 5-1). Also note that the title of ASHRAE Standard 30 is "Method of Testing Liquid Chillers". To be consistent, we will also include this change although in many cases the text was not open for comment as part of addendum X.

Note that this same issue exists in the reference rating standard AHRI 550/590-2020 and AHRI 551/591-2020. Therefore, AHRI will also need to update their standards.

[*Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (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.] Note that this is an ISC so only the changes made to the first public review are shown as changed text.*

Addendum x to 90.1-2019

Make the following changes in Section 3.2 Definitions (I-P):

...

integrated part-load value (IPLV.~~I-P~~IP): a single-number figure of merit based on part-load *EER*, *COP_C*, or *kW/kW* expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the *equipment*.

...

nonstandard part-load value (NPLV.IP): a single-number part-load *efficiency* figure of merit calculated and referenced to conditions other than *IPLV.I-P* conditions, for units that are not designed to operate at AHRI standard rating conditions.

...

Make the following changes in Section 3.3 Abbreviations and Acronyms (I-P):

...

~~IPLV.~~I-P~~IP~~ *integrated part-load value*

...

NPLV.IP *nonstandard part-load value*

...

Make the following changes in section 6.4.1.1(I-P):

c. Table 6.8.1-3, “~~Fluid~~Liquid-Chilling Packages—Minimum *Efficiency* Requirements” (See Section 6.4.1.2 for ~~fluid~~liquid-cooled centrifugal ~~fluid~~liquid-chilling packages that are designed to operate at nonstandard conditions.)

Make the following revisions to 6.4.1.2 (IP):

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 ~~Fluid~~Liquid-Cooled Centrifugal Chilling Packages Cooling *Efficiency* Adjustment ~~Fluid~~Liquid-cooled centrifugal chiller packages ~~cooling efficiency requirements defined in table 6.8.1-3 and 6.8.1-16~~ not designed for cooling operation at AHRI Standard 550/590 test and rating conditions of 44.00°F leaving and 54.00°F entering chilled-~~fluid~~liquid temperatures, and with 85.00°F entering and 94.30°F leaving condenser-~~fluid~~liquid temperatures, shall have maximum full-load (FL) *kW/ton* and part-load cooling energy efficiency (IPLV.IP) rating requirements, listed in Table 6.8.1-3 and 6.8.1-16, adjusted using the following equations:

$$\del{FL}_{adj} = \del{FL} / K_{adj} \quad \underline{FL}_{IP,adj} = \underline{FL}_{IP} / K_{adj}$$

$$\del{PLV}_{adj} = \del{IPLV.IP} / K_{adj} \quad \underline{PLV}_{IP,adj} = \underline{IPLV.IP} / K_{adj}$$

$$\del{K}_{adj} = A \times B \quad \underline{K}_{adj} = A \times B$$

where

FLIP = full-load *kW/ton* value from Table 6.8.1-3 or 6.8.1-16

~~FL~~adjIPadj = maximum full-load *kW/ton* rating, adjusted for nonstandard conditions

IPLV.IP = *IPLV.IP* value from Table 6.8.1-3 or 6.8.1-16

PLVIPadjadj = maximum NPLV.IP rating, adjusted for nonstandard conditions

$$A = 0.00000014592 \times (\text{LIFT})^4 - 0.0000346496 \times (\text{LIFT})^3 + 0.00314196 \times (\text{LIFT})^2 - 0.147199 \times (\text{LIFT}) + 3.93073$$

$$B = 0.0015 \times \text{LvgEvap} + 0.934$$

$$\text{LIFT} = \text{LvgCond} - \text{LvgEvap}$$

LvgCond = full-load condenser leaving **fluidliquid** temperature (°F)

LvgEvap = full-load evaporator leaving **liquid** temperature (°F)

The FL_{adj} and $\text{PLV}_{\text{adj}}/\text{PLV.IP}_{\text{adj}}$ values are only applicable for centrifugal **chillerschilling packages** meeting all of the following full-load design ranges:

- $36.00^\circ\text{F} \leq \text{LvgEvap} \leq 70.00^\circ\text{F}$ and
- $60.00^\circ\text{F} \leq \text{LvgCond} \leq 135.00^\circ\text{F}$ and
- $20.00^\circ\text{F} \leq \text{LIFT} \leq 80.00^\circ\text{F}$ and

Manufacturers shall calculate the FL_{adj} and $\text{PLV}_{\text{adj}}/\text{PLV.IP}_{\text{adj}}$ before determining whether to label the chiller per Section 6.4.1.5. Compliance with 90.1-2007, 2010, 2013, 2016, 2019, 2022 or combinations thereof, shall be *labeled* on **chillerschilling packages** within the scope of the standard.

Centrifugal **chillerschilling packages** designed to operate outside of these ranges are not covered by this standard.

Example (Section 6.4.1.2.1)

Path A 600-ton centrifugal chiller Table 6.8.1-3:

~~$$\text{FL} = 0.5600 \text{ kW/ton}$$~~

~~$$\text{PLV.IP} = 0.5000 \text{ kW/ton}$$~~

~~$$\text{LvgCond} = 91.16^\circ\text{F}$$~~

~~$$\text{LvgEvap} = 42.00^\circ\text{F}$$~~

~~$$\text{LIFT} = 91.16 - 42 = 49.16^\circ\text{F}$$~~

~~$$A = 0.00000014592 \times (49.16)^4 - 0.0000346496 \times (49.16)^3 + 0.00314196 \times (49.16)^2 - 0.147199 \times (49.16) + 3.93073 = 1.02331$$~~

~~$$B = 0.0015 \times 42.00 + 0.934 = 0.99700$$~~

~~$$K_{\text{adj}} = 1.02331 \times 0.99700 = 1.02024$$~~

~~$$\text{FL}_{\text{adj}} = 0.5600 / 1.02024 = 0.5489 \text{ kW/ton}$$~~

~~$$\text{PLV}_{\text{adj}} = 0.5000 / 1.02024 = 0.4901 \text{ kW/ton}$$~~

6.4.1.2.2 Chiller Packages Employing Freeze Protection **FluidsLiquids**

Electrically operated **chillerschilling packages** that employ freeze protection **fluidsliquids** in any heat exchanger with an application cooling duty evaporator **fluidliquid** leaving temperature or heating operation source **fluidliquid** temperature above 32.00°F shall show *efficiency* compliance as per the applicable requirements in 6.4.1.2.2.1 to 6.4.1.2.2.4.

Absorption **chillerschilling packages** with freeze **projection protection fluidsliquids** are exempt from the *efficiency* requirements listed in Table 6.8.1-3 and only shall show compliance when applied with water.

6.4.1.2.2.1 – All electrically operated **cooling-only** air-cooled and electrically operated positive displacement **fluidliquid**-cooled **chillerschilling packages** shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-3 when applied within the operating limits of AHRI 550/590, at AHRI 550/590 standard rating conditions when tested or rated with water used as a heat transfer **fluidliquid**.

6.4.1.2.2.2 – All **fluidliquid**-cooled electrically operated **cooling-only** centrifugal **chillerschilling packages** shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-3 when applied within the operating limits defined in AHRI 550/590, at the application rating conditions for efficiencies adjusted using K_{adj} as defined in 6.4.1.2.1 when tested or rated with water used as a heat transfer **fluidliquid**.

6.4.1.2.2.3 – All electrically operated air-cooled source and electrical operated positive displacement fluid liquid-source heat pump and heat recovery chillers chilling packages shall show compliance with the cooling efficiency requirements listed in Table 6.8.1-16 when applied within the operating limits of AHRI 550/590 at AHRI 550/590 standard rating conditions when tested or rated with water used as a heat transfer fluid liquid. They also shall show compliance with one Table 6.8.1-16 heating efficiency requirements at one of the AHRI 550/590 standard heating rating conditions when tested or rated with water used as a heat transfer fluid liquid. Heating-only chillers chilling packages only have to show compliance Table 6.8.1-16 heating efficiency requirements at one of the AHRI 550/590 rating conditions shall meet the heating efficiency requirements at one of the AHRI 550/590 heating liquid temperature rating conditions and are not required to meet the cooling efficiency requirements of Table 6.8.1-16.

6.4.1.2.2.4 – All fluid liquid-source centrifugal heat pump and heat recovery chillers chilling packages shall show compliance with the cooling efficiency requirements listed in Table 6.8.1-16 when applied within the operating limits defined in AHRI 550/590 at the application rating conditions for cooling efficiencies efficiency adjusted using K_{adj} as defined in 6.4.1.2.1 when tested or rated with water. They also shall show compliance with heating efficiency requirements listed in Table 6.8.1-16 at one of the AHRI 550/590 standard rating conditions when tested or rated with water used as a heat transfer fluid liquid. Heating-only chillers chilling packages only have to show compliance Table 6.8.1-16 heating efficiency requirements at one of the AHRI 550/590 rating conditions shall meet the heating efficiency requirements at one of the AHRI 550/590 heating liquid temperature rating conditions and are not required to meet the cooling efficiency requirements of Table 6.8.1-16.

Make the following revisions to Table 6.8.1-3 (I-P):

Table 6.8.1-3 FluidLiquiD-Chilling Packages—Minimum Efficiency Requirements^{a,b,e,f}

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure ^c
Air-cooled chillers	<150 tons	EER (Btu/(W·h))	≥10.10 FL	≥9.700 FL	AHRI 550/590
	≥150 tons		≥13.70 IPLV.IP	≥15.80 IPLV.IP	
Air-cooled without condenser, electrically operated	<150 tons	EER (Btu/(W·h))	≥10.10 FL	≥9.700 FL	AHRI 550/590
	≥150 tons		≥14.00 IPLV.IP	≥16.10 IPLV.IP	
FluidLiquiD-cooled, electrically operated positive displacement	All capacities	kW/ton	Air-cooled chillers without condensers must be rated with matching condensers and comply with air-cooled chiller efficiency requirements		AHRI 550/590
	<75 tons		≤0.7500 FL	≤0.7800 FL	
	≥75 tons and <150 tons		≤0.6000 IPLV.IP	≤0.5000 IPLV.IP	
	≥150 tons and <300 tons		≤0.7200 FL	≤0.7500 FL	
	≥300 tons and <600 tons		≤0.5600 IPLV.IP	≤0.4900 IPLV.IP	
	≥600 tons		≤0.6600 FL	≤0.6800 FL	
FluidLiquiD-cooled, electrically operated centrifugal	<150 tons	kW/ton	≤0.6600 FL	≤0.6800 FL	AHRI 550/590
	≥150 tons and <300 tons		≤0.5400 IPLV.IP	≤0.4400 IPLV.IP	
	≥300 tons and <400 tons		≤0.6100 FL	≤0.6250 FL	
	≥400 tons and <600 tons		≤0.5200 IPLV.IP	≤0.4100 IPLV.IP	
	≥600 tons		≤0.5600 FL	≤0.5850 FL	
			≤0.5000 IPLV.IP	≤0.3800 IPLV.IP	
Air-cooled absorption, single effect	<150 tons	COP (W/W)	≤0.6100 FL	≤0.6950 FL	AHRI 560
	≥150 tons and <300 tons		≤0.5500 IPLV.IP	≤0.4400 IPLV.IP	
	≥300 tons and <400 tons		≤0.6100 FL	≤0.6350 FL	
	≥400 tons and <600 tons		≤0.5500 IPLV.IP	≤0.4000 IPLV.IP	
	≥600 tons		≤0.5600 FL	≤0.5950 FL	
			≤0.5200 IPLV.IP	≤0.3900 IPLV.IP	
FluidLiquiD-cooled absorption, single effect	<150 tons	COP (W/W)	≤0.5600 FL	≤0.5850 FL	AHRI 560
	≥150 tons and <300 tons		≤0.5000 IPLV.IP	≤0.3800 IPLV.IP	
	≥300 tons and <400 tons		≤0.5600 FL	≤0.5850 FL	
	≥400 tons and <600 tons		≤0.5000 IPLV.IP	≤0.3800 IPLV.IP	
	≥600 tons		≤0.5600 FL	≤0.5850 FL	
			≤0.5000 IPLV.IP	≤0.3800 IPLV.IP	
Absorption double effect, indirect fired	All capacities	COP (W/W)	≥0.6000 FL	NA ^d	AHRI 560
			≥1.000 FL	NA ^d	
Absorption double effect, direct fired	All capacities	COP (W/W)	≥0.7000 FL	NA ^d	AHRI 560
			≥1.050 IPLV.IP	NA ^d	
Absorption double effect, direct fired	All capacities	COP (W/W)	≥1.000 FL	NA ^d	AHRI 560
			≥1.000 IPLV.IP	NA ^d	

- The requirements for centrifugal chillerschilling packages shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed there. The requirements for air-cooled, fluidliquiD-cooled positive displacement and absorption chillerschilling packages are at standard rating conditions defined in the reference test procedure.
- Both the full-load and IPLV.IP requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.
- Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.
- FL is the full-load performance requirements, and IPLV.IP is for the part-load performance requirements.
- Electrically operated chillerschilling packages employing a freeze-protection fluidliquiD per Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table.

Make the following changes in Section 3.2 Definitions (SI):

...

integrated part-load value (IPLV.SI): a single-number figure of merit based on part-load *COPC* expressing part-load *efficiency* for air-conditioning and heat pump *equipment* on the basis of weighted operation at various load capacities for the *equipment*.

...

nonstandard part-load value (NPLV.SI): a single-number part-load *efficiency* figure of merit calculated and referenced to conditions other than *IPLV.SI* conditions, for units that are not designed to operate at AHRI standard rating conditions.

...

Make the following changes in Section 3.3 Abbreviations and Acronyms (SI):

...

IPLV.SI *integrated part-load value*

...

NPLV.SI *nonstandard part-load value*

...

Make the following changes in section 6.4.1.1(SI):

c. Table 6.8.1-3, “**FluidLiquid**-Chilling Packages—Minimum *Efficiency* Requirements” (See Section 6.4.1.2 for **fluidliquid**-cooled centrifugal **fluidliquid**-chilling packages that are designed to operate at nonstandard conditions.)

Make the following revisions to 6.4.1.2 (SI):

6.4.1.2.1 FluidLiquid-Cooled Centrifugal Chilling Packages Cooling Efficiency Adjustment **FluidLiquid**-cooled centrifugal **chiller packages cooling efficiency requirements defined in Table 6.8.1-3 and 6.8.1-16** not designed for cooling operation at AHRI Standard 551/591 test and rating conditions of 7.00°C leaving and 12.00°C entering chilled-**fluidliquid** temperatures, and with 30.00°C entering and 35.00°C leaving condenser-**fluidliquid** temperatures shall have maximum full-load (FL) *COP* and part-load *cooling energy efficiency (IPLV.SI)* rating requirements, listed in Table 6.8.1-3 and 6.8.1-16, adjusted using the following equations:

$$FL_{adj} = FL / K_{adj} \quad FL.SI_{adj} = FL.SI / K_{adj}$$

$$PLV_{adj} = IPLV.SI / K_{adj} \quad PLV.SI_{adj} = IPLV.SI / K_{adj}$$

$$K_{adj} = A \times B \quad K_{adj} = A \times B$$

where

- $FL.SI$ = full-load COP_R value from Table 6.8.1-3 or 6.8.1-16
- $FL_{adj}.SI_{adj}$ = minimum full-load COP_R rating, adjusted for nonstandard conditions
- $IPLV.SI$ = *IPLV.SI* value from Table 6.8.1-3 or 6.8.1-16
- $PLV_{adj}.SI_{adj}$ = minimum *NPLV.SI* rating, adjusted for nonstandard conditions
- A = $0.00000153181 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times LIFT + 3.93073$
- B = $0.0027 \times LvgEvap + 0.982$
- $LIFT$ = $LvgCond - LvgEvap$
- $LvgCond$ = full-load condenser leaving **fluidliquid** temperature (°C)
- $LvgEvap$ = full-load evaporator leaving **liquid** temperature (°C)

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal **chillers** chilling packages meeting all of the following full-load design ranges:

- $2.20^\circ\text{C} \leq LvgEvap \leq 21.10^\circ\text{C}$ and
- $15.56^\circ\text{C} \leq LvgCond \leq 57.00^\circ\text{C}$ and
- $11.00^\circ\text{C} \leq LIFT \leq 44.00^\circ\text{C}$

(1) The more restrictive map requirements of leaving evaporator, leaving condenser, or lift shall apply.

Manufacturers shall calculate the FL_{adj} and $PLV_{SI_{adj}}$ before determining whether to label the chiller per Section 6.4.1.5. Compliance with 90.1-2007, 2010, 2013, 2016, 2019, 2022 or combinations thereof, shall be labeled on ~~chillers~~chilling packages within the scope of the standard.

Centrifugal ~~chillers~~chilling packages designed to operate outside of these ranges are not covered by this standard.

Example (Section 6.4.1.2.1)

Path A 2110 kW centrifugal chiller Table 6.8.1-3:

$$\begin{aligned} FL &= 6.286 COP_R \\ IPLV_{SI} &= 7.041 COP_R \\ LvgCond &= 37.00^\circ C \\ LvgEvap &= 6.00^\circ C \\ LIFT &= 37.00 - 6.00 = 31.00^\circ C \\ A &= 0.00000153181 \times (31.00)^4 - 0.000202076 \times (31.00)^3 + 0.0101800 \times \\ &\quad (31.00)^2 - 0.264958 \times 31.00 + 3.93073 = 0.894625 \\ B &= 0.0027 \times 6.00 + 0.982 = 0.998200 \\ K_{adj} &= 0.894625 \times 0.998200 = 0.893014 \\ FL_{adj} &= 6.286 \times 0.893014 = 5.613 COP_R \\ PLV_{adj} &= 7.041 \times 0.893014 = 6.288 COP_R \end{aligned}$$

6.4.1.2.2 Chilling Packages Employing Freeze Protection ~~Fluids~~Liquids

Electrically operated ~~chillers~~chilling packages that employ freeze protection ~~fluids~~liquids in any heat exchanger with an application cooling duty evaporator ~~fluid~~liquid leaving temperature or heating operation source ~~fluid~~liquid temperature above 0.00°C shall show *efficiency* compliance as per the applicable requirements in 6.4.1.2.2.1 to 6.4.1.2.2.4.

Absorption ~~chillers~~chilling packages with freeze ~~projection~~protection ~~fluid~~liquid are exempt from the *efficiency* requirements listed in Table 6.8.1-3 and only shall show compliance when applied with water.

6.4.1.2.2.1 – All electrically operated cooling-only air-cooled and electrically operated positive displacement ~~fluid~~liquid-cooled ~~chillers~~chilling packages shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-3 when applied within the operating limits of AHRI 551/591, at AHRI 551/591 standard rating conditions when tested or rated with water used as a heat transfer ~~fluid~~liquid.

6.4.1.2.2.2 – All ~~fluid~~liquid cooled electrically operated cooling-only centrifugal ~~chillers~~chilling packages shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-3 when applied within the operating limits defined in AHRI 551/591, at the application rating conditions for efficiencies adjusted using K_{adj} as defined in 6.4.1.2.1 when tested or rated with water used as a heat transfer ~~fluid~~liquid.

6.4.1.2.2.3 – All electrically operated air ~~cooled~~source and electrical operated positive displacement ~~fluid~~liquid-source heat pump and heat recovery ~~chillers~~chilling packages shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-16 when applied within the operating limits of AHRI 551/591 at AHRI 551/591 standard rating conditions when tested or rated with water used as a heat transfer ~~fluid~~liquid. They also shall show compliance with one Table 6.8.1-16 heating *efficiency* requirements at one of the AHRI 551/591 standard heating rating conditions when tested or rated with water used as a heat transfer ~~fluid~~liquid. Heating-only ~~chillers~~chilling packages ~~only have to show compliance Table 6.8.1-16 heating efficiency requirements at one of the AHRI 551/591 rating conditions shall meet the heating efficiency requirements at one of the AHRI 551/591 heating liquid temperature rating conditions and are not required to meet the cooling efficiency requirements of Table 6.8.1-16.~~

6.4.1.2.2.4 – All ~~fluid~~liquid-source centrifugal heat pump and heat recovery ~~chillers~~chilling packages shall show compliance with the cooling *efficiency* requirements listed in Table 6.8.1-16 when applied within the operating limits defined in AHRI 551/591 at the application rating conditions for cooling ~~efficiencies~~efficiency adjusted using K_{adj} as defined in 6.4.1.2.1 when tested or rated with water used as a heat transfer ~~fluid~~liquid. They also shall show compliance with heating *efficiency* requirements listed in Table 6.8.1-16 at one of the AHRI 551/591 standard rating conditions when tested or rated with water used as a heat transfer ~~fluid~~liquid. Heating only ~~chillers~~chilling packages shall ~~only have to show compliance with Table 6.8.1-16 heating efficiency requirements at one of the AHRI 551/591 rating conditions~~ shall meet the heating *efficiency* requirements at one of the AHRI 551/591 heating liquid temperature rating conditions and are not required to meet the cooling *efficiency* requirements of Table 6.8.1-16.

Make the following revisions to Table 6.8.1-3 (SI):

Table 6.8.1-3 FluidLiquid-Chilling Packages—Minimum Efficiency Requirements^{a,b,e,f}

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure ^c
Air-cooled E	<528 kW	COP (W/W)	≥2.985 FL	≥2.966 FL	AHRI 551/591
			≥4.048 IPLV.SI	≥4.669 IPLV.SI	
	≥528 kW		≥2.985 FL	≥2.866 FL	
			≥4.137 IPLV.SI	≥4.758 IPLV.SI	
Air-cooled without condenser, electrically operated	All capacities	COP (W/W)	Air-cooled chillers without condensers must be rated with matching condensers and comply with air-cooled chiller <i>efficiency</i> requirements		AHRI 551/591
FluidLiquid-cooled, electrically operated positive displacement	<264 kW	COP (W/W)	≥4.694 FL	≥4.513 FL	AHRI 551/591
	≥264 kW and <528 kW		≥5.867 IPLV.SI	≥7.041 IPLV.SI	
			≥4.889 FL	≥4.694 FL	
	≥528 kW and <1055 kW		≥6.286 IPLV.SI	≥7.184 IPLV.SI	
			≥5.334 FL	≥5.177 FL	
	≥1055 kW and <2110 kW		≥6.519 IPLV.SI	≥8.001 IPLV.SI	
			≥5.771 FL	≥5.633 FL	
≥2100 kW	≥6.770 IPLV.SI	≥8.586 IPLV.SI			
FluidLiquid-cooled, electrically operated centrifugal	<528 kW	COP (W/W)	≥5.771 FL	≥5.065 FL	AHRI 551/591
	≥528 kW and <1055 kW		≥6.401 IPLV.SI	≥8.001 IPLV.SI	
			≥5.771 FL	≥5.544 FL	
	≥1055 kW and <1407 kW		≥6.401 IPLV.SI	≥8.801 IPLV.SI	
			≥6.286 FL	≥5.917 FL	
	≥1407 kW and <2110 kW		≥6.770 IPLV.SI	≥9.027 IPLV.SI	
			≥6.286 FL	≥6.018 FL	
≥2110 kW	≥7.041 IPLV.SI	≥9.264 IPLV.SI			
≥6.286 FL	≥6.018 FL				
≥7.041 IPLV.SI	≥9.264 IPLV.SI				
Air-cooled absorption, single effect	All capacities	COP (W/W)	≥0.6000 FL	NA ^d	AHRI 560
FluidLiquid-cooled absorption, single effect	All capacities	COP (W/W)	≥0.7000 FL	NA ^d	AHRI 560
Absorption double effect, indirect fired	All capacities	COP (W/W)	≥1.000 FL	NA ^d	AHRI 560
			≥1.050 IPLV.SI		
Absorption double effect, direct fired	All capacities	COP (W/W)	≥1.000 FL	NA ^d	AHRI 560
			≥1.000 IPLV.SI		

- The requirements for centrifugal ~~chillers~~ *chilling packages* shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed there. The requirements for air-cooled, FluidLiquid-cooled positive displacement and absorption ~~chillers~~ *chilling packages* are at standard rating conditions defined in the reference test procedure.
- Both the full-load and IPLV.SI requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.
- Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.
- FL is the full-load performance requirements, and IPLV.SI is for the part-load performance requirements.
- Electrically operated ~~chillers~~ *chilling packages* employing a freeze-protection FluidLiquid per Section 6.4.1.2.2 shall be tested or rated with water for the purpose of compliance with the requirements of this table.