



**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

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

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FOREWORD

This addendum updates three requirements for chillers:

1. Section 6.4.1.2.1 K_{adj} cooling efficiency adjustment for centrifugal chillers.
2. Section 6.4.1.2.2 for chillers with a freeze protection fluid
3. In some cases in the standard we refer to the heat exchanger fluid as “water” and in others we refer to it as a “fluid” so we will also make changes to have consistent use of the heat exchanger “fluid” naming convention that was started in the 2010 standard

Note the following description is applicable to the IP version and SI version, but for clarity the forward has been created for the IP version. Similar changes are implemented for the SI version

Change 1 – K_{adj} Revision

In ASHRAE 90.1-2019, 2016, 2013, and 2010 versions of the standard there is a procedure in section 6.4.1.2.1 for adjusting the table 6.8.1-3 water-cooled centrifugal chiller packages minimum full load and part load efficiencies which states in the IP version;

“Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44.00°F leaving and 54.00°F entering chilled-fluid temperatures, and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures, shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted using the K_{adj} equations”.

AHRI 550/590 (IP) and AHRI 551/591 (SI) has expanded the conditions for certification for the evaporator leaving water temperature up to 70°F due to use in data centers. Also, AHRI allows certification at higher condenser leaving water temperature than the 115°F limit added in the 2013 update to the ASHRAE 90.1 standard. In addition, AHRI uses a 32°F lower limit for evaporator water for the freeze projection, but K_{adj} is limited to 36°F in ASHRAE 90.1. Updates to the K_{adj} equation that reflect these changes are proposed as part of this addendum.

In addition, ASHRAE 90.1 2019 standard added Table 6.8.1-16 for heat pump and heat recovery chillers minimum efficiencies, but did not state that K_{adj} could be used for the cooling efficiency adjustment listed in Table 6.8.1-16.

The following changes will be made to K_{adj} :

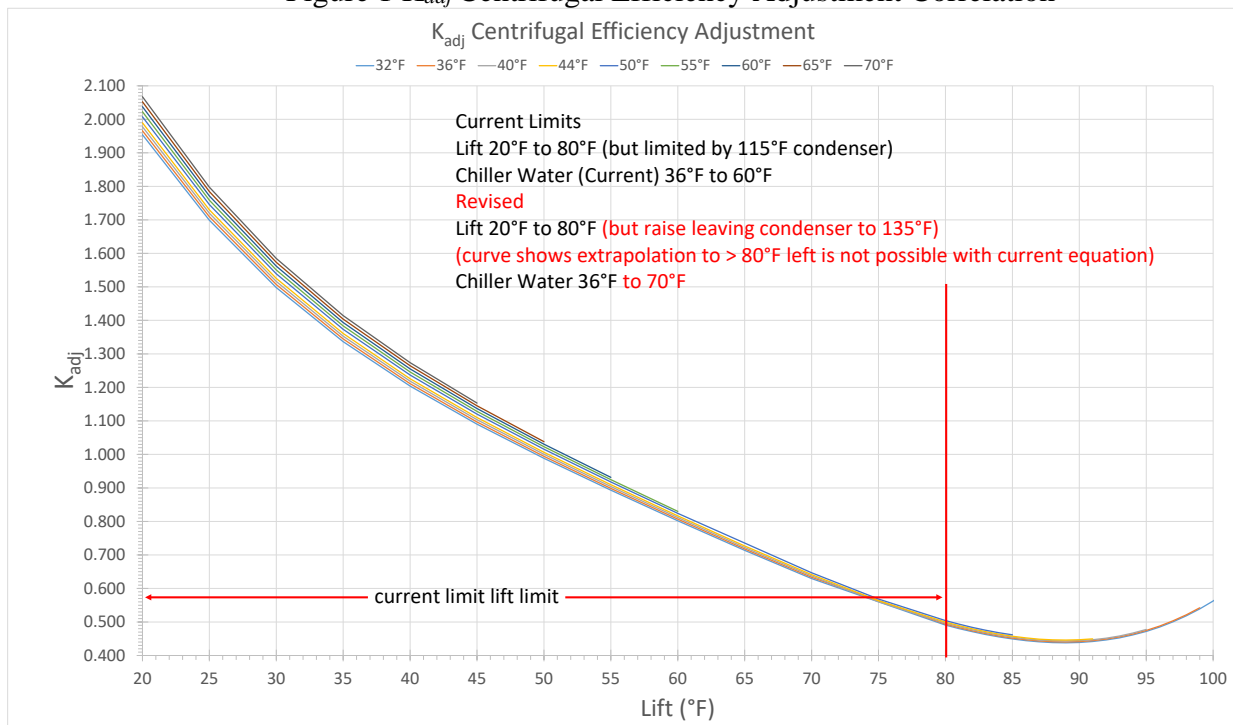
1. Increase the maximum evaporator leaving water temperature to 70.00°F to align with AHRI 550/590 and AHRI 551/591 certification program.
2. Increase the condenser leaving water temperature to 135°F but stay within the limit of 80°F lift.

The AHRI program allows certification of units with a setpoint above 32.00°F that are protected with glycol or similar fluids for freeze protection when tested at conditions within the scope of AHRI certification program. The lower limit for evaporator fluid temperatures in AHRI 550/590 certification program is 36.00°F, so we cannot extend the K_{adj} below 36.00°F.

The K_{adj} equation was developed by AHRI and has a limit of 20.00 °F to 80.00°F lift. Lift is the difference between the chilled fluid evaporator leaving temperature and the condenser fluid leaving temperature. Technically, the certification program covers lifts up to 99.00°F. However, analysis shows that the polynomial curve fit cannot be extrapolated to a lift higher than 80°F. As shown in figure 1 below, the correlation begins to fall apart at greater than 80.00°F lift and cannot be used to extrapolate to higher than 80.00°F lift. For the revised K_{adj} we will maintain the limit of 80.00°F lift, but where operation is within the that limit, the K_{adj} procedure will allow the condenser leaving water to rise to as much as 135.00°F but still be within the limits of the AHRI certification program.

This addendum does not propose to change the K_{adj} correlation equation but does propose to expand the limits defined for it use and the figure 1 shows the results of a detailed validation of the correlation over the expanded range.

Figure 1 K_{adj} Centrifugal Efficiency Adjustment Correlation



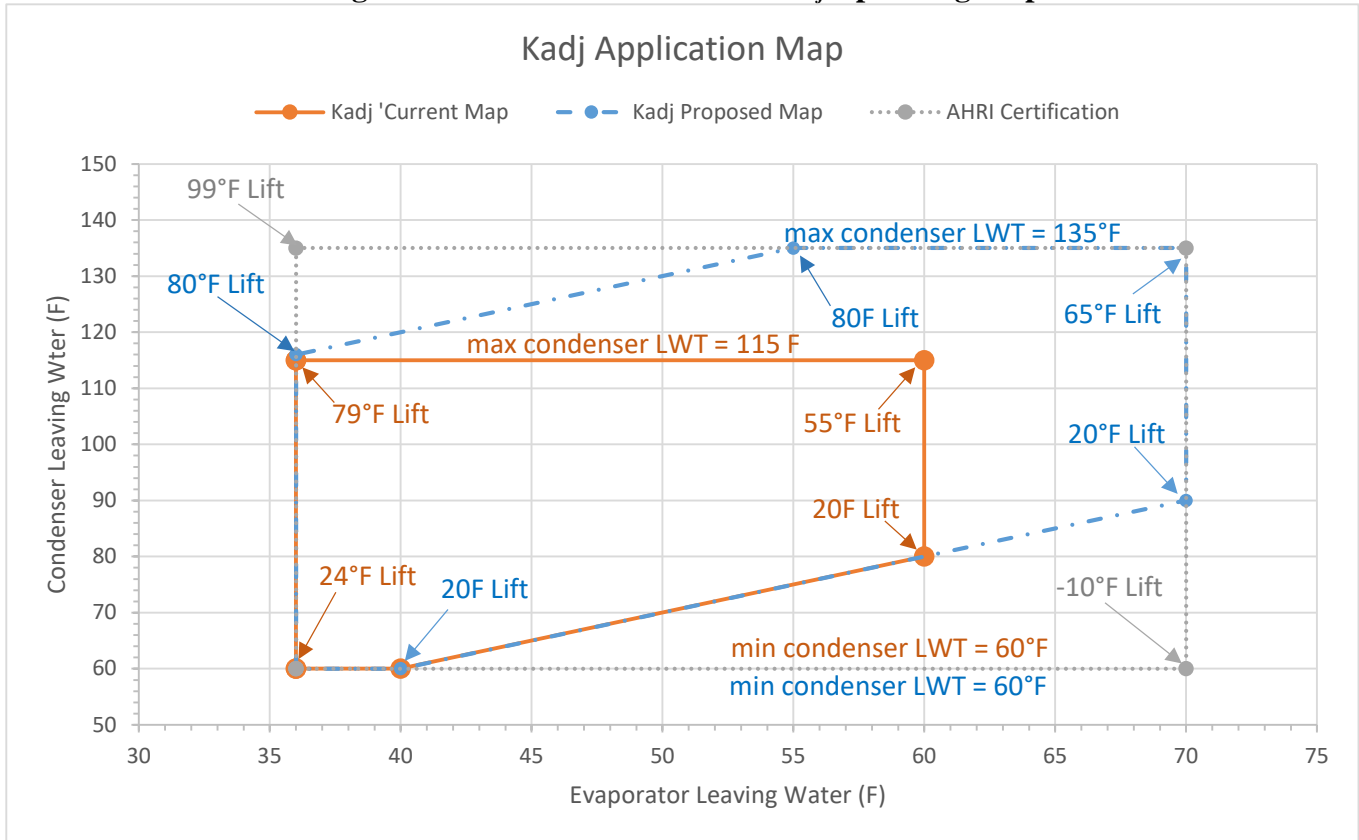
The following changes will be made to the K_{adj} limits:

K_{adj} Limits

K_{adj} Limits	Current	Proposed Revision
Leaving Evaporator	36.00°F ≤ LvgEvap ≤ 60.00°F	36.00°F ≤ LvgEvap ≤ 70.00°F and
Condenser Leaving	LvgCond ≤ 115.00°F	60.00°F ≤ LvgCond ≤ 135.00°F and
Lift (Leaving Cond – Leaving Evap)	20.00 °F ≤ Lift ≤ 80.00°F	20.00 °F ≤ Lift ≤ 80.00°F

In addition to the 135.00°F condenser leaving water we also added a 60.00°F lower limit based on the AHRI 550/590 certification program limit which have a lower limit of 55.00°F entering water and 6 gpm/ton flow which translates into a leaving water temperature of 60.00°F (55.00°F entering + 5.00°F delta = 60.00°F leaving). The AHRI certification program, prior K_{adj} , and proposed K_{adj} operating maps are shown on the following figure 2.

Figure 2 – Water Cooled Chiller K_{adj} Operating Map



In addition to the changes for the expanded range of operation, this addendum will also clarify that K_{adj} can be used with the new Table 6.8.1-16 for cooling efficiency adjustment for water-cooled centrifugal chillers. Note that there is no K_{adj} for heating efficiency metrics.

Note that K_{adj} is only applicable for use with centrifugal water-cooled chillers and is not applicable to any air cooled chiller or positive displacement water cooled chillers.

Change 2 – Chillers employing freeze-protection fluids

In the 2014 AHRI 550/590 (IP) and AHRI 551/591 (SI) Air-cooled chiller (ACCL) and Water-cooled Chiller (WCCL) certification program operational manuals, and earlier versions of the certification operational manuals, units that were protected with glycol for freeze protection and have a set point above 32 F and are positive displacement water-cooled chillers were allowed to be certified when tested with water with the conditions of the AHRI certification program. Centrifugal water-cooled chillers were not included in this certification allowance.

The 2014 AHRI 550/590 ACCL OM stated the following requirement for air-cooled;
“Units intended for use with glycol or other secondary coolant for freeze protection with a leaving chilled fluid temperature above 32.0°F are certified when tested with water at Standard Rating Conditions”

The 2014 AHRI 550/590 WCCL OM also had the following requirement for water-cooled;
“Positive Displacement Units intended for use with glycol or other secondary coolant for freeze protection with a leaving chilled fluid temperature above 32.0°F are certified when tested with water at Standard Rating Conditions”

The WCCL OM specifically excluded centrifugal chillers from using the option to prove compliance with ASHRAE 90.1 for glycol freeze protected chillers.

Based on this ASHRAE 90.1- 2010 standard was updated to include the following requirements:

“6.4.1.2.2 Positive displacement (air- and water-cooled) chilling packages. Equipment with an evaporator leaving fluid temperature higher than 32°F shall show compliance with Table 6.8.1C when tested or certified with water at standard rating conditions, per the referenced test procedure”.

In the ASHRAE 90.1-2013 the requirements were updated to the following:

“6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 32.00°F and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115.00°F shall show compliance with Table 6.8.1-3 when tested or certified with water at standard rating conditions, per the referenced test procedure.”

ASHRAE 90.-2013 added the 115.00°F condenser leaving temperature, but it is not in the requirements of the AHRI 550/590 OM certification program. The certification program follows the standard operating envelope, which defines the condenser maximum water temperature as 105.00°F entering with a flow range of 1.0 to 6.0 gpm/ton. This works out to be 135.00 °F maximum leaving condenser fluid temperature when operated at the 1.0 gpm/ton condenser water flow.

In the 2015 AHRI 550/590 Operational Manuals the requirement was revised to the following:

“Units containing freeze protection fluids in the condenser or in the evaporator with a leaving chilled fluid temperature above 32°F [0°C] are certified when rated per the Standard with water.”

This change eliminated the exemption for the centrifugal chiller and and were intended to allow water water-cooled centrifugal chillers with glycol for freeze protection to prove compliance with ASHRAE 90.1 minimum efficiencies. However,the ASHRAE 90.1-2016 and the recently published ASHRAE 90.1-2019 standard were not updated to remove the centrifugal exemption.

On Oct 12, 2019, an official interpretation, IC 90.1-2016-11, was approved that clarified that a centrifugal chiller with glycol as a freeze protection fluid and with a fluid temperature above 32.00°F could not use the AHRI procedure to claim compliance with ASHRAE 90.1, so all centrifugal chillers with freeze protection fluid are exempt from minimum efficiencies in ASHRAE 90.1-2019 and prior versions.. This addendum removes the exemption for freeze protection fluids from the efficiency requirements in Tables 6.8.1-3 and Tables 6.8.1-16 for water-cooled centrifugal chillers.

Based on the 2015 change to AHRI certification operational manual, a change to the ASHRAE 90.1-2019 requirements should be made to allow for certification of centrifugal chillers using freeze protection fluids in the fluid cooled condenser and or evaporator.

In addition with the new Table 6.8.1-16 for heat pump and heat recovery chillers can also be used with freeze protection fluids and for freeze protection and the requirements for minimum efficiency with freeze protection fluids needs to be addressed by ASHRAE 90.1.

Change 3 Heat exchanger fluid reference correction

This change will change the heat exchanger fluid to be consistently referred to as a “fluid” and not as “water”. There is inconsistent use of the terms in the ASHRAE 90.1-2019 standard

Economic Analysis

This addendum does not impact cost as the products are already being applied with freeze protection fluids but it does expand the scope of the ASHRAE 90.1 standard to cover more applications conditions and will likely have an impact on efficiency. Therefore no economic justification is required.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strike through~~ (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 x to 90.1-2019

In section 6.4.1.1 make the following change to item c for both IP and SI

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

Make the following revisions to 6.4.1.2.1 IP Requirements

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 ~~WaterFluid~~-Cooled Centrifugal Chilling Packages Cooling Efficiency Adjustment Fluid-cooled centrifugal cooling efficiency requirements defined in Table 6.8.1-3 and 6.8.1-16 ~~Equipment~~ 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 temperatures, and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures, shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted using the following equations:

$$\begin{aligned}FL_{adj} &= FL/K_{adj} \\ PLV_{adj} &= IPLV.IP/K_{adj} \\ K_{adj} &= A \times B\end{aligned}$$

where

- FL = full-load kW/ton value from Table 6.8.1-3
FL_{adj} = maximum full-load kW/ton rating, adjusted for nonstandard conditions
IPLV.IP = IPLV.IP value from Table 6.8.1-3
PLV_{adj} = maximum NPLV rating, adjusted for nonstandard conditions
A = 0.00000014592 × (LIFT)⁴ – 0.0000346496 × (LIFT)³ + 0.00314196 × (LIFT)² – 0.147199 × (LIFT) + 3.93073
B = 0.0015 × LvgEvap + 0.934
LIFT = LvgCond – LvgEvap
LvgCond = full-load condenser leaving fluid temperature (°F)
LvgEvap = full-load evaporator leaving temperature (°F)

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

- 36.00 °F ≤ LvgEvap ≤ ~~60.00~~70.00 °F and
- 60.00 °F ≤ LvgCond ≤ ~~115.00~~135.00 °F and
- 20.00 °F ≤ LIFT ≤ 80.00 °F

Manufacturers shall calculate the FL_{adj} and PLV_{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 within the scope of the standard.

Centrifugal chillers 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:

$$\begin{aligned} FL &= 0.5600 \text{ kW/ton} \\ IPLV_{IP} &= 0.5000 \text{ kW/ton} \\ LvgCond &= 91.16^\circ\text{F} \\ LvgEvap &= 42.00^\circ\text{F} \\ LIFT &= 91.16 - 42 = 49.16^\circ\text{F} \\ A &= 0.00000014592 \times (49.16)^4 - 0.0000346496 \times (49.16)^3 + 0.00314196 \times (49.16)^2 - 0.147199 \\ &\quad \times (49.16) + 3.93073 = 1.02331 \\ B &= 0.0015 \times 42.00 + 0.934 = 0.99700 \\ K_{adj} &= 1.02331 \times 0.99700 = 1.02024 \\ FL_{adj} &= 0.5600/1.02024 = 0.5489 \text{ kW/ton} \\ PLV_{adj} &= 0.5000/1.02024 = 0.4901 \text{ kW/ton} \end{aligned}$$

Make the following revisions to 6.4.1.2.2 IP Requirements

6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages Chiller Packages Employing Freeze-Protection Fluids

~~Equipment with an evaporator leaving fluid temperature higher than 32.00°F and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115.00°F shall show compliance with Table 6.8.1-3 when tested or certified with water at standard rating conditions, per the referenced test procedure.~~

Electrically operated chillers that employ freeze protection fluids in any heat exchanger with an application cooling duty evaporator fluid leaving temperature or heating operation source fluid temperature above 32.00°F shall show *efficiency* compliance in accordance with the applicable requirements in 6.4.1.2.2.1 to 6.4.1.2.2.4.

Absorption chillers with freeze projection fluids 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 air-cooled and electrically operated positive displacement fluid cooled chillers 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 fluid.

6.4.1.2.2.2 – All fluid-cooled electrically operated centrifugal chillers 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 a cooling *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.

6.4.1.2.2.3 – All electrically operated air-cooled and electrically operated positive displacement fluid source heat pump and heat recovery chillers 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. They also shall show compliance with one Table 6.8.1-16 heating *efficiency* requirement at one of the AHRI 550/590 standard heating rating conditions when tested or rated with water used as a heat transfer fluid. Heating-only chillers only have to show compliance Table 6.8.1-16 heating *efficiency* requirements at one of the AHRI 550/590 rating conditions.

6.4.1.2.2.4 – All fluid-source centrifugal heat pump and heat recovery chillers 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* 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 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. Heating-only chillers shall only have to show compliance with Table 6.8.1-16 heating *efficiency* requirements at one of the AHRI 550/590 rating conditions.

Make the following revisions to Table 6.8.1-3 IP to change “water” to “fluid” and correct some of the significant figures in the table to align with the requirements defined in AHRI 550/590 which requires 4 significant figures for efficiency metrics.

Table 6.8.1-3 ~~Water~~Fluid-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/Wh)	≥10.100 FL	≥9.700 FL	AHRI 550/590
			≥13.700 IPLV.IP	≥15.800 IPLV.IP	
	≥10.100 FL		≥9.700 FL		
	≥14.000 IPLV.IP		≥16.100 IPLV.IP		
	≥150 tons				
Air-cooled without condenser, electrically operated	All capacities	EER (Btu/Wh)	Air-cooled chillers without condensers must be rated with matching condensers and comply with air-cooled chiller <i>efficiency</i> requirements		AHRI 550/590
Water Fluid-cooled, electrically operated positive displacement	<75 tons	kW/ton	≤0.7500 FL	≤0.7800 FL	AHRI 550/590
	≥75 tons and <150 tons		≤0.6000 IPLV.IP	≤0.5000 IPLV.IP	
			≤0.7200 FL	≤0.7500 FL	
	≥150 tons and <300 tons		≤0.5600 IPLV.IP	≤0.4900 IPLV.IP	
	≥300 tons and <600 tons		≤0.6600 FL	≤0.6800 FL	
			≤0.5400 IPLV.IP	≤0.4400 IPLV.IP	
	≥600 tons		≤0.6100 FL	≤0.6250 FL	
		≤0.5200 IPLV.IP	≤0.4100 IPLV.IP		
		≤0.5600 FL	≤0.5850 FL		
		≤0.5000 IPLV.IP	≤0.3800 IPLV.IP		
Water Fluid-cooled, electrically operated centrifugal	<150 tons	kW/ton	≤0.6100 FL	≤0.6950 FL	AHRI 550/590
	≥150 tons and <300 tons		≤0.5500 IPLV.IP	≤0.4400 IPLV.IP	
			≤0.6100 FL	≤0.6350 FL	
	≥300 tons and <400 tons		≤0.5500 IPLV.IP	≤0.4000 IPLV.IP	
	≥400 tons and <600 tons		≤0.5600 FL	≤0.5950 FL	
			≤0.5200 IPLV.IP	≤0.3900 IPLV.IP	
	≥600 tons		≤0.5600 FL	≤0.5850 FL	
		≤0.5000 IPLV.IP	≤0.3800 IPLV.IP		
		≤0.5600 FL	≤0.5850 FL		
		≤0.5000 IPLV.IP	≤0.3800 IPLV.IP		
Air-cooled absorption, single effect	All capacities	COP (W/W)	≥0.6000 FL	NA ^d	AHRI 560
Water Fluid-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.IP		
Absorption double effect, direct fired	All capacities	COP (W/W)	≥1.000 FL	NA ^d	AHRI 560
			≥1.000 IPLV.IP		

- The requirements for centrifugal chillers 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, ~~water~~fluid-cooled positive displacement and absorption chillers 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 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.

Make the following revisions to 6.4.1.2.1 and 6.4.1.2.2 SI Requirements

6.4.1.2.1 ~~Water~~Fluid-Cooled Centrifugal Chilling Packages Cooling Efficiency Adjustment

Fluid-cooled centrifugal cooling efficiency requirements defined in Table 6.8.1-3 and 6.8.1-16 ~~Equipment~~ 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-fluid temperatures, and with 30.00°C entering and 35.00°C leaving condenser-fluid temperatures shall have maximum full-load (FL) *COP* and part-load rating requirements adjusted using the following equations:

$$FL_{adj} = FL \times K_{adj}$$

$$PLV_{adj} = IPLV.SI \times K_{adj}$$

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

where

- FL = full-load *COP_R* value from Table 6.8.1-3
- FL_{adj} = minimum full-load *COP_R* rating, adjusted for nonstandard conditions
- IPLV.SI = IPLV.SI value from Table 6.8.1-3
- PLV_{adj} = minimum *NPLV* 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 fluid temperature (°C)
- LvgEvap = full-load evaporator leaving temperature (°C)

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

- $2.20^\circ\text{C} \leq LvgEvap \leq 15.60$ ~~21.10~~ °C and
- $15.56 \text{ }^\circ\text{C} \leq LvgCond \leq 46.00$ ~~57.00~~ °C and
- $11.00^\circ\text{C} \leq LIFT \leq 44.00^\circ\text{C}$

Manufacturers shall calculate the FL_{adj} and PLV_{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 within the scope of the standard.

Centrifugal chillers 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:

- FL = 6.286 *COP_R*
- IPLV.SI = 7.041 *COP_R*
- LvgCond = 37.00°C
- LvgEvap = 6.00°C
- LIFT = 37.00 – 6.00 = 31.00°C
- A = $0.00000153181 \times (31.00)^4 - 0.000202076 \times (31.00)^3 + 0.0101800 \times (31.00)^2 - 0.264958 \times 31.00 + 3.93073 = 0.894625$
- B = $0.0027 \times 6.00 + 0.982 = 0.998200$
- K_{adj} = $0.894625 \times 0.998200 = 0.893014$
- FL_{adj} = $6.286 \times 0.893014 = 5.613 \text{ } COP_R$
- PLV_{adj} = $7.041 \times 0.893014 = 6.288 \text{ } COP_R$

6.4.1.2.2 ~~Positive Displacement (Air and Water-Cooled) Chilling Packages~~ Chiller Packages Employing Freeze Protection Fluids

~~Equipment with an evaporator leaving fluid temperature higher than 32.00°F and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115.00 shall show compliance with Table 6.8.1-3 when tested or certified with water at standard rating conditions, per the referenced test procedure.~~

Electrically operated chillers that employ freeze protection fluids in any heat exchanger with an application cooling duty evaporator fluid leaving temperature or heating operation source fluid 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 with freeze projection fluids 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 air-cooled and electrically operated positive displacement fluid cooled chillers 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.

6.4.1.2.2.2 – All fluid-cooled electrically operated centrifugal chillers 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 a cooling *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.

6.4.1.2.2.3 – All electrically operated air-cooled and electrically operated positive displacement fluid source heat pump and heat recovery chillers 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. They also shall show compliance with one Table 6.8.1-16 heating *efficiency* requirement at one of the AHRI 551/591 standard heating rating conditions when tested or rated with water used as a heat transfer fluid. Heating-only chillers only have to show compliance Table 6.8.1-16 heating *efficiency* requirements at one of the AHRI 551/591 rating conditions.

6.4.1.2.2.4 – All fluid-source centrifugal heat pump and heat recovery chillers 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* 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 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. Heating-only chillers shall only have to show compliance with Table 6.8.1-16 heating *efficiency* requirements at one of the AHRI 551/591 rating conditions.

Make the following revisions to Table 6.8.1-3 SI to change “water” to “fluid” and correct some of the significant figures in the table to align with the requirements defined in AHRI 551/591 which requires 4 significant figures for efficiency metrics.

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

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure^c
Air-cooled chillers	<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
Water Fluid-cooled, electrically operated positive displacement	<264 kW	COP (W/W)	≥4.694 FL	≥4.513 FL	AHRI 551/591
			≥5.867 IPLV.SI	≥7.041 IPLV.SI	
	≥264 kW and <528 kW		≥4.889 FL	≥4.694 FL	
			≥6.286 IPLV.SI	≥7.184 IPLV.SI	
	≥528 kW and <1055 kW		≥5.334 FL	≥5.177 FL	
			≥6.519 IPLV.SI	≥8.001 IPLV.SI	
	≥1055 kW and <2110 kW		≥5.771 FL	≥5.633 FL	
≥2100 kW	≥6.770 IPLV.SI	≥8.586 IPLV.SI			
Water Fluid-cooled, electrically operated centrifugal	<528 kW	COP (W/W)	≥5.771 FL	≥5.065 FL	AHRI 551/591
			≥6.401 IPLV.SI	≥8.001 IPLV.SI	
	≥528 kW and <1055 kW		≥5.771 FL	≥5.544 FL	
			≥6.401 IPLV.SI	≥8.801 IPLV.SI	
	≥1055 kW and <1407 kW		≥6.286 FL	≥5.917 FL	
			≥6.770 IPLV.SI	≥9.027 IPLV.SI	
	≥1407 kW and <2110 kW		≥6.286 FL	≥6.018 FL	
≥2110 kW	≥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
Water Fluid-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 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, ~~water~~fluid-cooled positive displacement and absorption chillers 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 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.