ADDENDA

ANSI/ASHRAE/IES Addendum dl to
ANSI/ASHRAE/IES Standard 90.1-2013

Energy Standard for Buildings Except Low-Rise Residential Buildings

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FOREWORD

The new AHRI 550/590 (I-P)-2015 and AHRI 551/591 (SI)-2015 makes changes to the I-P rating conditions that require an update to the K_{adj} *correction factor in ASHRAE Standard 90.1, Section 6.4.1.2. The rating conditions for I-P ratings as defined in AHRI 550/590 (I-P)-2011 with addendum 1 and AHRI 551/591 (SI)-2011 with addendum 1 standards were based on 44.00°F leaving evaporator water temperature with 2.40 gpm/ton flow, with 85.00°F entering water and 3.00 gpm/ton for the condenser water. The revised AHRI 550/590 I-P standard changes the evaporator ratings conditions to 44.00°F leaving with a 54.00°F entering water with the flow/ton as a reference. The I-P rating conditions change to 85.00°F entering water with 94.30°F leaving with the flow/ton as a reference. For the AHRI 551/591 (SI) rating conditions, no changes were made in the new standard as the rating conditions are already based on 7.00°C leaving evaporator temperature with 12.00°C entering temperature and with 30.00°C entering condenser water with 35.00°C leaving condenser water temperature.*

With the small change in the rating conditions, changes need to be made to the K_{adj} *correction factor for adjusting minimum efficiencies for nonstandard centrifugal chiller rating conditions as defined in Table 6.8.1-3 so that the adjustments are equal to 1 at the new standard rating conditions. With the new rating conditions based on a fixed delta temperature instead of flow/ton, the committee can correct a small error that is introduced when using the* K_{adj} *equations for correcting the centrifugal rating minimum efficiencies for nonstandard ratings conditions as defined in Section 6.4.1.2.*

With this change, AHRI is proposing changes to the text to clarify requirements and update examples. Changes are also being made to better define the applicable range for the evaporator and lift to reflect that for which the polynomial equation is accurate. The current standard allows conditions to be used in ways for which the adjustment equation is not qualified and, therefore, requires clarification. Addendum dl also includes updates to significant figures to reflect the requirements defined in Table 14 of the AHRI 550/590 (I-P)-2015 and AHRI 551/591 (SI)-2015 standards.

As part of this work, the K_{adj} *spreadsheet calculation tool provided with the 90.1-2013 User's Manual has been updated and will be included with the 2016 edition of the User's Manual.*

The change in rating conditions and to K_{adj} *will have no impact on the minimum efficiency levels in Table 6.8.1-3, and no changes are proposed or planned.*

Note: This addendum incorporates corrections identified in errata dated Oct 22, 2014.

This addendum has no impact on energy savings and cost of products so no energy and economic analysis is required.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and strikethrough (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dl to 90.1-2013

Make the following changes to the standard (I-P):

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 Water-Cooled Centrifugal Chilling Packages. 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 2.4 gpm/ton evaporator fluid flow~~ and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures ~~with 3.0 gpm/ton condenser-fluid flow~~ shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted using the following equations:

$$FL_{adj} = FL / K_{adj}$$

$$PLV_{adj} = IPLV / K_{adj}$$

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

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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 = IPLV value from Table 6.8.1-3

PLV_{adj} = maximum NPLV rating, adjusted for nonstandard conditions

A = 0.00000014592$\underline{0}$ × $(LIFT)^4$ – 0.0000346496 × $(LIFT)^3$ + 0.00314196 × $(LIFT)^2$ – 0.147199 × (LIFT) + ~~3.9302~~ $\underline{3.93073}$

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:

~~• Minimum Evaporator Leaving Temperature: 36°F~~

• 36.$\underline{00}$°F d LvgEvap d 60.00°F

~~• Maximum Condenser Leaving Temperature: 115°F~~

" LvgCond d 115.$\underline{00}$°F

• 20.$\underline{00}$°F d LIFT d 80.$\underline{00}$°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, $\underline{2016,}$ 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: Path A 600 ton centrifugal chiller Table 6.8.1-3 efficiencies effective 1/1/2015:

FL = 0.560$\underline{0}$ kW/ton

IPLV = 0.500$\underline{0}$ kW/ton

LvgCond = 91.16°F

LvgEvap = 42.00°F

LIFT = 91.16 – 42.$\underline{00}$ = 49.16°F

~~K_{adj} = A × B~~

A = 0.00000014592$\underline{0}$ × $(49.16)^4$ – 0.0000346496 × $(49.16)^3$ + 0.00314196 x $(49.16)^2$ – 0.147199 × (49.16) + ~~3.9302~~$\underline{3.93073}$ = ~~1.0228~~$\underline{1.02331}$

B = 0.0015 × 42.$\underline{00}$ + 0.934 = 0.9970$\underline{0}$

$\underline{K_{adj} = 1.02331 \times 0.99700 = 1.02024}$

FL_{adj} = ~~0.560/(1.0228 × 0.9970)~~ $\underline{0.5600 / (1.02024)}$= ~~0.549~~ $\underline{0.5489}$ kW/ton

PLV_{adj} = ~~0.500/(1.0228 × 0.9970)~~ $\underline{0.5000 / (1.02024)}$= ~~0.490~~ $\underline{0.4901}$ kW/ton

6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 32.$\underline{00}$°F and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115.$\underline{00}$°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.

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Make the following changes to the standard (SI).

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 Water-Cooled Centrifugal Chilling Packages. Equipment not designed for operation at AHRI Standard 551/591 test 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:

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

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

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

where

FL	= full-load COP value from Table 6.8.1-3
FL_{adj}	= minimum full-load COP rating, adjusted for nonstandard conditions
IPLV	= IPLV value from Table 6.8.1-3
PLV_{adj}	= minimum NPLV rating, adjusted for nonstandard conditions
A	= $0.00000153181 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times LIFT +$ ~~3.930196~~ ~~3.9302~~ 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:

- ~~Minimum Evaporator Leaving Temperature: 2.0°C~~
- " 2.20°C d LvgEvap d 15.60°C
- ~~Maximum Condenser Leaving Temperature: 46°C~~
- " LvgCond d 46.00°C
- 11.00°C d LIFT d 44.00°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, 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.

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Example: Path A 2110 kW centrifugal chiller Table 6.8.1-3 efficiencies effective 1/1/2015:

FL = 6.286 COP

IPLV = 7.041 COP

LvgCond = 37.00°C

LvgEvap = 6.00°C

~~37.00 – 6.00 = 31.00°C K_{adj} = A × B~~

LIFT = 37.00 – 6.00 = 31.00°C

A = 0.00000153181 × (~~30.0~~31.00)^4 – 0.000202076 × (~~30.0~~31.00)^3 + 0.0101800 × (~~30.0~~31.00)^2 – 0.264958 × ~~30.0~~31.00 + ~~3.9301963~~ 3.93073 = ~~0.9282~~ 0.894625

B = 0.0027 × 6.00 + ~~0.9811~~0.982 = ~~0.9973~~ 0.998200

K_{adj} = 0.894625 × 0.998200 = 0.893014

FL_{adj} = 6.286 × ~~0.9302 × 0.9973~~ 0.893014 = ~~5.831~~ 5.613 COP

PLV_{adj} = 7.041 × ~~0.9302 × 0.9973~~ 0.893014 = ~~6.531~~ 6.288 COP

6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 0.00°C and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 46.00°C shall show compliance with Table 6.8.1-3 when tested or certified with water at standard rating conditions, per the referenced test procedure.

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ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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