ADDENDA

ANSI/ASHRAE Addendum g to ANSI/ASHRAE Standard 90.4-2016

Energy Standard for Data Centers

Approved by the ASHRAE Standards Committee on June 22, 2019; by the ASHRAE Technology Council on June 26, 2019; and by the American National Standards Institute on June 27, 2019.

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FOREWORD

Addendum g lowers the Mechanical Load Component (MLC) values required for compliance in Section 6. The MLC values published in the 2016 edition of Standard 90.4 exceeded the required limits found in ASHRAE/IES Standard 90.1-2010 and in the energy codes for California, Oregon, and Washington, which are more conservative than intended for data centers guided by this standard.

The goal of this addendum is to provide an updated list of MLC values that can be achieved with the use of readily available packaged cooling products, including (a) packaged computer-room air conditioners with indirect evaporative cooling (IEC) and (b) packaged air-cooled chillers with integrated dry coolers serving packaged computer-room air handlers without air-side economizers. Both technologies are readily available from most of the leading computer-room air-conditioner manufacturers. An IEC unit uses an air-to-air heat exchanger to cool return air from the data center by spraying water on the outside of the heat exchanger and drawing outdoor air (scavenger air) across the outside of the heat exchanger. The outdoor air does not mix with the recirculated data center air. No outdoor air or humidity is introduced into the data center, which eliminates any air quality or humidity control issues associated with an air-side economizer. A DX coil handles any load that cannot be handled by the indirect evaporative air cooler.

The MLC values proposed herein are still conservative. Our analysis has shown that they can be achieved with or without the use of an air-side economizer and in keeping with ASHRAE TC 9.9 recommended thermal guidelines.

This addendum also removes the Design MLC compliance path from Section 6 in favor of a more accurate Maximum Annualized MLC calculation. Design MLC was intended only as an interim provision to be used as the necessary tools and techniques for calculating Annualized MLC were being developed. The Annualized MLC technique is detailed in this addendum.

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 g to Standard 90.4-2016

Modify Section 3.2 as shown.

~~***design mechanical load component (design MLC):*** the sum of all cooling, fan, pump, and heat rejection design power divided by the *data center ITE design power*.~~

Modify Section 4.2.2.2 as shown.

4.2.2.2 Supplemental Information. Supplemental information necessary to verify compliance with this standard, such as calculations, worksheets, compliance forms, vendor literature, or other data, shall be made available when required by the building official. Compliance may be documented using mechanical and electrical calculations to complete each required path. If compliance is to be shown for mechanical *systems* only, the designer performs the calculations in Section~~s 6.2.1.1 or 6.2.1.2~~6.6. If compliance is to be shown for electrical *systems* only, the designer performs the calculations in Section ~~8.2.1.1~~8.5. The calculations in Section ~~6.2.1.2~~6.6 can be used to take credit for existing mechanical *system* efficiencies when compliance is to be shown for electrical *systems* only. The calculations in Sections ~~8.2.1.1~~8.5 and ~~6.2.1.2~~6.6 can be used to take credit for existing electrical *system* efficiencies when compliance is to be shown for mechanical *systems* only.

Modify Section 6.2.1 as shown.

6.2 Compliance Paths

6.2.1 Compliance. The heating, ventilating, and air conditioning system shall comply with Section 6.1, "General"; Section 6.4, "Mandatory Provisions"; ~~and Section 6.7, "Submittals";~~ and ~~either:~~

~~a. Section 6.5, "Maximum *Design Mechanical Load Component (Design MLC)* Option", or~~

~~b.~~ Section 6.6, "Maximum *Annualized Mechanical Load Component (Annualized MLC)* Option"~~.~~; and Section 6.7, "Submittals."

Addendum d to Standard 90.4 renumbers Section 6.2.1.2 as Section 6.6. Addendum g further modifies Section 6.6 and its subsections as shown.

6.6 Maximum *Annualized Mechanical Load Component*. *Annualized MLC* shall be calculated using Equation ~~6.2.1.2~~6.6. The resulting value shall be less than or equal to the value in Table ~~6.2.1.2~~6.6, "Maximum *Annualized Mechanical Load Component*~~,~~" ~~when evaluated at 100% *ITE* load for the appropriate climate zone. The calculated MLC shall also be less than or equal to the corresponding Table 6.2.1.2 MLC value when evaluated at 50% of design *ITE* load~~.

~~6.2.1.2.1~~6.6.1 [. . .]

b. The systems' energy calculation may consider operation of economizer capacity in the design and available redundant equipment at the 100% ITE load condition and separately at the ~~50%~~ ITE part-load conditions if calculated using partially loaded equipment efficiencies.

[. . .]

~~6.2.1.2.1.1~~6.6.1.1 ***Data Center Energy***. The *data center energy* calculations shall be completed separately for 100% and for ~~50% of design~~ part-load *ITE* capacity in the calculations. The *system's UPS* and transformer cooling loads must also be included in this term, evaluated at their corresponding part-load efficiencies.

~~6.2.1.2.1.2~~6.6.1.2 Calculated Quantity of Operating Units (*N*). As shown in Table ~~6.2.1.2~~6.6, the number of HVAC units required to meet the load can vary [. . .]

$$(Annualized\ Mechanical\ Load\ Component) = \frac{(\text{Cooling Energy} + \text{Pump Energy [kWh]} + \cancel{\text{Heat Rejection Fan Energy [kWh]} +} \text{Air Handler Fan Energy [kWh]})}{(Data\ Center\ ITE\ Energy\ \text{[kWh]})}$$

$$(Annualized\ Mechanical\ Load\ Component) = \frac{\begin{pmatrix} Mech\_Energy25\% + Mech\_Energy50\% + \\ Mech\_Energy75\% + Mech\_Energy100\% \end{pmatrix}}{\begin{pmatrix} Data\ Center\ ITE\ Energy25\% + \\ Data\ Center\ ITE\ Energy50\% + \\ Data\ Center\ ITE\ Energy75\% + \\ Data\ Center\ ITE\ Energy100\% \end{pmatrix}} \quad (\cancel{6.2.1.2}6.6)$$

where

Mech_EnergyX% = Total Annual Cooling Energy + Pump Energy + Heat Rejection Fan Energy + Air-Handler Fan Energy

where each term is a constant value calculated at each of the following *ITE* loads: 25%, 50%, 75%, 100%.

Example:

Data Center *ITE* Energy50% for a design *ITE* load of 1000 kW

Data Center *ITE* Energy50% = 1000 kW × 8760 hours/year × 0.5 = 4,380,000 kWh)

and where

Cooling Energy (kWh) =

the sum of all site energy required to provide cooling and humidification via vapor compression, ventilation, dehumidification, evaporation, absorption, adsorption, or other means. In the case of cooling provided by a source other than electricity, the energy consumption shall be converted to *kilowatt*-hours. For *data center* designs that provide cooling for *UPS* and transformers, that cooling design power must be included in this term. When evaluating the cooling design energy at ~~50%~~ part-load, any change in *UPS* or transformer *efficiency* at that reduced load must be included in the ~~50%~~ part-load cooling design energy.

[. . .]

Addendum d to Standard 90.4 renumbers Section 8.2.1.2 as Section 8.6. Addendum g further modifies new Section 8.6 as shown.

8.6 Maximum *Design Electrical* Loss Component for Designs Involving Both Electrical and Mechanical *Systems*. *Design ELC* shall be calculated in accordance with Section 8.3 and shall be combined with the ~~Design~~ *Annualized MLC* in accordance with Section 11.

Revise Section 11 as shown.

11.1.1 Sections 6 and 8 Trade-Off Method Scope. The Sections 6 and 8 Trade-Off Method is an alternative to individually demonstrating compliance with Sections 6 and 8 requirements. It shall be allowed for demonstrating compliance when evaluating the proposed designs when either the ~~Design~~ *Annualized MLC* or *design ELC* is greater than the maximum allowed by the standard.

11.1.2 Sections 6 and 8 Trade-Off Method Rationale. A design that has various physical or other types of constraints shall be allowed flexibility to demonstrate compliance with this standard. These constraints may impact the mechanical or electrical design. The Trade-Off Method allows a less efficient electrical *system* to be offset by a more efficient mechanical *system* or a less efficient mechanical system to be offset by a more efficient electrical system ~~vice versa~~ in order to demonstrate compliance.

11.2 Sections 6 and 8 Trade-off Method

[. . .]

b. The sum of the calculated values of the ~~design~~ *Annualized MLC* value and the *design ELC* shall be equal to or less than the maximum overall *systems* design value. (The sum of the ~~design~~ *Annualized MLC* value and the *design ELC* value create an overall *Systems* design value.)

[. . .]

Examples

For a particular design in Climate Zone 1A with a single-feed *UPS* at 100% load, the maximum MLC = ~~0.460~~ 0.260 from Table ~~6.2.1.1~~.6.6, and the maximum ELC = 0.297 from Table ~~8.2.1.1~~8.5. Adding the two values together provides a maximum overall *systems* design value of ~~0.757~~ 0.557.

Max MLC Value [~~0.460~~ 0.260] + Max ELC Value [0.297] = Maximum Overall *Systems* Value [~~0.757~~ 0.557]

If the electrical *system* design produces a *design ELC* of 0.328, which exceeds the maximum ELC value, a more efficient mechanical system can be used to offset this. If the mechanical *system* had an ~~design~~ annualized MCL of ~~0.390~~ 0.190, then the overall *systems* design value would be less than the maximum overall systems design value and would demonstrate compliance with the standard.

~~*Design*~~ *Annualized MLC* Value [~~0.390~~ 0.190] + *Design ELC* Value [0.327] = Overall *Systems* Design Value [~~0.717~~ 0.517]

Renumber Table 6.2.1.2 as Table 6.6 and modify as shown.

TABLE 6~~.2.1.2~~6.6 *Maximum Annualized Mechanical Load Component (Annualized MLC)*

Climate Zones as Listed in ASHRAE Standard 169	HVAC Maximum *Annualized MLC* ~~at 100% and at 50% *ITE* Load~~ for Data Center ITE Design Power > 300 kW	HVAC Maximum *Annualized* MLC for *Data Center ITE Design Power* ≤ 300 kW
0A	~~0.37~~ 0.25	0.31
0B	~~0.40~~ 0.28	0.34
1A	~~0.36~~ 0.26	0.31
1B	~~0.38~~ 0.27	0.32
2A	~~0.35~~0.23	0.29
3A	~~0.33~~0.21	0.27
4A	~~0.33~~ 0.18	0.26
5A	~~0.33~~ 0.16	0.25
6A	~~0.32~~ 0.16	0.24
2B	~~0.36~~ 0.17	0.27
3B	~~0.35~~ 0.17	0.26
4B	~~0.35~~ 0.14	0.24
5B	~~0.33~~ 0.14	0.23
6B	~~0.34~~ 0.14	0.24
3C	~~0.32~~ 0.14	0.23
4C	~~0.32~~ 0.14	0.23
5C	~~0.32~~ 0.14	0.23
7	~~0.32~~ 0.14	0.23
8	~~0.32~~ 0.13	0.22

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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.

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

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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.

ASHRAE · 1791 Tullie Circle NE · Atlanta, GA 30329 · www.ashrae.org

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