# DENVER AMENDMENT PROPOSAL FORM
## FOR PROPOSALS TO THE 2019 DENVER BUILDING CODE AMENDMENTS AND THE 2021 INTERNATIONAL CODES

## 2021 CODE DEVELOPMENT CYCLE

**1) Name:** **John Arent** **Date:** **11/30/2021**
**Email:** **jarent@noresco.com** **Representing (organization or self): Denver**

**2)** One proposal per this document is to be provided with clear and concise information.

Is a separate graphic file provided ( "X" to answer): ___ Yes or ___ No

**3)** Highlight the code and acronym that applies to the proposal

| Acronym | Code Name | Acronym | Code Name |
|---|---|---|---|
| **DBC-AP** | Denver Building Code–Administrative Provisions | **IPC** | International Plumbing Code |
| **IBC** | International Building Code | **IRC** | International Residential Code |
| **IECC** | International Energy Conservation Code | **IFGC** | International Fuel Gas Code |
| **IEBC** | International Existing Building Code | **IMC** | International Mechanical Code |
| **IFC** | International Fire Code | **DGC** | Denver Green Code |

Please provide all the following items in your amendment proposal.

**Code Sections/Tables/Figures Proposed for Revision:**
**Instructions:** If the proposal is for a new section, indicate (new), otherwise enter applicable code section.

**Section CC102**
**C403.1.2**

**Proposal:**
**Instructions:** Show the proposal using ~~strikeout~~, underline format.
**Place an "X" next to the choice that best defines your proposal:** **X** Revision **X**_ New Text __ Delete/Substitute __ Deletion

**SECTION CC102**
**DEFINITIONS**

WATER USAGE EFFECTIVENESS, SITE. The total water consumed onsite for a data center divided by its electrical energy consumption, in units of liters per kilowatt hour (L/kWh). Represented as $WUE_{site}$ or WUE; when no subscript is present the water usage effectiveness is presumed to be at the site level.
WATER USAGE EFFECTIVENESS, SOURCE. The total of both water consumed onsite for a data center and the water required consumed by the source to produce electricity for the data center divided by its electrical energy consumption, in units of liters per kilowatt hour (L/kWh). Represented as $WUE_{source}$.

**C403.1.2 Data centers.** Data center systems shall comply with Sections 6, 7, 8, 9 and 10 ~~and 8~~ of **ASHRAE 90.4** with the following changes:
~~1. Replace design mechanical load component (MLC) values specified in Table 6.2.1.1 of the **ASHRAE 90.4** with the values in **Table C403.1.2(1)** as applicable in each climate zone.~~
~~2~~ 1. Replace annualized MLC values specified in Table ~~6.2.1.2~~ 6.5 of the **ASHRAE 90.4** with the values in **Table C403.1.2(~~1~~2)** as applicable in each climate zone.
2. Any humidification in data centers shall be adiabatic.

3. Air Containment**.** Computer rooms with air-cooled computers in racks and with a *ITE design load* exceeding 10 kW (2.8 tons) per /room shall include air barriers such that there is no significant air path for computer discharge air to recirculate back to computer inlets without passing through a cooling system.

EXCEPTION 1: Expansions of existing computer rooms.

EXCEPTION 2: Computer racks with a design load less than 1 kW (0.28 tons) per /rack.

4. Evaporative cooling towers used in data centers shall use only non-potable water.

~~5. Data centers shall be required to report the site-level water usage effectiveness ($WUE_{site}$) annually.~~

~~**TABLE C403.1.2(1)**~~
~~**MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)**~~

| ~~Climate Zone~~ | ~~DESIGN MLC AT 100% AND AT 50% ITE LOAD~~ |
|---|---|
| ~~0A~~ | ~~0.24~~ |
| ~~0B~~ | ~~0.26~~ |
| ~~1A~~ | ~~0.23~~ |
| ~~2A~~ | ~~0.24~~ |
| ~~3A~~ | ~~0.23~~ |
| ~~4A~~ | ~~0.23~~ |
| ~~5A~~ | ~~0.22~~ |
| ~~6A~~ | ~~0.22~~ |
| ~~1B~~ | ~~0.28~~ |
| ~~2B~~ | ~~0.27~~ |
| ~~3B~~ | ~~0.26~~ |
| ~~4B~~ | ~~0.23~~ |
| ~~5B~~ | ~~0.23~~ |
| ~~6B~~ | ~~0.21~~ |
| ~~3C~~ | ~~0.19~~ |
| ~~4C~~ | ~~0.21~~ |
| ~~5C~~ | ~~0.19~~ |
| ~~7~~ | ~~0.20~~ |
| ~~8~~ | ~~0.19~~ |

**TABLE C403.1.2(1)**
**MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)**
***(supercedes Table 6.5, ASHRAE 90.4)****

| **Climate Zones as Listed in ASHRAE Standard 169** | **HVAC Maximum *Annualized MLC* for *Data Center ITE Design Power* > 300 *kW*** |
|---|---|
| 5B | ~~0.14~~ 0.12 |

** Note: strikethrough text is in ASHRAE 90.4-2019 but not IECC; this is presented as an improvement over ASHRAE 90.4-2019 for clarity but should be shown entirely as new text in mark-up code language.*

**Supporting Information:**

All proposals must include a written explanation and justification as to how they address physical, environmental, and/or customary characteristics that are specific to the City and County of Denver. The following questions must be answered for a proposal to be considered.

- Purpose: What does your proposal achieve?
- Reason: Why is your proposal necessary?
- Substantiation: Why is your proposal valid? (i.e. technical justification)

**Purpose:** This proposal will greatly reduce water consumption in newly constructed data centers in the City and County of Denver. While some new data center capacity may be required in the future to support Denver's growth and data capacity needs, water use is a critical issue in Denver and throughout the Western United States. Water usage is not well tracked, and although measures exist to reduce water consumption, it is very rarely reported. A requirement for data centers to report water usage effectiveness (WUE) will aid regulators in advancing rules to limit water use.

**Reason:** Put simply, the Western United States is running out of water, and data centers consume a large amount of water, often potable water. The increase in data center capacity is outpacing population growth to meet consumer data needs, and aggressive measures are needed to curb energy use and water use. Data centers can be cooled by one of several different system types. Evaporative cooling through the use of cooling towers consumes a tremendous amount of electricity and should be avoided, and there are severable viable system alternatives for both small and large data center. Best practices such as warmer data center temperatures, efficient hot aisle / cold aisle containment, and UPS efficiency should be implemented in all new data centers. The IECC 2021 language on data center efficiency is outdated and does not incorporate the annualized MLC metric specified in ASHRAE 90.4-2019.

**Substantiation**:

Adiabatic humidification is possible through a number of techniques, such as the use evaporative media. Modern data centers can tolerate wider range of indoor humidity levels; many can operate with indoor dewpoint temperatures of 40 to 42F. Hot aisle containment is a common procedure on newer data centers. It allows heat from computer servers to be exhausted directly via a hot aisle, allowing the supply air introduced for cooling to be significantly warmer.

There are several system options for cooling data centers, including CRAC units with airside economizers, CRAH units with chillers, evaporatively cooled by cooling towers, adiabatic cooling where the condenser is cooled evaporatively only during summer peak conditions, refrigerant economizers, and CRAH with water-cooled chillers and a cooling tower. The cooling tower option is relatively energy efficient, but consumes a lot water. The tower requires a periodic "blowdown" to cycle the tower water when scaling and contaminants impact system performance. Often, cooling towers in data centers use potable water as it is accessible with municipal water systems. A requirement to use non-potable greywater will greatly improve water efficiency; another policy option is to enable the local water authority to disallow the use of cooling towers and waterside economizers.

Uninterruptible power supply (UPS) efficiency increases through requiring the Energy Star UPS 2.0 would save energy in two ways: it would directly reduce the power required to supply the data centers and would also reduce cooling loads. An in-depth CASE study by Red Car Analytics demonstrated the feasibility and cost effectiveness of this requirement in California for Title 24. While the California market is different in many ways, including consumer prices, both regions have warm to hot, dry summers, and both are experiencing severe water shortages. The California study (Red Car Analytics 2021) determined incremental costs from higher efficiency UPS power supplies of $91 to $112 per kW of data center load. This efficiency level can be cost effective in some jurisdictions. Cost effectiveness will depend on the savings from reduced peak demand. UPS power supplies are assumed to have an effective life of 10 years.

A recommendation to require slightly more stringent mechanical efficiency, MLC, than ASHRAE 90.4-2019 is based on the following: (1) good practice containment strategies will lead to return air temperatures of 90F, compared to the ASHRAE 90.4-2019 assumption of 85F, leading to increased economizer operation, and (2) opportunities for beyond-code computer room air conditioning equipment (CRAC). This improvement is achievable with today's equipment. Alignment with the ASHRAE 90.4-2019 requirement will set annualized mechanical efficiency requirements for small and large data centers and incorporate electrical power distribution and other efficiency requirements in the Standard.

Water use is not well-tracked in data centers and reported by only major corporation. A site-based water usage effectiveness metric (WUE) is needed to assess how judiciously water is used in data centers. A typical data center might use 1.8 L/ kWh of electricity used. A second metric for source water usage effectiveness also considers the water consumption used by the source (utility and other electricity sources) to generate the electricity used by the data center. The minimum recommendation is to require annual reporting of water use.

$$\mathrm{WUE} = \frac{\text{Annual Site Water Usage}}{\text{IT Equipment Energy}}$$

$$\mathrm{WUE}_{\mathrm{source}} = \frac{\text{Annual Source Energy Water Usage} + \text{Annual Site Water Usage}}{\text{IT Equipment Energy}}$$

**Bibliography and Access to Materials** (as needed when substantiating material is associated with the amendment proposal):

2021 Red Car Analytics. Nonresidential Computer Room Efficiency, Final CASE Report. Codes and Standards Enhancement (CASE) Initiative, 2022 California Energy Code. Copyright 2020, Revised March 2021. Pacific Gas and Electric Company, Southern California Edison, San Diego Gas & Electric Company, Los Angeles Department of Water and Power, and Sacramento Municipal Utility District.

2021 California Energy Commission. Title 24 Building Energy Efficiency Standards, August 2021.

ASHRAE 2019. ANSI/ASHRAE Standard 90.4-2019, Energy Standard for Data Centers.

Gillin, Paul 2021. "Tackling Data Center Water Usage Challenges Amid Historic Droughts, Wildfires, Data Center Frontier, Accessed September 21, 2021. https://datacenterfrontier.com/data-center-water-usage/

Kosik, Bill 2021. "What ASHRAE 90.4 does for data center energy efficiency", Consulting and Specifying Engineer, July 20, 2020, Accessed September 21, 2021. https://www.csemag.com/articles/what-ashrae-90-4-does-for-data-center-energy-efficiency/

Miller, Rich 2009. Data Centers Move to Cut Water Waste. Data Center Knowledge 2009. https://www.datacenterknowledge.com/archives/2009/04/09/data-centers-move-to-cut-water-waste

Mytton, D. Data centre water consumption. *npj Clean Water* 4**,** 11 (2021). https://doi.org/10.1038/s41545-021-00101-w

**Other Regulations Proposed to be Affected**

***For proposals to delete content from the 2019 Denver Green Code in conjunction with adding it to other mandatory Denver codes and/or regulations, only.**

Please identify which other mandatory codes or regulations are suggested to be updated (if any) to accept relocated content.

Water authorities having local jurisdiction could eliminate the use of evaporative cooling towers in new data centers. They may also require data centers that use evaporative cooling towers or other "intensive" water processes to require the use of non-potable water for their processes. Water treatment for intensive evaporative cooling processes would be the responsibility of the data center.

A single agency should collect information reported on water usage from data centers. The water usage effectiveness (WUE) may be better managed through a water authority.

**Referenced Standards:**

List any new referenced standards that are proposed to be referenced in the code.

ASHRAE 90.4-2019, Energy Standard for Data Centers

**Impact:**

How will this proposal impact cost and restrictiveness of code? ("X" answer for each item below)

| | | | |
|---|---|---|---|
| Cost of construction: | _X_ Increase | ___ Decrease | _X_ No Impact |
| Cost of design: | _X Increase | ___ Decrease | ___ No Impact |
| Restrictiveness: | _X_ Increase | ___ Decrease | ___ No Impact |