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2022 Energy Code â€“ Computer Room Comments

Additional submitted attachment is included below.

TAYLOR ENGINEERING

To: CEC

From: Jeff Stein

Subject: docket number 21-BSTD-01 “2022 Energy Code” – Computer Room Comments

Date: June 14, 2021

Below are some of our comments on the 2022 Energy Code Pre-Rulemaking

1. 140.9(a)1 – Please restore this section to the version in the Submeasure Summary dated 3/16/2020, i.e.

   1. **Economizers.** Each individual cooling system primarily serving computer rooms shall include ~~either~~:

      ~~A.~~ ~~A~~an integrated ~~air~~ economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of ~~5~~65°F dry-bulb and below or ~~/~~50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i)~~; or~~

      ~~B. An integrated water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 40°F dry-bulb/35°F wet-bulb and below~~.

   Rationale:

   a. The version in the Submeasure Summary will impact designs and result in real, cost-effective energy savings. The current proposed version will not result in real savings. Raising the air economizer DB from 55F to 65F will have minimal real savings. Per the definition of air economizer, any system directly supplying outside air to eliminate mechanical cooling will have no trouble meeting the load if the OADB is 65 since SAT >=70F is standard practice for data centers. Any air economizer system that meets the 55F threshold also meets the 65F threshold.

   b. Raising the water economizer DB threshold from 40F to 50F has no value since a water economizer, by definition, uses water evaporation to offset mechanical cooling, and water evaporation depends only on the wetbulb, not the drybulb. The current proposed version raises the water economizer WB from 35F to 45F, but this is still well below the 50F value that was shown to be cost effective in the CASE report.

   c. So the air and water economizer sections are largely unchanged but now there are several new options and exceptions that dramatically weaken the standard, most notably the pumped refrigerant economizer with a threshold of 50F, or 40F if using exception 3.

d. A pumped refrigerant economizer meeting 50F DB (and certainly at 40F DB) will not come close to matching the energy efficiency of an air economizer meeting the load at 55F DB or a water economizer meeting the load at 50F WB or even 45F WB.

e. There is no need for a separate pumped refrigerant economizer prescriptive option. A single prescriptive economizer requirement at 65F DB / 50 WB provides all the flexibility needed. There are air economizer, water economizer and pumped refrigerant economizer options that meet 65DB/50WB. Note that if water reliability is a concern and the data center is too many stories to use air-economizing then air-cooled chillers with fluid coolers, or evaporative pre-coolers can be used (rather than dry coolers).

f. The computer room economizer requirements were put into Title 24 in 2013 (delayed from 2011) and were the first time Title 24 had any computer room requirements. As such they were a conservative, first step to get a foot in the door. The original version of the water economizer requirement for the 2013 version was 40F. This analysis was done in 2008 and was based on the fact that containment was not common and that computer room supply air temperatures of 55-60F were common. Since 2008 great strides have been made in improving computer room efficiency (driven in no small part by Title 24 and 90.1). Now containment is ubiquitous and supply air temperatures of 70-80F are the norm. The CASE Report shows that water economizers can easily and cost-effectively be sized to meet 100% of the load at 50F WB. Leaving the WB threshold at 35F is a shame. It means a designer can use undersized cooling towers (e.g. 15F approach vs 6F approach) and put in a tiny heat exchanger (e.g. 10F approach) that will have a fraction of the energy savings of a reasonably sized HX (e.g. 3F approach).

g. One of the many faults with the most common pumped refrigerant economizer on the market is that it is not fully integrated. It has 2 refrigerant circuits that can either be on compressor or economizer pump. If a circuit switches to economizer pump the economizer may only be able to achieve a small fraction of the load so the controls must wait until the DB is low enough for the economizer to meet enough of the load to make up for the loss of the compressor. So at best this product is half way between integrated and non-integrated. Unfortunately, “integrated” is not defined in the standard.

h. My direct experience with this pumped refrigerant economizer on real data centers is that it does not come close to achieving the PUE of data centers with air or even water economizers, when compared on an apples-to-apples basis (similar climate, load ratio, etc.). Hopefully the CEC will not make a decision based only on glossy marketing and biased energy models put forth by the refrigerant economizer manufacturer, but instead will insist on real data from real projects showing similar or better efficiency than air or water economizer systems.

i. One of the reasons the Submeasure Summary got rid of air and water and simply refers to "economizer" is because many data center economizer systems do not meet the definitions of air or water economizer. For example an air-cooled chiller with an integrated dry cooler (ACC-IDC) is not an air economizer because it is not "a ducting arrangement, including dampers, linkages, and an automatic control system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical cooling." It also does not meet the water economizer definition: "…the supply air of a cooling system is cooled directly or indirectly by evaporation of water, or other appropriate fluid…" And it is clearly not a refrigerant economizer.

j. But an air-cooled chiller with a dry-cooler is clearly an economizer. So the user gets to decide which type it is. The user will of course choose water economizer because it lists the lower drybulb of 50F. (why else would the water economizer list a drybulb, they will argue). Users will also claim they meet Exception 3 and/or Exception 4 to get away with a 40F drybulb. This is also a shame because an air-cooled chiller with a dry-cooler is not an efficient design, even at 50F, and especially at 40F. An air-cooled chiller with a dry-cooler will not meet the PUE requirement in ASHRAE 90.4-2019, as shown in the table below. Taylor Engineering serves on 90.4. We performed the analyses below that were used to raise the bar in 90.4-2019.

ASHRAE Climate Zone	Mechanical PUE required by ASHRAE 90.4-2019	Mechanical PUE for Air Cooled Chiller with Dry Cooler
Zone 3C (most of coastal CA)	1.14	1.16
Zone 3B (rest of CA)	1.17	1.22

k. So while ASHRAE and the rest of the country is moving forward with data center efficiency standards, California is clearly moving backwards, lowering the bar for data center efficiency standards. For comparison, the same analysis we performed for 90.4 showed a PUE of 1.055 for an air-cooled chiller with air-economizer in zone 3C (including disabling the air economizer outside the TC9.9 humidity envelope). So the system with the dry cooler uses 3 times as much energy as the system with the air economizer.

l. Some history: After T24-2013 went into effect most data center owners followed the code and put in direct airside economizers or chilled water plants with waterside economizers. Many of these are operating successfully today and enjoying the associated energy efficiency. However, some of these designs were botched, resulting in reliability issues and colo SLA violations. (We know because we have been hired to fix several botched economizers at data centers in CA). These botched designs, combined with aggressive marketing by the (DSE) refrigerant economizer and air-cooled chiller with integrated drycooler (ACC-IDC) vendors, convinced some data center owners to switch to DSE or ACC-IDC for recent designs, particularly outside California, where these systems meet code (90.4-2019 is not in effect yet in most of the country). I would argue that DSE and ACC-IDC do not meet the prescriptive code in CA but vendors of DSE and ACC-IDC have successfully argued otherwise in many cases. After no improvements in the Title 24 computer room economizer requirements for 9 years, the 2022 CASE team demonstrated that significant improvements were cost effective, as shown in the Submeasure Summary and CASE report. When the DSE and ACC-IDC vendors got wind of the changes they rallied their recent customers and trade association to lobby the CEC and Statewide Team, which appears to have capitulated on improving the standard and gone one further by weakening it. The solution to botched design, of course, is proper engineering, construction and commissioning. Just like DSE and ACC-IDC, air/water economizers can be reliable, or not, depending on the quality of the design and installation.

2. Revise Exceptions 3 to 140.9(a)1 as follows:

   EXCEPTION 3 to Section 140.9(a)1: If the local water authority does not allow cooling towers the cooling system shall include an integrated economizer capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by section 120.2(j).

   Rationale:

   a. There is already at least one truly integrated pumped refrigerant economizer whose system is capable of meeting 100% of the load at 65F DB and likely others that can meet the load at 55F DB.

   b. From our research, there are multiple aircooled chiller with integrated drycooler vendors whose products can meet 100% of the load at 55F DB. Note: our analyses were based on 90% load on the chiller. Redundancy between 10% and 50% is standard in data centers and can be counted towards prescriptive compliance.

3. Restore the Heater Recovery proposal in the CASE Report

   Rationale:

   a. Per the CASE report, computer room heat recovery is cost effective. The CASE report proposal is conservative and only covers a small fraction of computer rooms. It is almost certainly cost effective in many more cases not covered by the proposal.

   b. Electrification and reducing natural gas use is a major focus in California. As such there are many new requirements in Title 24-2022 that require heat pumps for space and water heating, such as schools, office buildings and libraries. Many of these new requirements have negative cost-effectiveness. Heat pumps are higher first cost, higher maintenance, and higher energy cost than gas heating. But it makes sense from a societal perspective based on climate change.

   c. An air-source heat pump for a school or office has a heating COP of around 2.0. Computer room heat recovery can have a heating COP anywhere from 4.0 (heat recovery chiller) to 10.0 (direct air transfer). And this does not include the free cooling!

d. If we are serious about electrification, then we should start with the low hanging fruit. Computer room heat recovery is about as low hanging as it gets.

e. Data center heat recovery is extremely low risk and increasingly accepted. We know of at least three tech companies in the Fortune 50 that routinely recover heat from their data centers for space heating.

4. Restore the PUE Monitoring proposal in the CASE Report

Rationale:

a. This is a no cost requirement with a huge upside. All large data centers, to which this applies, already collect this data. The requirement simply standardizes the calculation of PUE. Most importantly, this paves the way for a California Data Center Energy Benchmarking Program, similar to the California Building Energy Benchmarking Program, which allows anyone to see the site EUI of the thousands of benchmarked buildings in CA. Site EUI is not a particularly interesting or useful metric because it gives little insight into the energy efficiency of a building and thus little incentive to change behavior. This is because EUI varies greatly based on building program, occupancy, whether the building includes computer rooms, labs, a call center, runs 24/7, etc. PUE of a large data center, on the other hand, is a very accurate measurement of energy efficiency. This is because the load is almost entirely IT (e.g. almost no envelope or people loads) and PUE is normalized to the IT load. There is no consensus of what a good EUI is for an office building and thus no embarrassment by a high EUI. In contrast, everyone in the data center business knows a good or bad PUE. Owners of poorly performing data centers will be highly incentivized to design and operate their data centers to improve PUE. Google, Apple, Facebook and many others are spending massively on data center PR and "greening" their data centers with PV. Yet the actual efficiency of their data centers is of little interest to many data center owners and operators because no one can see it. The folks running the data centers on a daily basis are rarely incentivized by efficiency. They are incentivized by uptime. Consequently, it is common for operators to disable economizers and otherwise undermine efficiency to keep it simple. What would happen if the New York Times ran an article comparing the efficiency of data centers in CA owned by high profile companies? The incentive to save energy would be massive.

5. Revise Exception 2 part ii to "The economizer system has the ability to deliver either the computer room ITE design load or 5 tons"

Rationale:

a. This exception has been narrowed down to just rooms <20 tons. And the "25% of economizer capacity" only applies to rooms over 5 tons. The intent in the

Submeasure Summary of limiting it to "available economizer capacity on the same floor and within 30 feet" is because it may not always be cost effective (or possible) to oversize the ductwork to the computer room. Deleting "available economizer capacity" and replacing it with "25% of the economizer system capacity" does not address this problem because the house air system with the economizer is often quite large (e.g. over 75 tons), serving multiple floors and large floor areas. So changing it to "25% of the economizer capacity" effectively requires the economizer system to meet the full computer room load. Capping it at 5 tons will not result in a significant loss of energy savings for the handful of rooms between 5 and 20 tons, in part because they still have to put in at least 5 tons. Computer rooms are rarely fully loaded so 5 tons may be the whole load most of the time, anyway. And the ones that can reasonably be designed to meet the design load (e.g. 10 tons) will probably do so anyway because the incremental cost is small and the benefit in energy and/or reliability could be significant.

6. Revise 141.1(b).1 to match 140.9(a)1 per Comment 1 above, i.e.

   1. **Economizers.** Each individual cooling system primarily serving computer rooms shall include ~~either~~:

      ~~A.~~ ~~A~~a n integrated ~~air~~ economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of ~~5~~65°F dry-bulb and below or ~~/~~50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i)~~; or~~

      ~~B. An integrated water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 40°F dry-bulb/35°F wet-bulb and below~~.

   Rationale:

   a. See Comment 1 above.

7. Add a definition of an integrated economizer, specific to computer rooms. The definition should make it clear that the economizer should be capable of meeting any fraction of the load (between 1% and 100%), while the refrigerant compressor meets the remaining load fraction (between 99% and 0%).