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Ian Atkins Comments on Final CASE Report

Comments in Attached PDF

Additional submitted attachment is included below.

I am a licensed mechanical engineer who is focused almost exclusively on HVAC design for indoor cultivation facilities. Over the last decade, I have designed and evaluated a wide variety of integrated, decoupled, 2- and 4-pipe chilled-water, VRF, and hybrid cultivation HVAC systems. Because this proposal would directly affect the types of systems my clients can use, I reviewed the Final CASE Report in detail (as well as the Draft CASE Report and the ASHRAE 90.1 document). My comments are intended to improve the technical basis of the proposal rather than oppose energy-efficiency improvements.

Overall, I feel the proposed rules add too many requirements that do not have strong energy efficiency justification, and as currently written, may (unintentionally) restrict some efficient system options. It's good to have clarity on ventilation rates. And I think increasing the required reheat in integrated systems from 75% of annual reheat energy to 90% of heat rejection would save energy, as long as it doesn't exclude efficient system types (more on this one). **All page numbers cited are the page numbers shown on the pages, not the digital PDF page numbers.**

1. The modeled comparison changes too many variables to establish the savings attributable to each proposed requirement.

The comparison between the baseline decoupled system and the proposed CASE integrated system changes both the fundamental system architecture and numerous equipment and control characteristics. The proposed case is described as an integrated, variable-capacity, variable supply fan volume system with integrated controls, while the baseline consists of standalone dehumidifiers, single-stage space-conditioning equipment, constant-volume fans, and electric resistance reheat.

As a result, the modeled 25% difference in energy use represents the combined effect of many simultaneous differences, including:

- integrated versus decoupled equipment;
- variable-capacity versus single-stage cooling;
- variable-airflow versus constant-airflow operation;
- recovered-heat reheat versus electric resistance reheat;
- differing equipment efficiencies;
- differing sensible heat ratios;
- differing control sequences;
- potentially also, differing equipment-sizing assumptions

The analysis therefore does not establish which of the proposed requirements are responsible for the modeled savings.

The CASE analysis should evaluate comparable baseline and proposed systems within each system category. For example:

- A baseline integrated system complying with the existing 75% annual recovered-reheat requirement should be compared with an integrated system complying with the proposed requirements.
- A current-code decoupled system should be compared with a decoupled system incorporating the proposed staging, control, and dehumidifier-efficiency requirements.

This would allow the Commission to identify the incremental energy savings attributable to each proposed requirement rather than attributing the total difference between two substantially different system designs to the proposed measure as a whole.

2. The baseline code minimum system description including "electric reheat" is inconsistent with my view of both the definition of a decoupled system and a code compliant system under the existing Title24 efficient dehumidification rule

Page 170 describes the baseline system as follows:

"The baseline system includes humidistat-controlled standalone dehumidifiers and thermostat-controlled, single-stage space conditioning systems with electric resistance reheat."

In a "fully decoupled system", standalone dehumidifiers provide humidity control, not reheat.

The report should also identify the existing compliance pathway under which that arrangement of electric resistance reheat is considered code compliant, given the existing 75% recovered heat requirement applicable to integrated or reheat-based dehumidification systems, which in my understanding, pure electric resistance reheat would not comply with.

Table 98 appears to include 4 kW of electric resistance heat per unit. Across 24 units, this represents 96 kW of installed electric heat. This is a highly unusual amount of heat for a fully decoupled system.

3. Multiple single-stage units should be permitted to satisfy staging requirements at the system level

Section 2.2.2 (pg 203) requires at least two stages of fan control and two stages of cooling capacity for cooling equipment used in decoupled systems. This requirement should be based on room level capacity control rather than requiring every individual unit to have multiple stages.

A room served by multiple single stage units can provide substantial capacity turndown by staging the units in groups or by controlling units from separate local thermostats with coordinated setpoints. For example, the baseline modeled room with 24 5-Ton units has many possible increments of cooling capacity even when each individual unit is single-stage.

Requiring every unit to have two-stage or variable-capacity operation may unnecessarily exclude common 3Ton and 5Ton equipment without demonstrating energy savings. Single stage equipment will generally also achieve lower leaving air temperatures and lower coil SHR than variable capacity equipment operating at reduced compressor speed.

4. The 65,000 BTU/hr minimum unit-capacity requirement lacks a demonstrated energy-efficiency basis.

Section 2.2.2 (pg 204) appears to exclude cooling equipment with capacities of 65,000 BTU/h or less from decoupled systems. The Final CASE Report does not demonstrate that smaller equipment is inherently less efficient or that multiple smaller units consume more annual energy than using larger units.

3Ton and 5Ton split and mini-split equipment are widely available and may have high rated efficiencies, strong part-load performance, and practical redundancy benefits. Multiple small units are also commonly used to serve a single zone in restaurants and bars for example, among other spaces, and I am not aware of energy code limiting the use of multiple smaller units in these applications.

5. The mandatory requirements should explicitly recognize chilled-water cooling combined with standalone dehumidifiers

The proposed system categories do not clearly include a decoupled system consisting of chilled-water fan coils and standalone dehumidifiers. This is, in my opinion, a really good and efficient system type that should be expressly permitted.

I recently evaluated a successful cultivation facility using a two-pipe chilled-water system with standalone dehumidifiers and 8 nominal 5-ton fan coils per flower room. The code should not inadvertently exclude this system type by imposing a minimum indoor-unit capacity or by defining compliant decoupled cooling systems around direct-expansion equipment.

6. The requirement that the integrated system meet 80% of the latent load (pg 203, 2.1.2) is not supported by a demonstrated energy-efficiency basis and restricts an efficient system architecture of "combined systems"

I do not think the requirement that 80% of the latent load be met by the integrated system has any basis in energy efficiency. The integrated system needs to meet the sensible cooling load, and total load with all standalone dehumidifiers running. But once it does, adding dehumidifiers to then also meet the latent load at the desired setpoints can have multiple benefits including cost and efficiency. For example, integrated systems can easily need 1 Ton capacity per kW lighting to meet the moisture removal at say 75F/50% later flower. However, using a half ton integrated system and half ton of dehumidifiers per kW of lighting can have several advantages. For one, it will generally cost less (lower cost per incremental Ton/moisture removal of dehumidifier vs Integrated unit). In addition, fully meeting (or meeting 80%) of the latent load with integrated units also means excess supply fan capacity for much of the grow cycle, limited turndown, and excess condenser capacity. In addition, using a significant amount of dehumidifiers in combination with integrated DX units, allows using lower cost packaged DX units that may recover closer to 50-75% of their heat of rejection (described more in next comment), while also avoiding additional resistance or combustion reheat.

7. "Combined" systems with lower than 90% recovery of Integrated Unit heat of rejection should be permitted where supplemental dehumidifiers eliminate the need for non-recovered reheat.

An integrated system that cannot independently recover 90% of its heat rejection should be permitted to operate in conjunction with standalone dehumidifiers, provided the combined control sequence prevents electric resistance or combustion heat from being used for dehumidification reheat.

Some commercially available integrated or DOAS-type units can recover approximately 50% to 70% of heat of rejection for hot gas reheat. These units are often more cost-effective than "purpose built" units and when combined with standalone dehumidifiers

that add heat to the room, can be part of efficient systems that do not require external sources of reheat energy.

A pathway for these “Combined Systems” could require the heat from dehumidifiers and hot gas reheat to cover all of the reheat needed at the design conditions.

8. The 3.0 L/kWh CIEF threshold should have some justification

9. Existing standardized equipment efficiency ratings remain valuable indicators of relative equipment efficiency and should not be dismissed simply because they are based on standardized operating conditions

Throughout the Final CASE Report, the CASE Team repeatedly states that existing federal and industry efficiency ratings "do not reflect the operating conditions" found in indoor growing facilities. Examples include EER, IEER, SEER, IPLV, ISMRE2, consumer dehumidifier test procedures, commercial cooling equipment, VRF equipment, and commercial dehumidifiers. The report further states that actual equipment performance and efficiency "can deviate significantly from its official rating" and uses this as justification for developing additional California-specific performance requirements.

I agree that standardized rating conditions are not perfect. Indoor growing spaces experience unique combinations of sensible load, latent load, lighting schedules, and operating setpoints, etc.

However, the report appears to equate **"not identical to actual operating conditions"** with **"not useful for evaluating equipment efficiency."** I do not believe the report demonstrates this conclusion.

Standardized efficiency ratings are fundamentally **comparative metrics**, not project-specific energy models. For example, DX dedicated outdoor air systems (DOAS) are evaluated using the ISMRE2 rating, even though the same equipment may be installed in substantially different climates such as in Dallas vs Denver, it can still be a useful metric.

The same principle applies to commercial dehumidifiers. A dehumidifier that removes more moisture per unit of electrical energy at the AHAM rating condition of 80F / 60% (a very common condition in indoor grows) generally remain more efficient than a lower-rated unit when both are operated at cooler and drier cultivation conditions such as 73F / 50%, even though both units will experience lower capacity and lower efficiency at those

conditions. The report provides no analysis demonstrating that equipment efficiency rankings materially change under representative cultivation operating conditions.

10. Liquid desiccant is included in the definition of an “integrated system” (pg 198) without having been modelled. However, solid desiccant is not explicitly included. I think solid desiccant should be allowed and explicitly listed if liquid desiccant is, as long as recovered heat is used for desiccant regeneration.

11. And finally, while the proposal has certainly dialed back the narrative on integrated systems being more energy efficient than decoupled systems compared to the Draft CASE Report, I still take issue with how the Final CASE Report frames decoupled systems as inherently energy inefficient and needing to compensate in various ways (higher efficiency dehumidifiers, central control system).

The Draft Case Report notes that One Stakeholder (me), “objected to the characterization of integrated systems as generally more efficient than decoupled systems, citing instances of integrated systems with insufficient hot gas reheat capacity.” I wanted to expand on why I objected to this characterization beyond just integrated systems with insufficient hot gas reheat capacity.

The Integrated vs Decoupled topic has been actively discussed for years, including during the 2022 Title 24 CEH code cycle, where it was first proposed to require integrated systems in facilities with greater than 2000 sf canopy, but following public comment, it was determined that decoupled systems should continue to be allowed, including for facilities with greater than 2,000 sf canopy. (https://title24stakeholders.com/wp-content/uploads/2021/03/2022-T24-NR-CEH-Final-CASE-Report_w-Addendum.pdf, pg 165). Given the rejection of the 2022 proposal, and the prevalence of decoupled systems per data included in the Draft CASE Report (up to 75% of facilities in California, pg 117, 129), a high standard of evidence should be used to establish the categorical claim that integrated systems are more energy efficient than decoupled systems.

The Final CASE Report continues to perpetuate the idea that the heat from dehumidifiers results in systems including them being overall less energy efficient than "integrated" systems without standalone dehumidifiers because “the heat they generate then needs to be removed by the cooling system”. This is not inherently true because anytime a dehumidifier is running, its because there is a call for dehumidification, the heat generated by the dehumidifier, actually helps the cooling system dehumidify more. It is not “extra” heat, it is helpful heat. While its true ACs can often have high SHRs at say 73F/48%, the

assumption for the baseline cooling system having an SHR of 1.0 in Table 104 is not accurate across the grow cycle. As the Final Case Report notes, only some facilities try to or have the capacity to get this low. At the conditions for most of the grow cycle (Table 63), a cooling only AC does do significant moisture removal. In addition, there are various factors like the high moisture removal efficiency of some standalone dehumidifiers, high cooling efficiencies of VRF, minisplits, and chillers operating at higher chilled water temperatures that offset the inefficiency of the higher SHR of some cooling only equipment.

Publicly available data is lacking. Though I have often heard over the years that in general HVAC (including dehumidification) and lighting energy use are close to 1:1, and this ratio is also noted in the Final CASE Report. A 2018 study (link below) by SMUD documented energy use for 2 integrated systems (AAON and Desert Aire). (https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/Advanced-Tech-Solutions/Indoor-Horticulture-HVAC-System-Evaluation-Final-Report-113018.ashx). The HVAC to lighting energy use ratios were 125.8% and 99.8% for the two integrated systems in the SMUD study. This seems like normal energy use, but does not necessarily show high efficiency.

Closing Statement

I appreciate the significant work performed by the CASE Team in developing this proposal. My comments are not intended to oppose improvements in energy efficiency for controlled environment horticulture. Rather, I believe the current proposal introduces numerous design requirements whose individual energy savings have not been sufficiently demonstrated and limits the implementation of a couple efficient system types. Please feel free to contact me with any questions or to discuss.

Sincerely,

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