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Regulation Needs a Firm Foundation in Science

Additional submitted attachment is included below.

Regulation Needs a Firm Foundation in Science

Comments by Bruce Severance, Mitsubishi Electric US, on the Proposed VCHP Compliance Option
July 26, 2019, CEC Docket Number: 19-BSTD-02

Lack of Peer Review on Research Underlying the VCHP Compliance Option

During the February 15 Workshop on the VCHP Compliance Option, the CVRH research team claimed that the test data for all the scenarios is "in the reports". A careful review of all of the CVRH reports does not yield clear data for all ten of the test scenarios that are said to provide the basis of the VCHP Compliance Option requirements. There is reason for substantial concern that this research has never been adequately peer reviewed by anyone inside or outside the CEC, and given the authority with which the research findings are being used to support the VCHP Compliance Option requirements, such peer review is warranted. When various members of the CEC team were asked to provide all of the test scenario data on one chart, including system capacity, calculated load, AHRI ratings, and measured SEER and HSPF, our office was told "the data is not available'. This answer is inadequate when equipment performance is being judged statewide on this basis, and if the data is truly not available, it is clear the research was never independently peer reviewed. Equipment manufacturers have cause for concern.

MERV 13 Filtration Requirement for Low-static Ducted Systems

Although the MERV 13 filtration requirement is not clearly stated in the body of the VCHP Compliance Option anywhere, recent emails and conversations with CEC staff and CVRH research staff state that they fully intend to require MERV 13 filtration on low-static systems under the new VCHP compliance option. What is stated in the "Variable Capacity Heat Pump Proposed Compliance Option" (pg.22, submitted 2-6-19) is the following:

"In order to ensure that ducted low-static systems provide the required airflow rates, and do not consume fan energy greater than systems monitored in the CVRH project, the air filter requirements in 2019 Title 24 Part 6 Standards Section 150.0(m)12B shall be met for systems that use any length of duct. The systems shall be equipped with air filters that meet one of the following two alternatives:

1. Nominal two-inch minimum depth filter(s) shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch w.c. at the design airflow rate, or

2. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized based on a maximum face velocity of 150 ft per minute at the design airflow rate, and a maximum allowable clean-filter pressure drop 0.1 inch w.c."

Although this passage says nothing directly about MERV 13 filtration, the authors and CEC staff interpret this to mean MERV 13 filtration is required on low static systems under this compliance option. The CEC code section 150.0(m)12.B referenced above pertains to filter sizing and pressure drop and does not require MERV 13 filtration which is referenced in 150.0(m) 12.C. The only phrase in the passage above that may hint at applicability to low-static systems is the reference to "systems that use any length of duct", because there is an exclusion under Section 150.0(m)12.A.i that excludes systems with under 10' of duct, an exclusion meant to be applicable specifically to low-static systems.

However, even if this phrase said “low-static system” in place of “any length of duct” the phrasing would remain ambiguous because the code section cited (150(m)12.B) only pertains to filter grill sizing and not MERV filtration values. Regardless of how you read it, there is nothing in this reference that actually reverses the exclusion under Section 150.0(m)12.A.i which clearly states that systems with under 10’ of ducting, and by implication, all low-static systems, are exempt from the MERV 13 requirements defined in 12C.

When asked for any test data on how MERV 13 filtration may impact the other VCHP compliance requirements such as ESP and airflow, the CEC admitted it has NO test data which demonstrates how to make low-static systems conform with the MERV 13 requirement. This is entirely unfair. Not only is the requirement ambiguous, they have no testing, no set of system design guidelines or even a place to begin. I do not currently know of any systems that have been tested and sold by a manufacturer that already complies with this standard, and most importantly, the CEC doesn’t have a clue if it is possible to install MERV 13 filtration on low-static systems without impacting their other requirements: 350-400cfm/ton, maximum static pressure of .35 w.c., and a maximum clean filter pressure drop of .1 w.c.

There is a high likelihood that this set of interacting requirements structured around tight tolerances will create an obstruction rather than a path to compliance. It is almost incomprehensible, that staff would impose such stringent requirements without having tested the impacts of these very interactive variables.

One must ask if the ambiguities in this document are intentional. Other stakeholders who have read this document also do not believe it requires MERV 13 on low-static systems. The text seems clear that it does not require compliance with 12C, only 12B, and yet CEC maintains otherwise.

When I asked one CEC official to send out a memorandum to industry stakeholders clarifying the CEC’s intent to require MERV 13 on low-static, he said that it was up to industry to comment on the VCHP Compliance Option as is. The refusal to clarify such a completely misinterpreted passage leads one to think that some CEC staff prefer this to remain ambiguous to keep the industry response and resistance to a minimum.

Given the circumstances, it is improbable that manufacturers are generally aware of the CEC’s intent to interpret the current VCHP Compliance Option to impose the MERV 13 requirement. The ambiguous statements in the VCHP Compliance Option may take many of them by surprise, which will leave manufacturers scrambling to comply, and few, if any, may be prepared when the VCHP Compliance Option takes effect next year.

If the CEC was trying to actually get manufacturers to comply, clarity in writing the requirements would be a good place to start. Intentional or not, the MERV 13 filtration requirement is a “curve ball”.

No Central VCHP Compliance Option

The CVRH research project did not set out to test central high-static VCHP heat pumps and as a result, the VCHP Compliance Option has no provision for them, yet this is one of the most affordable types of VCHP systems on the market. Perhaps this is due to the bias for putting all ducts in conditioned space (DCS) in new construction, but there are problems with that as well, unless you also require all ducts in conditioned space to be hard metal ducting sealed in mastic – so it will never fail. Otherwise, flex ducts will start to leak in twenty or thirty years and residents will be reticent to repair them if drywall must be removed.

When CEC staff was asked if there was any clear data measuring BTUs lost through the ducting in both a DCS condition and when ducts are deeply buried in a high performance attic (HPA), they did not have clear data. Provided all supply grills are located near interior walls, and ducts are deeply buried, and attics are well ventilated to prevent high attic temperatures (over 110°), loss through the duct wall is minimal. This is easily calculated and the energy savings are not reflected in CBECC, which doesn't have an option for short-ducts in HPA. The CEC has known this for some years, but has not generated installation guidelines for "short-ducting" central systems. Key advantages are significant total project cost reduction and energy savings when R-50 to R-60 is blown to deeply bury ducts, compared to the typical R-38 with a DCS condition created with a hall drop ceiling. The additional cost of R-50 is about $.20 cents per sf and R-60 is about $.40 per sf. On a typical 1600sf home that is an additional $650 dollars, with added insulation over the entire house, while the cost of the drop ceiling adds about the same cost with no additional ceiling insulation. It is hard to justify that DCS actually provides a better energy savings value than short ducts in an HPA would.

Nevertheless, central high-static VCHP heat pumps deserve better ratings and a path to higher compliance credit than the minimal 14 SEER cap that is currently imposed upon them by the CEC. They have even more applicability to energy upgrades. Especially for the low to moderate income households that SB350 and SB1477 are mandated to target, few systems are more cost effective for conventional split system replacement than high-static central VCHP heat pumps. Because so much of the California housing stock already has ducted systems, if ducts are in reasonable or repairable shape, replacing a central furnace with an central VCHP heat pump is a clear path to carbon-free higher efficiencies. These systems have lower cycling losses than typical single stage systems and they merit closer examination.

In-Slab Hydronic Systems Get Credit for DCS in CBECC

There is some irony in the fact that in-slab hydronic systems are not required to have full under-slab insulation while these systems enjoy DCS credit. The state's CBECC software doesn't even allow an option for full slab insulation, and only requires four feet of horizontal perimeter insulation in CZ16. Running heat load calcs indicates that there is as much heat lost to ground in the absence of full slab insulation as there is through long R-6 ducts in an unimproved attic. So what is the scientific basis for giving hydronic systems DCS credit? Energy Code Ace trainers are encouraging classrooms full of architects in webinars to use in-slab hydronic heating systems as an efficient solution, but there is no scientific basis for asserting that this saves energy.

By contrast, there is no allowance for VCHP high-static air handlers with deeply buried ducts in a deeply buried condition. And there is substantial evidence from work and data gathered by Rick Chitwood, that this is extremely cost effective on retrofit projects. His data indicates that heating and cooling loads can be consistently cut by 60% to 70% in older retrofitted homes. How much more effectively will this alternative work in new homes? There are reams of data on Chitwood's approach, and it is far more cost effective than in-floor hydronics which can easily add $15,000 to $20,000 above the cost of a central heat pump system, nevermind that they are usually dependent on a boiler. The CEC has not given the central VCHP alternative fair hearing. This just testifies to the extent that the code requirements, and preference given to one technology over another are governed by bias in the absence of scientific research and hard data. Bias also arises from what the CEC's research teams choose to study or not study.

Conflict of Interest in CBECC

The CVRH research that has provided the basis of the VCHP Compliance Option, has been conducted by research contractors who also write the algorithms for the State's approved compliance modeling software. There is an inherent conflict of interest in this arrangement that manifests itself in less transparency regarding errors in the HVAC field test procedures as well as inaccuracies built into the CBECC model. For example, the CVRH research paradigm was set up so that the performance of VCHP equipment would be compared or benchmarked against a single-speed, 14 SEER "reference" system, - a reasonable enough proposition. However, the 14 SEER "reference" system was not actually a 14 SEER system at all.

The research team was so interested in experimenting with efficiency that they removed the factory motors and installed much higher performance motors that used about 40% less energy (average of .35W/cfm instead of .58W/cfm). Nevertheless, the CVRH research referred to the reference system as "14 SEER" throughout their reports and used the factory performance data as the benchmark, fully aware that this was inaccurate and an unfair representation that would make VCHP performance look worse in the public facing reports. The report did include footnotes about the reference system modifications. However, adjustments for this error were later made, not by mathematically estimating the actual SEER of the reference systems in the reports, which would be awkward, but by altering the algorithms in the CBECC software, where the error is less scrutinized and if found appears to be a generous "boost" to how VCHP's are modeled. The result is that CBECC now has an artificially high fan Watt draw rating built into the VCHP modeling.

What is wrong with this picture? First, the research team was able to use a 14 SEER benchmark when the systems were more likely operating at the 15 or 16 SEER level, and the team was able to minimally rate VCHP technology for last five years based on this minimal rating. Second, this minimal rating is now used as leverage to induce manufacturers to comply with the VCHP Compliance Option requirements, because they can't market their products without getting a minimum level of "compliance credit" which directly translates into cost-competitiveness. Otherwise architects start looking for other options that are easier to integrate and which will not require expenditure on other building measures to "buy" the needed compliance credit. Lastly, it's just wrong. The CVRH researchers have built erroneous data into their software to mask their errors, and consequently the software is wrong. Any future software editors will have to unwind such errors if they are working from correct filed test data.

For these reasons it becomes abundantly clear that the CEC's research must be adequately peer reviewed, and software development should not be led by the research teams. The inaccuracies have hurt the VCHP manufacturers, and they have hurt the public interest.