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Please note typo (letter missing in intro) in original submission and use this instead. Thank you

Additional submitted attachment is included below.

Mitsubishi Electric Comments on 45-Day Language of Proposed Draft 2022 California Energy Code

Submitted by Bruce Severance, Regulatory Compliance Engineer, Mitsubishi Electric US

Docket: 21-BSTD-01, June 15, 2021

Introduction

Mitsubishi Electric US, Inc., Heating and Air Conditioning Division (MEUS HAD), is a leading manufacturer of ductless and Variable Refrigerant Flow (VRF) heat pumps and air conditioning systems. We appreciate the Commission's efforts to mitigate the impacts of buildings on climate change and recognize the importance of rapid mobilization strategies that produce measurable reductions in GHGs over the next thirty years as well as the broader goal to transform California's economy to carbon free and carbon negative alternatives.

While we generally support the Commission's improvements to Title 24, Part 6, we continue to have several concerns related to VRF products and use of economizers and DOAS systems. Changes proposed will make use of VRF systems less efficient, opposite of the Commission's desired outcome.

Requiring Economizers on VRF is Neither Cost-Effective Nor Efficient

The CEC 45-day language proposes to make economizer requirements more stringent on commercial systems by lowering the requirement threshold from 54kbtu to 33kbtu (Section 140.4 (e) 1). Exception 6 to this section requires compliance with 140.4(p)1B i-iii, which would require economizer modes of operation for VRF systems paired with decoupled DOAS (definition includes ERVs that are separate from conditioning systems). According to 140.4(p)1Biii, these must have flow rates of outside air in a bypass mode of .3cfm/sq. foot (300cfm per 1000sf of conditioned space).

While it may appear that imposing economizer requirements on VRF systems would yield some efficiency gains, it is also clear that that economizer run hours (after sunset) are some of the most efficient (partial-load) run hours for VRF, and it is not at all clear that the modeling used to assess the energy savings for such configurations clearly factored all of the VRF efficiency variables. In short, a DOAS system attempting to increase VRF system efficiency by operating with direct outside air cooling under evening partial load conditions is attempting to improve VRF efficiencies when they are likely to be idling at their highest system efficiencies. One can compare the power demand of a compressor running at low-load times to the high fan power required to run an economizer during the same conditions and conclude they are at best a wash.

To meet the .3cfm/sq.ft. economizer requirement, there must be a significant increase in fan energy for most applications as the result of shifting from predominantly recirculated air and fractional outside air to high outside air flows required to “economize”. In essence, there’s an energy trade-off between compressor energy and fan energy and it may amount to a zero sum gain in terms of energy consumption in many applications. This is even more likely to weigh against economizers now that MERV 13 filtration is required for DOAS systems, which can easily result in higher fan watt-draw. Actual efficiency of this fan versus compressor power trade-off will vary with several factors such as total length of ventilation ductwork, number of bends in the ducting, filter area, type of fans used in the ERV/HRV/DOAS, etc.Despite modeling performed on VRF-coupled economizers, they may not prove to be either efficient or cost-effective for most commercial applications (office, hotel, retail, multifamily residential, religious centers, etc.) since this requirement will result in a ventilation system which adds complexity, with marginal and variable efficiency gains. Oversizing the ventilation system by a factor of two above ASHRAE 62.1 requirements will inherently result in a system with lower operating efficiency for all run hours except the small subset of run hours where it is economizing. Inevitably, it will add unreasonable cost to VRF projects.

VRF without Economizers Are More Efficient Than Roof Top Units with Them

Airside economizers were developed predominantly for packaged RTU equipment, for which they offer a significant benefit with minimal added cost and complexity. VRF systems without economizers are far more efficient than code compliant RTU’s with economizers. VRF systems with heat recovery are even more efficient in low-load conditions adding another 20% efficiency due to their ability to move waste BTUs from one zone to another without the refrigerant cycling through the compressor, resulting in a significant savings in compressor energy. VRF systems offer more diverse zone control and the ability to fully shut off unoccupied zones. This is not an option with central RTU type systems. These features lead us to question the desire to require economizers for VRF systems. We suggest modeling this comparison of RTUs with economizers versus VRF and factoring all such variables, with and without refrigerant heat recovery (not to be confused with ERV heat recovery) in any commercial energy modeling program (eQUEST, EnergyPro, Energy Plus, Trane Trace, Carrier HAP, etc.). Our engineering team is confident, that VRF would win in this head to head comparison. We feel there is cause to question the modeling and cost trade-off analysis that found economizers on VRF systems to be "cost-beneficial".

Before making any changes in the terminal unit size for which economizers are required, we should consider revisiting the existing energy modeling data to see if different conclusions are reached based upon this comparison of system types. It is our engineering team's belief that VRF warrants an exemption based upon superior energy performance without economizers complicating the design.

The Code Should Allow for VRF plus Decoupled DOAS System Configurations

This new requirement also provides an exception for VRF systems to allow decoupled DOAS systems (including ERVs & HRVs) instead of economizers in order to *"prevent unintended impacts on the growing variable refrigerant flow (VRF) market segment and other large indoor units"*. However, the new economizer requirement and the exclusion of a "coupled DOAS" configuration from the exception, are very likely to have unintended impacts on the VRF market due to inherently higher cost without notable efficiency advantages. Both coupled and decoupled DOAS configurations should be allowed under the exception. The Energy Code should include specific definitions for coupled and decoupled DOAS systems with explicit reference to which zones and install conditions ERVs or other DOAS are required to have a bypass duct. We would argue that bypass ducts and economizer functionality combined with VRF systems will yield marginal energy savings if any, and that if all VRF system operating modes and efficiencies are modeled , there is no clear justification for requiring either decoupled DOAS or economizer functionality given the additional system complexity and cost.

VRF with Heat Recovery Should be Given Greater Compliance Credit

The exceptions that are built into a lower economizer requirement on central systems should recognize the inherent superior efficiencies achieved by VRF zone control especially when they include heat recovery systems. Although Table 140.4-D (below) offers some economizer exemptions for the improved efficiency of any system with 30% to 70% higher IEER (or COP), it doesn't specifically acknowledge the additional efficiency of VRF with heat recovery estimated to add an additional 20% to 30% system efficiency depending upon climate zone and load conditions. Not to be confused with "heat recovery" in an ERV or HRV, VRF heat recovery is moving "waste" heat from one zone in a VRF system calling for cooling, to another zone in the same system calling for heat and it does so through branch control boxes (valve boxes) that

TABLE 140.4-D ECONOMIZER TRADE-OFF TABLE FOR COOLING SYSTEMS

Climate Zone	Efficiency Improvement [a]
1	70%
2	65%
3	65%
4	65%
5	70%
6	30%
7	30%
8	30%
9	30%
10	30%
11	30%
12	30%
13	30%
14	30%
15	30%
16	70%

[a] If a unit is rated with an annualized or part-load metric, ~~IPLV, IEER or SEER,~~ then to eliminate the required ~~air or water~~ economizer, only the applicable minimum cooling efficiency of the ~~HVAC~~ unit must be increased by the percentage shown. If the ~~HVAC~~ unit is only rated with a full load metric, ~~such as~~ like EER or COP cooling, then that metric must be increased by the percentage shown. To determine the efficiency required to eliminate the economizer, when the unit equipment efficiency is rated with an energy-input divided by work-output metric, the metric shall first be converted to COP prior to multiplying by the efficiency improvement percentage and then converted back to the rated metric.

allow the heat to be moved to other zones in the building through the refrigerant loops without that refrigerant going through the outdoor unit (compressor). These system efficiencies tend to be highest when loads are moderate, and not on very hot or cold days when all zones are more likely to call for heating or cooling rather than a mix. Notably, these are similar or overlapping conditions for when economizers may be operating, and it is unlikely that the efficiencies are cumulative. That is why it is so important to recognize VRF heat recovery in the requirements, otherwise the overlay of requirements create conditions wherein the overlay of system features cancels the measurable efficiency in the field. It does not appear that the modeling that was performed for the CASE Report has factored in the cross canceling of these variables.

Furthermore, economizers or DOAS systems are not designed to optimize delivery for many zones simultaneously calling for heating and cooling as is often the case in larger structures with a great deal of glazing and high interior temperature differentials. An overlay of economizer requirements or DOAS may in fact lower the overall operational efficiency of a VRF system under such conditions.

We had previously suggested that a graduated phase in of the economizer-DOAS requirements over a period of years may allow industry to develop design solutions. However, it is also not clear that a compromise phase-in of a new VRF plus economizer or DOAS requirements over time would actually yield the engineered solutions to this design challenge. The additional time it would afford to design solutions that would produce more cumulative efficiencies in a cost-effective manner may not result in marketable solutions. Anything other than an economizer exception for VRF under 54kbtu threatens to kill a critical, innovative solution that already incorporates greater product advantages and efficiencies than the code seems to recognize.

Non-Continuous Fan Operation of Coupled and Decoupled ERV or DOAS Systems

The CASE Team's report references the intent or purpose of the 140.4(p) code changes as including: "*3) Zone terminal fans for cooling or heating must cycle to off if (there is) no call for conditioning*", and: "*4) Decoupled ventilation pathway for outdoor air to each space*." (pg. 123). We agree with and appreciate the inclusion of the exception that to 140.4(p)3 that allows fans to continuously operate at .12W/cfm at deadband temperatures to assist in destratification and mixing. If this is allowed, all the more reason to also allow coupled DOAS configurations. There is little energy benefit to forcing the fans to off while a decoupled system continues to run, as compared to coupling VRF with an ERV, and setting the lowest fan coil fan speed to run above minimum ventilation requirements. (Note: This assertion is supported by fan affinity laws where power input is proportional to the cube of shaft speed.)

DOAS Air Supply Location

The proposed language in Section 140.4(p) 4 also requires that "the DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating/or cooling coils" and the reason for this requirement is not at all clear. We would like to request clarification from staff on why they added this requirement in the Express Terms, and continue to require this in the 45-day language without explanation. Mitsubishi recommends that a coupled DOAS deliver air **upstream** of the terminal unit fan coil as this provides for a more controlled and comfortable environment with better mixing. Please explain the technical reason and justification for this requirement.

Prescriptive Requirements for Space Conditioning Systems by Climate Zone

Under Section 140.4 (a) 2B-C, the energy code express terms language had specified that retail and grocery applications in climate zones 1 and 16 for systems with cooling capacities less than 54kbtu had to be served by a furnace plus AC system. The 45-day language now changes the threshold for requiring a furnace plus AC to 65kbtu for these applications.

However, for office, library and financial buildings, the requirement for systems under 65kbtu has been changed from a furnace plus AC to allow also a dual fuel system (although the word "or" appears to be missing and clarification is needed). Given the state's decarbonization mandates, we feel that this compromise does not go far enough. Dual-fuel HP systems should be required and conventional furnaces plus AC should not be allowed.

For the record, Mitsubishi Electric doesn't make either type of system. We do however make "cold-climate heat pumps (CCHPs) which are capable of extracting heat at much colder temperatures at very high rates of efficiency. Although we have submitted comments requesting that you include cold-climate heat pumps as an option for such applications and this has not been considered, it is our hope that you would include them for such applications in this code cycle.

It is important to note that many manufacturers that produce furnace plus AC systems also have dual fuel heat pump products and such technology is well established and within the capabilities of the market. There is no reason to settle for non-optimized solutions in this category.

Whereas the 45-day language for Section 140.4 (a) 2E-F has been revised to allow dual-fuel heat pumps, Section 140.4 (a) 2B continues to impose a seemingly arbitrary furnace plus AC requirement and doesn't allow duel-fuel HPs for grocery stores in climate zone 1 and 16. At very least, the same compromise that was made in Section 140.4 (a) 2E-F should be applied to grocery stores.

We continue to recommend adding language specifically allowing cold-climate HPs to comply using the performance method in climate zones 1 and 16 across all commercial applications either above or below the 65kbtu capacity threshold. Any climate that sees temperatures below -20 F. should have dual fuel systems with cold climate compressors, so the temperature at which the furnace is set to go on can be adjusted to 10 F.

Partial Electric Baselines as Applied to Specific Climate Zones

We are deeply appreciative that Section 150.1(c)7, sets partial electric baselines with compliance credit (EDR) to highly motivate the specification of either a heat pump hot water heater (HPWH) or an air-source heat pump for HVAC applications.

However, our team doesn't understand the logic of the climate zones that have been chosen for single family dwellings. It appears that the CEC has set a very low bar for how well they expect the ASHP systems to perform. Section 150.1 (c)7 currently calls for HP space heating (ASHPs) in climate zones 3, 4, 10, 13 and 14. These climate zones were chosen based on cost effectiveness of the systems, but wholesale gas versus ASHP equipment costs posted to the docket by NRDC indicate that ASHP equipment is 15% to 30% cheaper than similar central furnace plus AC systems of the same brand and efficiency. This fact alone would dictate that ASHPs should be required in all jurisdictions that now require ultra-low NOx furnaces and where AC is generally installed in new homes (30% more expensive that ASHPs) which includes the San Juaquin AQMD and SCAQMD jurisdictions (CZs 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15. However, ASHPs are far more effective in cold climates than many commonly acknowledge, and they are well suited and economical for all climates. Therefore we recommend that central ASHPs be encouraged in climate zones 3,4,5,6,7,8,9,10,12,13,14,15 and that dual fuel ASHPs be required in climate zones 1, 2, 11 and 16. However, we also specifically request that the CEC add language allowing the use of cold-climate heat pump systems in these more extreme climate zones under the performance method. The technology is capable of providing heat efficiently down to -15F. Cold-climate heat pumps are even more cost effective when the cost of gas-line connection can be eliminated.

Prohibit Integrated HPWH Units in Indoor Closets Due to Comfort and Efficiency Impacts

There have been a number of CEC staff and energy trainer PowerPoint presentations circulating that show pictures of integrated HPWH units located in 3' x 4' sized closets inside the house with a simple louvre door on the closet. Although some advocates hold that this type of install is acceptable, we strongly recommend that the code be modified to prohibit this type of indoor installation of a compressor because it is both a comfort and efficiency compromise unless the compressor units are ducted to the outside.

A system configured with an indoor compressor that extracts heat from conditions space will cause severe uneven temperatures in the interior and excessive dehumidification which can cause discomfort and eye irritation. Actively cooling the interior of a home during cold weather by locating an HPWH in a closet is simply a poor application of the technology and is extremely difficult to address after the fact with a different system integration solution.

With the introduction of more flammable low-GWP refrigerants in the coming years, there will also be restrictions on containment of the unit in a tight indoor closet. The code should anticipate such future requirements and restrict this application in the meantime.

Sound levels are also an issue. Section 150.0 (o) 1Gvi references an ASHRAE standard for no more than 3 zones for exhaust fans (ASHRAE Section 7.2.2). Why then is it acceptable to have a compressor in the living space that is many times as loud (up to 40 decibels)?

At very least, the CEC should conduct field testing on interior HPWH compressor impact on interior temperature balance and obtain consumer feedback before allowing or encouraging interior compressors. Allowing interior compressors in advance of such consumer feedback poses a high risk of stranded assets and consumer opposition to electrification as a whole. It is very difficult to retrofit buildings with central water heating after the fact, and there are no products on the market that allow a retrofit alternative to interior HPWH compressor configurations should residents be unhappy with the poor temperature control and noise levels this option imposes. This appears to be an obvious problem, and it should be prohibited in this code cycle pending further research.

Conclusions

Mitsubishi Electric is very concerned that rushing to implement economizer requirements on all VRF indoor units under 54kbtu fails to recognize the efficiencies and advantages of VRF systems in their various configurations. Economizer requirements should be limited to packaged systems for which economizers are designed, and it is inherently disadvantageous to overlay this requirement onto VRF multi-split systems. An overlay of additional stringent requirements puts these inherently more efficient systems at an even greater cost disadvantage. These rules should be applied carefully and with consideration. We specifically ask for an economizer exemption on equipment below 54kbtu to remain and not to impose this requirement on indoor equipment down to the 33kbtu economizer threshold. There are few existing ERV or DOAS systems with the economizer functionality and bypass required to meet the 140.4(p)1B requirements. Proceeding with the 33kbtu requirement as the CEC appears to be doing will very likely reduce the installation and use of these inherently more efficient VRF products in the state, contrary to the intent of this new version of Title 24, Part 6.

Thank you for the opportunity to comment and we look forward to working with the Commission to ensure desired efficiency results.

Respectfully,

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