DOCKETED	
Docket Number:	24-BSTD-01
Project Title:	2025 Energy Code Rulemaking
TN #:	258645
Document Title:	Staff Memo – Revisions to 2025 Energy Code, Section 1404(a)3 - Variable Refrigerant Flow Systems for Schools
Description:	This is a staff memo to justify the proposed revision to Section 140.4(a)3 of the 2025 Energy Code, on multi-zone space conditioning system types, specifically for variable refrigerant flow systems for schools, to support the August 2024 15-day language.
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CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

MEMORANDUM

TO: 2025 BUILDING ENERGY EFFICIENCY STANDARDS DOCKET (24-BTSD-01)

FROM: CALIFORNIA ENERGY COMMISSION (CEC)

SUBJECT: Justification for CEC-proposed Revisions to 2025 Energy Code, Section 140.4(a)3 on Multi-zone Space-conditioning System Types to Support the August 15-day Comment Period – Variable Refrigerant Flow Systems for Schools

DATE: AUGUST 22, 2024

INTRODUCTION

The June 2024 Express Terms for the 2025 Building Energy Efficiency Standards (Energy Code) included proposed prescriptive requirements and options for multi-zone space-conditioning system types. Variable refrigerant flow (VRF) with heat recovery system with dedicated outdoor air system (DOAS) was listed as one of the prescriptive compliance options in Section 140.4(a)3Ai for office buildings only. VRF was not an available prescriptive compliance option for school buildings.

Comments from stakeholders submitted to the 24-BSTD-01 docket, pointed out that VRF is a desirable system for schools. The CEC further explored the VRF system type for school buildings by comparing it to the 2022 Alternative Calculation Method (ACM) standard design System 5 – Packaged Variable Air Volume (PVAV) with direct expansion (DX) cooling and gas heating. The results and proposed regulatory language for the August 2024 15-day comment period are documented in this memo.

DISCUSSION

The Small School prototype was used for the analysis (see appendix A). The baseline system, System 5, PVAV, is used as the standard design to evaluate situations when multi-zone systems are used to serve the building. The proposed design is a VRF with DOAS system. Both the PVAV and VRF with DOAS systems meet the minimum prescriptive requirements as specified in the June 2024 15-day language, including:

1. Heat recovery is added to the PVAV system in climate zones 1, 2 and 11 through 16 to comply with Table 140.4-J.

2. The DOAS for the VRF system is sized to meet the design ventilation flow rate. Air side heat recovery is added to the VRF system in all climate zones to achieve the necessary LSC savings.

Table 1 below shows the present value per square foot (PV$/sf) of LSC savings and the expected incremental costs and the benefit-to-cost ratio for all climate zones. Measures are cost-effective when LSC benefits meet or exceed measure costs. When costs are less than the standard they are compared to, they are shown as a negative value, such as climate zone 1 in the following table. These measures with negative costs are still considered cost effective as long as total LSC savings are positive.

Table 1: Small School Cost-effectiveness Summary

Climate Zone	Benefit: Total LSC Savings (PV$/sf)	Cost: Total Incremental First Costs and Maintenance Costs (PV$/sf)	Benefit-Cost Ratio (BCR)
1	3.72	-0.53	N.A.
2	2.48	2.24	1.1
3	1.37	0.78	1.8
4	4.85	2.58	1.9
5	1.31	0.43	3.0
6	0.74	1.46	0.5
7	0.35	2.49	0.1
8	3.34	2.56	1.3
9	3.32	1.70	1.9
10	4.69	1.94	2.4
11	7.52	2.41	3.1
12	4.82	1.42	3.4
13	6.66	2.09	3.2
14	7.14	2.07	3.4
15	9.56	3.86	2.5
16	2.78	2.00	1.4

CONCLUSION

The energy analysis and benefit-to-cost ratio summary indicates VRF is a cost-effective solution in all climate zones except for climate zones 6 and 7. The proposed language below adds VRF as an option under Section 140.4(a)3a.

PROPOSED REVISIONS TO SECOND 15-DAY LANGUAGE

Revise Section 140.4(a)3 as follows:

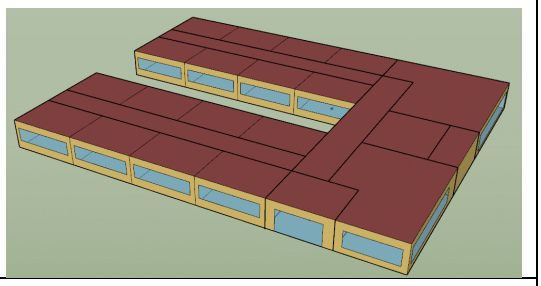
3. **Multi-zone space-conditioning system types.** Office buildings in all climate zones, and school buildings in climate zones 1 through 5 and 8 through 16 not covered by Section 140.4(a)2 and are less than 150,000 square feet and less than or equal to five stories shall meet the following requirements:

   A. Space-conditioning systems shall comply with one of the following:
   i. The space-conditioning system shall be a variable refrigerant flow (VRF) heat pump system that incorporates refrigerant-loop heat recovery and with a dedicated outdoor air system (DOAS) providing ventilation to all zones served by the space-conditioning system. Indoor fans shall meet the requirements of Section 140.4(a)3D. The DOAS shall comply with Section 140.4(a)3E

APPENDIX A: SMALL SCHOOL PROTOTYPE OVERVIEW

Table 2 provides an overview of the key specifications of the Small School prototype.

Table2: Small School Prototype Details

Form	
Building shape	
Number of Floors	1
Dimensions	190.2'*148.1'*14.8'
Window Fraction (Window-to-Wall Ratio)	35.6%
Exterior walls Construction	Steel-framed Walls (2x4, 16" OC) 0.875" stucco + cavity insulation + 0.5" gypsum board
Floor	Uninsulated Slab On Grade F 0.73
Roof Construction	Built-up roof Roof membrane + roof insulation + metal decking
Window Construction	Fixed windows: U-Factor: 0.34 SHGC: 0.22 VT: 0.42

Space Functions	Classroom, Lecture, Training, Vocational Areas, Corridor/Lobby Office Area (>250 SF) Dining Area (Cafeteria/Fast Food) Electrical, Mechanical, Telephone Rooms Restrooms
HVAC Standard Design System Type	Common_Cafeteria zone: Single-Zone VAV Heat Pump (SZVAVHP) Allother zones: Single-Zone Heat Pump (SZHP)
Service Hot Water	
Service Hot Water Type	Heat Pump Water Heater Hot Water Temperature: 135° F
Interior Lights	
Lighting Specification	Area Category Method Lighting Power Density (LPD): Regulated - Based on ACM 2022 (Appendix 5.4A)
Plug Loads	
Plug Loads Specification	Plug Loads Density: Based on ACM 2022 (Appendix E)