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TN # 258643 15-Day Language VRF Cost Data Analysis Review

Please see attached.

Additional submitted attachment is included below.

Western Allied MECHANICAL

To: California Energy Commission
From: Todd Gottshall, PE, WAM Engineering
Date: September 3, 2024
Subject: Docket Number: 24-BSTD-01 15-Day Language

Thank you for the opportunity to review the revised proposed Title 24 draft posted in the 15-Day Language. We have reviewed the language and the supporting cost analysis for Schools and Medium Office of the Section 140.4(a)3.A(i) Multizone Space Conditioning System based on VRF + DOAS. In general, we expect that VRF has higher first, maintenance, and replacement costs, compared to VAV, but that is not reflected in the CEC's analysis. We feel that the factors used in arriving at a Benefit to Cost Ratio (BCR) of greater than 1 were not accurate and when corrected would result in BCRs of much less than 1 in all climates and should therefore be reconsidered.

The points highlighted below and in the excerpts illustrate the factors that are incorrect:

1. VAV: Boiler Plant Costs
    a. The boiler plant cost regression was based on boilers that are less than 90% efficient which is required in some climate zones and of the plant capacity used in the example building. Condensing boilers cost factor as used in the analysis is approximately $25/1000 btuh versus $16.32/1000 btuh.
    b. The costs therefore are inaccurate in all of the climate zones measures used as the Baseline.
2. VRF: Condensate Piping
    a. The costs for VRF fan coil condensate piping appears to be too low at $317/ton. The factors that are typical in our market are approximately $1100/ton though we would typically express this parameter as $2500/zone.
    b. Additionally, the number of VRF zones is half the number of VAV zones (30 vs 60, respectively). We feel it is more accurate for the VRF fan coils zones to match the VAV zones.
3. VRF: Refrigerant Piping
    a. The costs for refrigerant piping at $4.40/sf appear to be low. Based on 2020 costs, this value would be approximately $13/sf. In 2024 costs, it would be $16/sf.
4. VRF: Indoor Units
    a. The cost factor of $1/sf is too low to capture all the components included with VRF Indoor Units. This factor is typically approximately $4.50/sf or $1790/ton or $4020/zone.
5. VRF: DOAS Unit
    a. The subtotal for this cost does not include Overhead and Profit.
6. VAV/VRF: Maintenance and Replacement Costs
    a. These factors were incorrectly coded in the Final Results table, including the incorrect number of VAV terminals and missing costs for VRF fan coils.
7. *Adjusted* BCR
    a. As an example of the effects of adjusting these factors, we reviewed the Medium Office CZ1 measure.

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b.

Medium Office Prototype - VRF/DOA		
		CZ1
VRF	Capacity	135
	Qty	
	Mat Cost (per ton)	$1,620
	Labor Cost (per ton)	$721.90
	O&P	15%
	Subtotal	$363,502
Condensate Line	Qty	60
	Subtotal	$150,000
Rx Piping	Capacity	135
	Qty	
	Unit Cost	
	Mat Cost	$388.40
	Labor Cost	$913.90
	O&P	15%
	Subtotal	$202,182
Indoor Units	Capacity	
	Qty	60
	Mat Cost (per SF)	$4.48
	Labor Cost (per ton)	0
	O&P	15%
	Subtotal	$276,000
DOAS Unit	Capacity	
"Std Package"	Qty (cfm)	8043.27
110% multiplier	Unit Cost	
on Std HRV Cost	Mat Cost	$8.14
for bypass	Labor Cost	$1.87
	O&P	15%
	Subtotal	$92,590

c.

Medium Office VRF/DOAS Cost-Effecti		
	CZ	1
Base Case	Baseline First Cost	$1,549,694
	Replacement Cost	$268,486
	Maintenance Cost	$74,697
	Total	$1,892,877
VRF/DOAS	Proposed First Cost	$1,741,174
	Replacement Cost	$418,216
	Maintenance Cost	$617,363
	Total	$2,776,753
Cost-Effectiveness	Incremental Cost	$16.48
	AGIC Avoided Cost	$0.43
	Net Incremental Cost	$16.05
	LSC Energy Model Savings	$2.44
	BCR, Medium Office LCC'	**0.152024715**