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Project Title:	2022 Energy Code Pre-Rulemaking
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Document Title:	Presentation-November 3,2020 Energy Code Pre-Rule Making Workshop
Description:	Staff Presentation on Reduced Infiltration in Nonresidential Construction, Residential Ventilation for Indoor Air Quality, and By: Payam Bozorgchami on November 3, 2020 Energy Code Pre-Rule Making Workshop
Filer:	Tajanee Ford-Whelan
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2022 Pre-Rulemaking for Building Energy Efficiency Standards

Payam Bozorgchami, P.E.

November 3, 2020

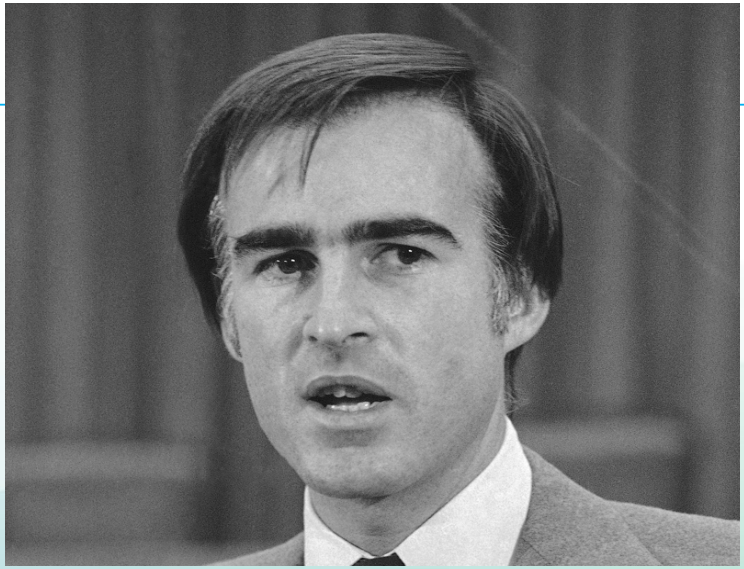
Start Time: 9:00 AM

What We Will Cover Today

- **Some Basic Background**
- **How Title 24, Part 6 is Developed**
- **Danuta Drozdowicz**
  - Reduced Infiltration in Nonresidential Construction
- **Jeff Miller P.E.**
  - Residential Ventilation for Indoor Air Quality
    - Energy or Heat Recovery Ventilator (ERV or HRV):
    - Multifamily Building Central Ventilation Duct Sealing
    - Kitchen Exhaust Minimum Capture Efficiency

Authority & Process

- **Public Resources Code (PRC 25402):** Reduction of wasteful, uneconomic, inefficient, or unnecessary consumption of energy
  - (a)(1) Prescribe, by regulation, lighting, insulation, climate control system, and other building design and construction standards that increase the efficiency in the use of energy and water…
  - Warren Alquist Act Signed into law in 1974 by Governor Ronald Reagan and launched by Governor Jerry Brown in 1975 which mandates updates Building Efficiency Standards and requires the building departments to enforce them through the permit process.



Goals of the California Energy Code

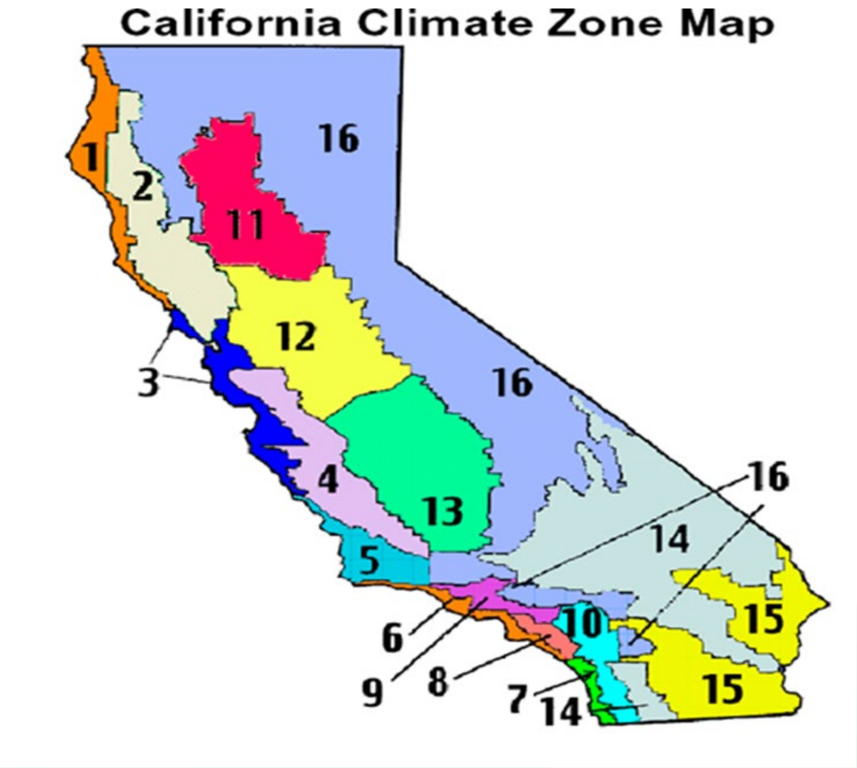
1. Increase building energy efficiency cost-effectively
2. Contribute to the state's GHG reduction goals
3. Enable pathways for all-electric buildings
4. Reduce residential building impacts on the electricity grid
5. Promote demand flexibility and self-utilization of PV generation
6. Provide tools for local government reach codes

Process Used to Updated Energy Codes

CEC staff, with input from utility partners and industry stakeholders, develop the triennial standards update

Opportunities for participation
- Utility-Sponsored Stakeholder Meetings
- CEC-Sponsored Workshops

Standards must be cost-effective
- Life-Cycle Costing Methodology
- Time Dependent Valuation (TDV)



2022 Standards Process

2022 STANDARDS UPDATE SCHEDULE	
DATE	**MILESTONES**
November 2018 - November 2019	Updated Weather Files
November 2018-December 2019	Metric Development
November 2018-July 2019	Measures Identified and approval
August 2019 to October 2020	Stakeholder meeting/workshop & final staff workshop
August 2020-October 2020	CASE Reports submitted to the CEC
February 2021	45-day Language Hearings
July 2021	Adoption of 2022 Standards at a Business Meeting
July 2021 to November 2021	Staff work on Software, Compliance Manuals, Electronic Documents Available to Industry
December of 2021	Approval of the Manuals
January 2022	Software, Compliance Manuals, Electronic Documents Available to Industry
January 1, 2023	Effective Date

Tentative Pre-Rulemaking Schedule

- **September 1**
  - Energy Savings and Process Improvements for Alterations and Additions
    - Roof deck insulation for low-slope roofs
    - Prescriptive attic insulation for alterations
    - Prescriptive duct sealing
    - Electric resistance water heating
    - Electric resistance space heating
    - 40-ft trigger for prescriptive duct requirements
    - Cool roof for steep-slope roofs
    - Cool roof for low-slope roof
- **September 9**
  - Nonresidential Grid Integration
  - Controlled Receptacle, CEA Proposal
- **September 10**
  - Verification Testing
- **September 22**
  - Outdoor lighting
  - Daylighting
- **September 23**
  - Computer Room Efficiencies
  - Pipe Sizing and Leak Testing for Compressed Air Systems
  - Refrigeration System Operation

Tentative Pre-Rulemaking Schedule (Cont.)

- **September 30**
  - Indoor Air Quality Roundtable discussion with the outside world
- **October 6 and November 19**
  - Solar Photo Voltaic and Electrification
  - Multifamily All Electric
- **October 7**
  - Nonresidential Indoor Lighting
  - Air Distribution
  - Nonresidential HVAC Controls
- **October 13**
  - Multifamily Domestic Hot Water
  - Multifamily Restructuring
- **October 20**
  - Nonresidential High Performance Envelope
- **October 27**
  - Control Environmental Horticulture
  - New Construction Steam Trap
- **November 3 (Commissioner roundtable discussion on September 30 on IAQ)**
  - Residential Ventilation for Indoor Air Quality
  - Nonresidential Reduced Infiltration

Key Web-Links

2022 Title 24 Utility-Sponsored Stakeholder
http://title24stakeholders.com/

Building Energy Efficiency Program
http://www.energy.ca.gov/title24/

Comments to be submitted to:
https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-BSTD-03

NOTE: For this workshop comments To Be Submitted By November 17, 2020

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Comments For Todays Workshop

Due Date: November 17, 2020 By 5:00 PM

Comments to be submitted to:
https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-BSTD-03

Questions ?

Thank You!

Reduced Infiltration in Nonresidential Construction Proposal for 2022

Staff Pre-Rulemaking Workshop

Presenter: Danuta Drozdowicz, Energy Specialist

Date: November 3, 2020

Proposal Summary

Staff received a proposal for measures relating to Reduced Infiltration in Nonresidential Newly Constructed Buildings, Additions and Alterations in all building types in all California climate zones.

- The proposal would expand the current prescriptive requirement for continuous air barriers in climate zones 10 – 16 to all climate zones and strengthen the requirement by requiring verification.
- The proposal would apply to nonresidential new construction, additions, and altered components where 50% or more of the envelope is altered.
- The proposal offers two options to demonstrate that the air barrier is installed correctly: whole building air leakage testing and visual inspection.

Sections Affected

Energy Code Sections

- Title 24, Part 1 Section 10-103.3
- Title 24, Part 6 Section 100.1(b)
- Title 24, Part 6, Section 140.3(a)9A
- Title 24, Part 6, Section 140.3(a)9Ci
- Title 24, Part 6, Section 140.3(a)9Cii
- Title 24, Part 6, Section 140.3(a)9C
- Title 24, Part 6, Section 141.0(a)1

Reference Appendix Sections

- JA 1 Definitions
- NA2.4 Field Verification and Diagnostic Testing of Nonresidential Whole Building Air Leakage
- NA 2.5 Field Verification of Continuous Air Barrier

Verification: Whole Building Leakage Testing

Confirm via blower door testing that the air barrier is effective at limiting leakage to 0.4 cfm/ft2 at 75 Pa pressure differential, through all six sides of the building envelope.

- For buildings under 10,000 SF, test in accordance with ANSI 380.
- For larger buildings, test in accordance with ASTM E3158.
- If the measured leakage is above 0.4 cfm/ft2 the following corrective actions would be required:
  - Locate leaks with tracer gas or thermal imaging
  - Seal leaks
  - Retest if the original test was above 0.6 cfm/ft2 @ 75 Pa

Verification: Visual Inspection

- Follow inspection procedures in NA 2.5, Field Verification of Continuous Air Barrier (shown on page 92 of the report).
- Proposed steps include:
  - Review the design documents,
  - Visually inspect during construction when the continuous air barrier is accessible, and
  - Have site visit reports reviewed and stamped by a licensed California state Engineer or Architect.

Envelope / Air Barrier Performance Assumptions

The cost analysis in this report (beginning page 60) uses the leakage rate assumptions recommended for the Compliance Software: (See Table 11: Recommended Leakage rates for 2022 CASE analysis, page 44). Measured through the entire building envelope, 6 sides, they are assumed to be true for all building types in all climate zones.

• **No continuous air barrier**	1.1 Cfm/ft2 @ 75 Pa
• **Continuous air barrier only**	0.7 Cfm/ft2 @75 Pa
• **Air barrier + field inspection**	0.5 Cfm/ft2 @ 75 Pa
• **Air barrier + testing**	0.4 Cfm/ft2 @ 75 Pa

Estimated Impacts

- **Modest Impacts for:**
  - Design and Construction Industry Professionals
  - Building Owners – energy savings and improved air quality anticipated
  - Building Economy in General
- **No Impact on Maintenance and Replacement Costs**
- **Relationship to Industry Standards:**
  - ASHRAE 90.1-2019 has a mandatory requirement for continuous air barriers in all climate zones that are verified by whole-building leakage test or third-party verification.
  - The 2021 IECC includes a whole-building testing requirement consistent with ASHRAE 90.1 but exempts Climate Zones 2B, 3B, 3C & 5C.

First-Year Statewide Energy Impacts

Measure	Electricity Savings (GWh / year)	Peak Electrical Demand Reduction (MW)	Natural Gas Savings (MMTherms / year)	TDV Energy Savings (TDV million kBtu / year)
New Construction	0.03	0.43	0.93	317.76
Additions and Alterations	0.08	0.35	0.99	339.04
TOTAL	**0.12**	**0.78**	**1.92**	**658.80**

Statewide Energy and Energy Cost Impacts – New Construction, Alterations and Additions

Construction Type	First Year Electricity Savings (GWh)	First Year Peak Electrical Demand Reduction (MW)	First Year Natural Gas Savings (MMTherms)	30-Year Present Valued Energy Cost Savings (PV$ million)
New Construction	0.03	0.43	0.93	$47.95
Additions and Alterations	0.08	0.35	0.99	$52.21
TOTAL	**0.12**	**0.78**	**1.92**	**$101.15**

First-Year Statewide Greenhouse Gas Emissions Impacts

	Avoided GHG Emissions (Metric Tons CO2e / year	Monetary Value of Avoided GHG Emissions ($2,023)
TOTAL	11,033	$1,171,723

Incremental Cost for Buildings Without Air Barriers

Building Prototype	Gross Wall Area Above Ground (ft2)	Cost of Air Barrier ($ per prototypical building)
Apartment / High Rise	43,244	$2,162.21
Grocery	22,362	$1,118.11
Small Hotel	18,242	$912.11
Large Office	124,738	$6,236.89
Small Office	3,031	$151.53
Large Retail	50,005	$2,500.24
Stand Alone Retail	12,671	$633.53
Secondary School	64,245	$3,212.26
Primary School	13,951	$697.57

Cost of testing buildings under 10,000 SF in CZ 10 - 16

Building Prototype	Conditioned Floor Area – Square Feet	Range of Testing Cost	Average Testing Cost
Office Small	5503	$400 - 600	$500
Fast Food Restaurant	2501	$500 - 700	$600
Retail/Mixed Use	9376	$600 - 1000	$800
Retail/Strip Mall	9376	600 - 1000	$800

Cost of testing buildings over 10,000 SF in CZ 10 - 16

Envelope Area (6 sides) in Square Feet	Cost from Agency 1 ($/ft2)	Cost from Agency 2 ($/ft2)	Cost from Agency 3 ($/ft2)	Average Cost ($/ft2)
10,000	0.30	0.40	0.64	0.45
25,000	0.15	0.22	0.29	0.22
50,000	0.12	0.14	0.15	0.14
100,000	0.11	0.09	0.09	0.10
200,000	0.10	0.05	0.07	0.07
400,000	0.10	0.03	0.06	0.06

Construction Weighted Average Benefit-to-Cost Ratio for CZ 1 - 8

Climate Zone	New Construction B/C Ratio	Alterations B/C Ratio
1	6.4	6.2
2	4.2	4.1
3	6.3	6.0
4	4.0	3.6
5	3.9	3.6
6	3.1	2.7
7	1.2	0.9
8	1.5	1.3

Construction Weighted Average Benefit-to-Cost Ratio for CZ 9 - 16

Climate Zone	New Construction B/C Ratio	Alterations B/C Ratio
9	3.8	3.4
10	1.9	2.5
11	4.9	6.6
12	3.7	4.6
13	3.2	4.5
14	4.9	7.5
15	2.5	3.8
16	4.8	7.3

Preliminary Findings

Technical Feasibility

- Air barrier materials, roofing / waterproofing assemblies, and glazed framing assemblies that meet the design requirements are readily available
- Required construction techniques are within the scope of standard construction practices
- Testing equipment and testing procedures, i.e. ANSI 380 & ASTM 3158, are well established standards

Cost Effectiveness

- Per the report, air barriers are cost effective in all climate zones
- Cost of whole building air leakage testing is less than the cost of visual inspections for all building types other than large retail (Table 22, page 64)
- Air barriers verified with air leakage testing or visual inspection are cost effective in all climate zones except 7

Staff Questions

Staff is highly interested in input on the following questions:

- **Q1:** Cost analysis is based on the infiltration rates listed below. How rigorous and realistic are these numbers?
  - No continuous air barrier — 1.1 Cfm/ft2 @ 75 Pa
  - Continuous air barrier only — 0.7 Cfm/ft2 @75 Pa
  - Air barrier + field inspection — 0.5 Cfm/ft2 @ 75 Pa
  - Air barrier + testing — 0.4 Cfm/ft2 @ 75 Pa
- **Q2:** Have issues with installation of air barriers in currently required climate zones been observed, and do these issues occur with sufficient frequency to justify the improvement in performance claimed for verification (30% to 40% over non-verified)?

Staff Questions

Staff is highly interested in input on the following questions:

- **Q3:** Are there sufficient trained and qualified professionals in the state to assure a consistent level of verification performance and consistent results in all building types?
  - What qualifications are needed for performing a visual inspection of an air barrier?
  - What qualifications are needed for performing air barrier leakage testing?

Comments for Today's Workshop

Due Date: November 17, 2020 By 5:00 PM

Comments to be submitted to:
https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-BSTD-03

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Thank You!

Residential Ventilation for Indoor Air Quality Proposals for 2022

Staff Pre-Rulemaking Workshop

Jeff Miller, PE, Mechanical Engineer

November 03, 2020

Acknowledgements

CEC staff wish to acknowledge the substantial time, effort and expertise of those who have worked to develop the technical details and justifications for these IAQ proposals:

- California Statewide Utility Codes and Standards Enhancement (CASE) Team:

  Marian Goebes, Robert Grindrod, Gwen McLaughlin, Mia Nakajima, Neil Perry, Elizabeth McCollum (TRC); David Springer, Alea German, Josh Peralta (Frontier Energy); Nelson Dichter, Curtis Harrington (UC Davis); Nick Young (Association for Energy Affordability)

- Indoor Environment Group, Lawrence Berkeley National Laboratory (LBNL):

  Brett Singer, Iain Walker, Wanyu R. Chan, William Delp, Sangeetha Kumar, Alexandra Johnson

Proposal Summary

Staff received proposals for three measures for improved effectiveness of Residential Ventilation for Indoor Air Quality.

- Energy or Heat Recovery Ventilator (ERV or HRV): Require HRV or ERV be used to meet the balanced ventilation system compliance alternative. Applicable to MF dwelling units only.
- Multifamily Building Central Ventilation Duct Sealing: Require sealing of MF building central ventilation duct systems through leakage testing using fan pressurization of ducts. Applicable to MF dwelling units only.
- Kitchen Exhaust Minimum Capture Efficiency: Require kitchen range hoods to have the capability to more effectively remove cooking-related pollution, through use of models that have been tested and rated to meet a specified performance for capture efficiency or increased airflow. Applicable to both MF and SF dwelling units.

Energy or Heat Recovery Ventilator (ERV or HRV)

HRV ERV

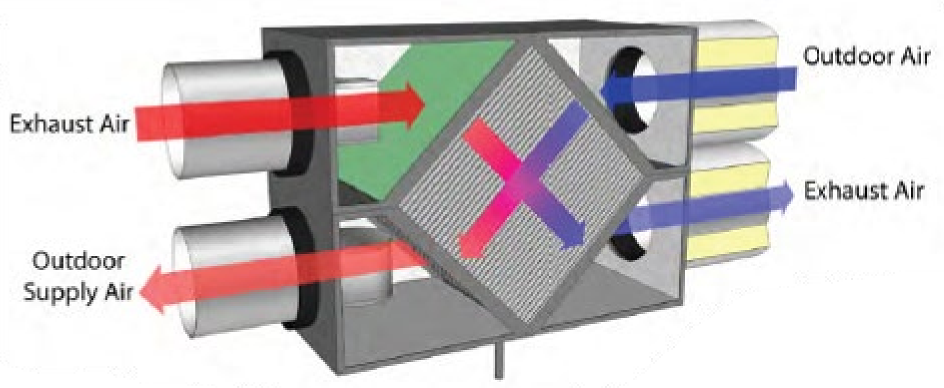
Heat recovery ventilator (HRV) or energy recovery ventilator (ERV).

- An HRV captures outgoing energy (sensible) in exhausted air and transfers it to incoming air, thus essentially preheating or precooling incoming air.

- An ERV does the same thing but also transfers moisture, thereby transferring latent energy.

- An HRV or ERV is a "balanced" ventilation system type.

- Balanced system: a ventilation system where the total supply fan flow and total exhaust fan flow are within 20% of each other.



HRV ERV

- <u>Unitary equipment </u>(one ERV or HRV serving each dwelling unit) must have a sensible heat recovery efficiency of at least 67 percent, and fan efficacy ≤ 0.6 W/ cubic feet per minute (cfm);

- <u>Central equipment </u>(one ERV or HRV serving multiple dwelling units) must have a sensible heat recover effectiveness of at least 67 percent, minimum fan efficacy as required in Section 140.4, and include a bypass function whereby the intake air bypasses the heat exchanger, and the equipment functions like an economizer.

HRV ERV

- Proposed measure builds on language in the 2019 Standards that currently requires all new multifamily units to either provide balanced ventilation or alternatively to field verify that dwelling unit enclosure leakage is less than specified value using a blower door test (compartmentalization).
- Proposed measure requires that when projects comply using balanced ventilation, that the balanced system must be an HRV or ERV.
- Proposed as a prescriptive requirement only for Climate Zones 1-2 and 11-16.
- Proposed requirements would be assumed for the standard design in the performance path in Climate Zones 1, 2, and 11-16.
- Minimum fan efficacy requirements for unitary ERVs/HRVs are proposed as 0.6 W/cfm in the prescriptive path and 1.0 W/cfm for mandatory requirements

HRV ERV

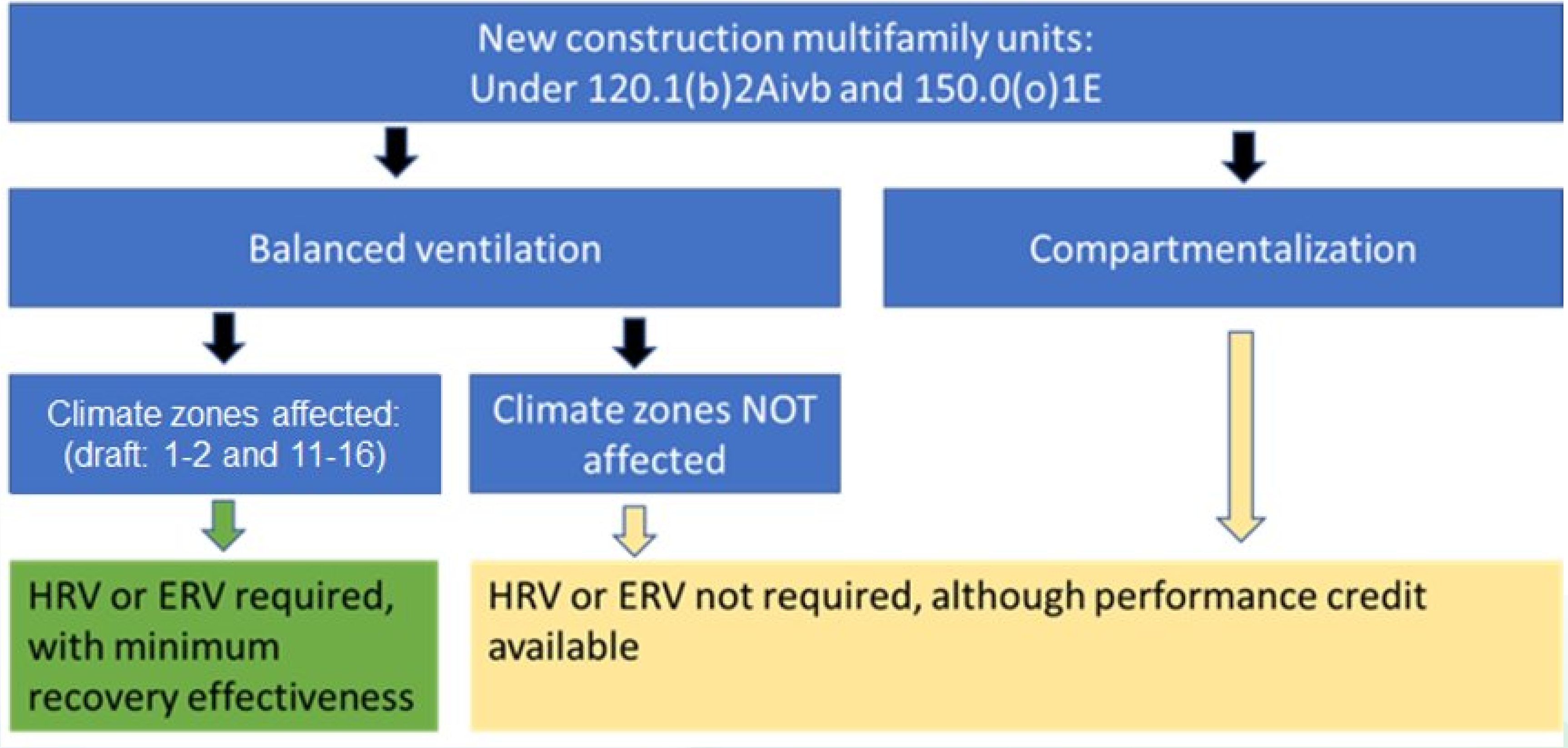
Sections affected by proposed measure:

- For high-rise MF
  120.1(b)2Aivb and 140
- For low-rise multifamily
  150.0(o)1E, 150.1(c)

- Nonresidential Appendix 2.4
- Residential Appendix 3.4.4

HRV ERV

Overview of multifamily dwelling units affected by proposed ERV/HRV requirement



HRV ERV

Field Verification for unitary systems:

- Existing 2019 Standards already require field verification of airflow for HRV/ERV installations that are used to meet the IAQ ventilation requirement. (no change)

- Existing 2019 Standards already allow field verification of unitary systems to be performed by either a HERS Rater or an ATT. (no change)

- This proposal adds a step to verify the installed HRV/ERV sensible heat recovery rating published in the HVI or AHAM product directory.

HRV ERV

ATT Field Verification for central equipment:

- Verifies that an ERV or HRV is installed,
- Verifies that airflows for the dwelling unit's balanced ventilation systems are met,
- Verifies nominal SRE and fan efficacy for the installed model in product databases (HVI, AHRI) or from product specifications from the manufacturer.
- Verify that the bypass function exists,
- Conduct functional testing as listed under Section NA 7.5.4 Air Economizer Controls.

HRV ERV

Cost of Base Case: Discrete Supply In-line Fan

Product Description	Quantity	Material Cost	Labor Cost	Labor Hours	Cost per Residential Unit
Supply Fan	1	$200	$130	1.5	$330
Supply Air Filter (MERV13)	1	$41	$0	0	$41
Exhaust Fan	1.4	$209	$111	2.03	$319
Total Cost					$690

Cost of Proposed Case: ERV

Product Description	Quantity	Material Cost	Labor Cost	Labor Hours	Cost per Residential Unit
ERV	1	$900	$130	1.5	$1,030
ERV Filter (MERV 13	1	$40	$0	0	$40
Total Cost					$1,070

Unitary systems incremental first cost: **$380 per dwelling unit**.

HRV ERV

Cost Category	Labor Rate	Base Scope (Supply Fans)				Proposed Case: Central ERVs			
		Quantity	Material Cost	Labor Hours	Total Cost	Quantity	Material Cost	Labor Hours	Total Cost
Filtered Supply Fans	$106	1	$50,000	8	$50,848				
Bathroom Fans	$106	164	$24,570	328	$59,296				
ERVs	$106					1	$40,000	8	$40,848
Supply Ductwork	$106	2,800 lbs	$2,100	504	$55,524	2,800 lbs	$2,100	504	$55,524
Roof Supply Ductwork	$106	2,000 lbs	$2,000	160	$18,960	4,000 lbs	$6,150	320	$37,920
Exhaust Ductwork	$106	7,722 lbs	$4,050	387	$87,869	6,285 lbs	$6,428	845	$95,951
Detailing & Material Handling	$106			134	$14,204			146	$15,476
Fire Smoke Dampers	$106	117	$58,500	234	$83,304	234	$117,000	468	$166,608
GRDs/ Exhaust Louvers	$106	117	$29,250	117	$41,652	164	$8,190	82	$16,871
Startup, Balancing, & Commissioning	$104			144	$15,018			144	$15,018
Insulation Budget		4,100 ft$_2$			$39,500	5,700 ft$_2$			$71,500
Electrical Budget					$10,000				$10,000
		Mark-Up		Rate		Mark-Up		Rate	
		Taxes for material cost only (Sacramento)		7.75%	$16,569	Taxes for material cost only (Sacramento)		7.75%	$19,314
		Design & Engineering		5%	$23,809	Design & Engineering		5%	$26,286
		Permit, testing, & inspection		2.5%	$11,904	Permit, testing, & inspection		2.5%	$13,143
		General Costs & Overhead		15%	$79,269	General Costs & Overhead		15%	$87,669
		Contractor profit		5%	$30,386	Contractor profit		5%	$33,606
		Total			$638,112	Total			$705,735
		Incremental Cost for Building (117 dwelling units)							$67,623
		Incremental Cost per Dwelling unit							$578

Central systems incremental first cost: **$578 per dwelling unit.**

HRV ERV

		Statewide Average Cost			Statewide Average Replacement Cost in 2023 PV$		
		Material	Labor	Total	Material	Labor	Total
Baseline	Supply Appliance: Stand-alone In-line Fan*	$198	$125	$675	$127	$80	$433
	Exhaust Appliance: ENERGY STAR Multi-Speed Bath Fan	$206	$106		$132	$68	
	Filter: MERV13	$41	$0		$26	$0	
Proposed	Appliance: ERV*	$889	$125	$1,053	$571	$80	$676
	Filter: MERV13	$39	$0		$25	$0	
Incremental Cost							$243

Unitary systems

Incremental replacement cost:

- **$243 per dwelling unit**

HRV ERV

Cost Category	Labor Rate	Base Scope (Supply Fans)				Proposed Case: Central ERVs			
		Quantity	Material Cost	Labor Hours	Total Cost	Quantity	Material Cost	Labor Hours	Total Cost
Filtered Supply Fans	$106	1	$50,000	8	$50,848				
Bathroom Exh. Fans	$106	164	$24,570	328	$59,296				
ERVs	$106					1	$40,000	8	$40,848
Detailing	$106			134	$14,204			146	$15,476
Fire Smoke Dampers	$106	117	$58,500	234	$83,304	234	$117,000	468	$166,608
Startup, Balancing, & Commissioning	$104			144	$15,018			144	$15,018
Insulation Budget		1,600 ft^2			$32,000	3,200 ft2			$64,000
Electrical Budget					$10,000				$10,000
		Mark-Up		Rate		Mark-Up		Rate	
		Tax for material (Sacramento)		7.75%	$12,793	Taxes for material cost only (Sacramento)		7.75%	$17,128
		Design & Engineering		5%	$13,233	Design & Engineering		5%	$15,597
		Permit, testing, & inspection		2.5%	$6,617	Permit, testing, & inspection		2.5%	$7,799
		General Costs & Overhead		15%	$44,597	General Costs & Overhead		15%	$52,871
		Contractor profit		5%	$17,095	Contractor profit		5%	$20,418
		Total			$359,005				$425,612
		Incremental Cost for Building (117 dwelling units) at Year 15							$ 66,607
		Incremental Cost per Dwelling unit at Year 15							$569
		Incremental Cost per Dwelling unit (2023 $)							$365

Central systems

Incremental replacement cost:

- **$365 per dwelling unit**

HRV ERV

Climate Zone	30-Year TDV Electricity Cost Savings (2023 PV$)	30-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 30-Year TDV Energy Cost Savings (2023 PV$)
1	$620	$2,162	$2,783
2	$362	$1,271	$1,634
3	$146	$762	$908
4	$191	$740	$931
5	$92	$690	$782
6	($126)	$205	$79
7	($281)	$119	($161)
8	($79)	$92	$12
9	$117	$268	$385
10	$252	$468	$721
11	$776	$1,141	$1,917
12	$501	$1,073	$1,574
13	$733	$921	$1,654
14	$751	$1,102	$1,853
15	$1,097	$22	$1,119
16	$596	$2,080	$2,675

TDV Energy Cost Savings Per Dwelling Unit

Low-Rise Garden-style

Newly Constructed

HRV ERV

Climate Zone	30-Year TDV Electricity Cost Savings (2023 PV$)	30-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 30-Year TDV Energy Cost Savings (2023 PV$)
1	$456	$1,778	$2,234
2	($46)	$1,163	$1,118
3	($175)	$658	$482
4	($141)	$823	$682
5	($239)	$689	$450
6	($590)	$179	($410)
7	($697)	$6	($690)
8	($527)	$65	($462)
9	($429)	$182	($247)
10	($142)	$263	$121
11	$495	$1,077	$1,572
12	$84	$1,045	$1,129
13	$463	$964	$1,428
14	$466	$1,092	$1,557
15	$858	$0	$858
16	$469	$2,096	$2,564

TDV Energy Cost Savings Per Dwelling Unit:

- Low-Rise Loaded Corridor
- Newly Constructed

HRV ERV

Climate Zone	30-Year TDV Electricity Cost Savings (2023 PV$)	30-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 30-Year TDV Energy Cost Savings (2023 PV$)
1	$43	$1,889	$1,932
2	($52)	$1,097	$1,045
3	($177)	$893	$715
4	($99)	$675	$575
5	($402)	$764	$362
6	($387)	$285	($101)
7	($600)	$196	($404)
8	($347)	$228	($119)
9	($171)	$349	$179
10	($950	$476	$380
11	$424	$1,137	$1,561
12	$125	$1,007	$1,132
13	$333	$887	$1,220
14	$337	$1,035	$1,372
15	$674	$179	$854
16	$39	$1,888	$1,926

TDV Energy Cost Savings Per Dwelling Unit:

- Mid-Rise Mixed-Use
- Newly Constructed

HRV ERV

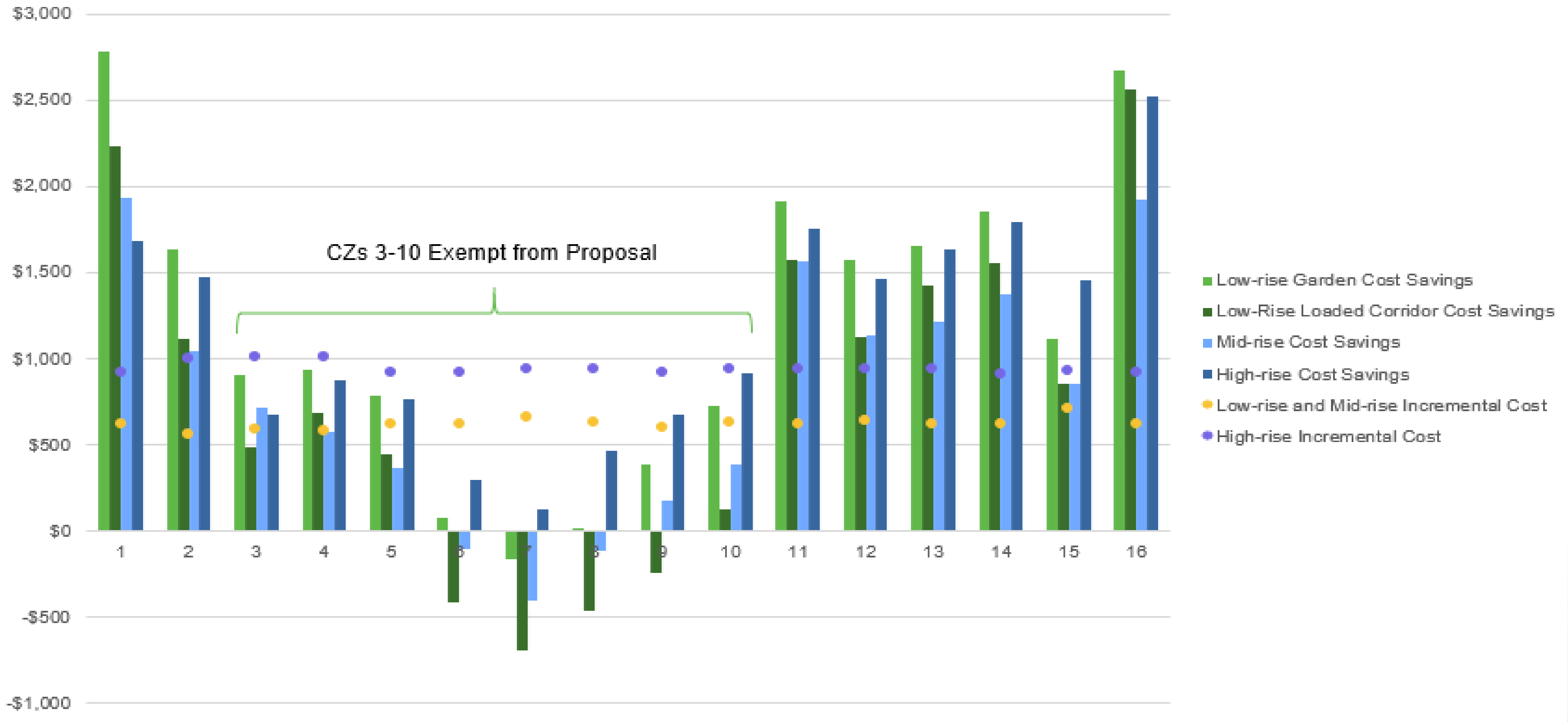
Climate Zone	30-Year TDV Electricity Cost Savings (2023 PV$)	30-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 30-Year TDV Energy Cost Savings (2023 PV$)
1	$17	$1,665	$1,683
2	$234	$1,243	$1,477
3	$59	$613	$672
4	$255	$623	$878
5	$5	$763	$768
6	$88	$205	$293
7	$23	$102	$125
8	$244	$218	$462
9	$352	$323	$675
10	$339	$577	$916
11	$578	$1,172	$1,750
12	$428	$1,041	$1,469
13	$695	$940	$1,635
14	$493	$1,306	$1,799
15	$1,283	$177	$1,460
16	$24	$2,497	$2,521

TDV Energy Cost Savings Per Dwelling Unit:

- High-Rise Mixed-use
- Newly Constructed

HRV ERV

Total 30 Year TDV Energy Cost Savings and Incremental Cost (2023 $/Dwelling Unit)



HRV ERV

First-Year Statewide GHG Emissions Impacts

Measure	Electricity Savings[a] (GWh/yr)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings[a] (million therms/yr)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced CO_2e Emissions[a,b] (Metric Tons CO2e)
ERV/HRV	(2.59)	(622)	0.46	2,492	1,870

HRV ERV

Technical Feasibility:

- The proposal expands use of an existing compliance alternative.
- HRV and ERV products that meet the proposed requirements are widely available.
- Builders are familiar with the HRV and ERV technologies and have experience installing HRV and ERV units.
- 21 percent of ERVs and HRVs in the HVI database meet the prescriptive requirement of 0.6 W/cfm but most (79 percent) meet the mandatory minimum efficacy requirement of 1.0 W/cfm.
- Project teams using the performance approach could install a product with a worse fan efficacy but trade this off for a different measure

HRV ERV

Cost Effectiveness:

- The proposal is cost effective in Climate Zones 1, 2, and 11-16

HRV ERV

Staff Questions:

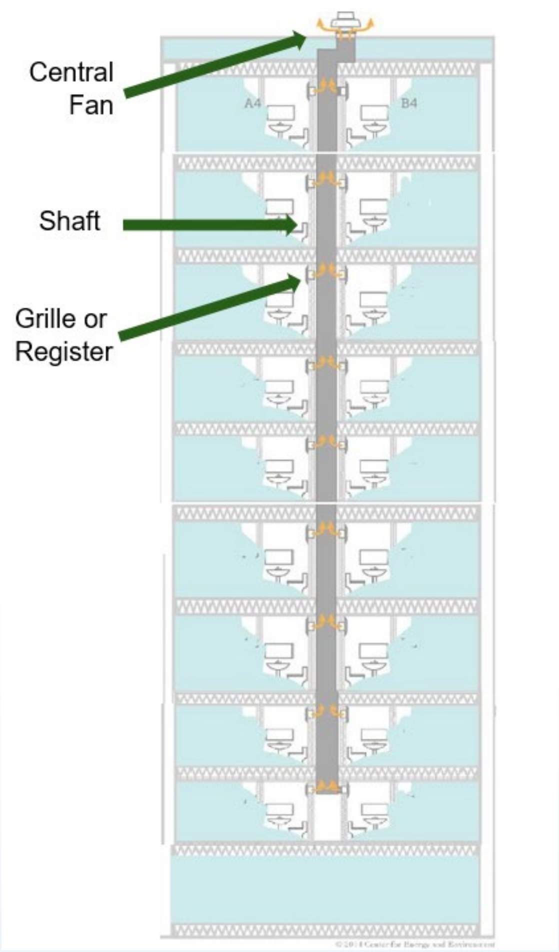
- Is there more that staff should know about the feasibility of expanding use of HRV and ERV technologies in multifamily dwelling units?

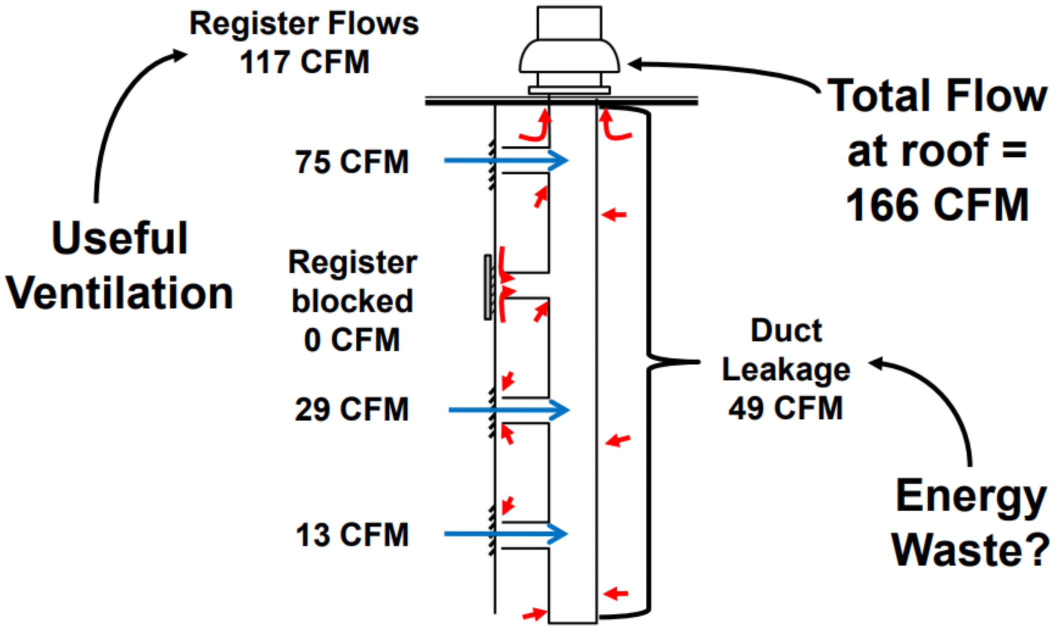
HRV ERV

Questions?

MF Building Central Ventilation Duct Sealing

MF Building Central Ventilation Duct Sealing





The central ventilation ductwork is typically comprised of a central fan (often located at the rooftop), a central ventilation duct ("shaft") that runs between floors, horizontal branches to connect the dwelling units to the shaft, and in-unit connection points such as grilles to deliver (for supply) or remove (for exhaust) air from each dwelling unit.

MF Building Central Ventilation Duct Sealing

Why are we proposing this measure?

- Primarily for energy savings:
  - Reduce ventilation fan power.
  - Reduce waste of heating and cooling energy caused by air leakage from conditioned space.
- Secondarily, for improved IAQ for multifamily residents:
  - Central exhaust duct: Improves removal of bathroom pollution (moisture, smells, VOCs)
  - Central supply ventilation duct: Helps ensure supply air is evenly distributed.

MF Building Central Ventilation Duct Sealing

Proposal:

- Mandatory requirement applicable to newly constructed buildings and additions.
- Applicable only to continuously operating MF building central ventilation systems that are used to meet the minimum whole-dwelling unit IAQ mechanical ventilation requirements in 150.0(o) and 120.1.
- Require duct sealing for central ventilation system ductwork to ensure ducts leak less than or equal to the maximum leakage allowed.

MF Building Central Ventilation Duct Sealing

Proposal:

- Require field verification (ATT) to confirm a sample of systems in the MF building have leakage less than or equal to the maximum allowed.
- Required leakage test method: ASTM Standard E1554 (fan pressurization test).
- Maximum leakage allowed: 6 percent of the central ventilation system design airflow.
- Required test pressure for field verification:
  - 25 Pa (0.1 inches w.c.) if the duct serves six or fewer dwelling units.
  - 50 Pa (0.2 inches w.c.) for ducts serving more than six dwelling unit.

Sections Affected

Sections affected by proposed measure:

- for high-rise MF
  120.4(g), 120.5(a)3, 140.4(l), 141.0(b)2

- for low-rise MF
  150.0(m)11

- Nonresidential Appendix
  1.6.3, 1.9.1, 2.1.4.2

- Residential Appendix
  2.6.2

MF Building Central Ventilation Duct Sealing

Field verification by ATT:

- Leakage testing may be performed either at rough-in stage of construction, or after installation is complete. However ductwork sealing may only be possible at rough-in.
- Sample groups limited to be all in the same building.
- Sampling rate:
  - Test a minimum of one system out of each sample group of three central ventilation systems.
  - Test a minimum of one system out of any sample group of less than 3 central ventilation systems.

MF Building Central Ventilation Duct Sealing

Sealing Component	Assumption
Material	RCD 6 water-based mastic
Coverage: linear feet (LF) per gallon. Based on manufacturer's data: Wet film coverage at 50 mils thick x 3" wide	125 LF/gallon
Coverage: square feet (ft_2) per gallon – 125 linear feet x 3/12 ft wide	31 ft_2/gallon
Coverage per shaft: vertical seams plus connection seams Length of seam from Table 59/ 125 LF/gallon = 262/125=	2.1 gallon/shaft
Cost per shaft: branches Area of branch from Table 59 / 31 ft_2/gallon = 3.14/31 =	0.10 gal/branch
Building total, vertical seams plus connection seams 7 shafts X 2.1 gallons/shaft	14.7 gallons
Building total, branches 1 shaft x 1 branch per floor x 9 floors x 0.10 gallons per branch 6 shafts x 2 branches per floor x 9 floors x 0.10 gallons per branch	0.90 gallons 1.9 gallons
Total Gallons = 14.7 + 0.9 + 1.9=	18 gallons
Waste allowance	15%
Waste and rounding(gallon) = 18*(1+15%) =	20.7 Gallons
Gallon cost (web pricing)	$35.95/gallon
Total for all 7 shafts in building	$744
Cost per dwelling unit: $744 / 117 units	$6.36

Incremental Material Cost:

- $6.36 per dwelling unit

MF Building Central Ventilation Duct Sealing

Length of seam to seal per shaft: (linear feet) Long seams = length of shaft x 2 seams = 90 x 2 =	180 LF
Perimeter of 8in. x 18in. shaft = (8*2+18x2)/12 = 4.33 ft	4.33 LF
Number of joint seams = (Length of shaft / length of each segment) = 90 / 5 =	18
Total length of joint seams = (No. of joints + end cap) x perimeter = (18+1) x 4.33	82.3 LF
Totals length of seam to seal: Long seams + joint seams = 180 + 82.3	262.3 LF
Surface area of each branch 2ft length x 0.5ft diameter x 3.1415	3.14 ft_2
Surface area of branches per shaft with 1 branch/floor 3.14 x 1 per floor x 9 floors	28.3 ft_2
Surface area of branches on shafts with 2 branches/floor 3.14 x 2 per floor x 9 floors	56.6 ft_2
labor time, 1 branch/floor shafts 262 LF / shaft x 0.013 hr. per linear foot coated = 3.4 hours 28.3 ft_2 of branch per 1-branch shaft x .012 hr./ ft_2 = 0.4 hrs. Hours per 2 branch per floor shaft = 3.4 + 0.4=	3.7 hrs.
labor time, brush application: 2 branch/floor shafts 262 LF / shaft x 0.013 hr. per linear foot coated = 3.4 hours 56.5 ft_2 of branch per 2-branch shaft x .012 hr./ ft_2. = 0.7 hrs. Hours per 2 branch per floor shaft = 3.4 + 0.7=	10.3 hrs.
Labor cost brush application: 1 branch/floor shafts hrs. per shaft x 111.45	$412.24
Labor cost brush application: 2 branch/floor shafts 4.1 hrs. per shaft x 111.45	$455.57
Total Labor Brush Application: all 7 shafts 1 x $477.41 + 6 x $482.73	$3,145.65
Cost per shaft: Total Cost / 7 shafts	$419.38
Cost per dwelling unit:	$26.89

Incremental Labor Cost:

- $26.89 per dwelling unit

The total cost of duct sealing is the sum of material costs and labor costs:

- $6.36+$26.89 = $33.25 per dwelling unit

MF Building Central Ventilation Duct Sealing

Cost Summary	Count	Labor (hours) each fan	Total hours	Labor rate per hour	Labor ($) each duct	Total labor
Mounting duct tester fans 2 person crew.	7	1.0	7.0	$181.48	$181.48	$1,270.38
Temporarily sealing openings 2 person crew.	117	0.3	29.3	$181.48	$45.37	$5,308.37
Run test. 2 person crew.	7	2.0	14.0	$181.48	$362.97	$2,540.76
Building Total			50.3			$9,119.50
Project Planning & Coordination			8.0	$119.35	$954.83	$954.83
Travel: 2 hour round trip, 2 person crew.			8.4	$181.48	$1,519.92	$1,519.92
Visual Inspection 3 ½-day trips includes travel			12.0	$119.35	$1,432.24	$1,432.24
Reporting			6.0	$119.35	$716.12	$716.12
Grand Total without sampling			84.6			$13,742.60
Cost per dwelling unit: without sampling	Grand total / 117					$117.46

Cost for Leakage Testing Central Ventilation Ducts without Sampling:

- $117.46 per dwelling unit

MF Building Central Ventilation Duct Sealing

Costs with Sampling	Count	Labor (hours) each	Total hours	Labor rate per hour	Labor ($) each	Total labor
Mounting duct tester fans 2 person crew.	3	1.0	2.0	$181.48	$181.48	$544.44
Temporarily sealing openings 2 person crew.*	50	0.3	15	$181.48	$45.37	$2,268.50
Run test. 2 person crew.	3	2.0	6.0	$181.48	$362.97	$1,088.88
Building Total			23			$3,901.82
Project Planning & Coordination			6.0	$119.35	$716.12	$716.12
Travel: 2 hour round trip, 2 person crew.			2.1	$181.48	$385.65	$385.65
Visual Inspection 1 ½-day trips includes travel			4.0	$119.35	$477.41	$477.41
Reporting			4.0	$119.35	$477.41	$477.41
Grand Total with sampling			39.1			$5,958.41
Cost per dwelling unit with sampling	Total cost with sampling / 117 units					$50.93

Cost for Leakage Testing Central Ventilation Ducts with Sampling:

- $50.93 per dwelling unit

MF Building Central Ventilation Duct Sealing

Summary of total cost per dwelling unit for this measure:

Cost for Sealing per dwelling unit (2019$)	Cost for Testing per dwelling unit (with sampling) (2019$)	Total Cost per dwelling unit (2019$)
$33	$51	$84

MF Building Central Ventilation Duct Sealing

First-Year Energy Impacts Per Dwelling Unit – High-Rise Mixed Use

Climate Zone	Electricity Savings (kWh)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms)	TDV Energy Savings (TDV kBtu)
1	43	(0.02)	34	8,228
2	22	0.05	23	14,437
3	(4)	0.01	17	3,683
4	12	0.04	17	5,108
5	(5)	(0.01)	19	3,791
6	(23)	0.04	8	1,492
7	(45)	0.02	3	(325)
8	(4)	0.08	6	2,088
9	26	0.08	9	4,067
10	35	0.09	10	4,602
11	83	0.10	21	8,729
12	55	0.10	21	7,847
13	82	0.08	19	8,221
14	74	0.11	20	8,131
15	176	0.15	5	7,846
16	19	0.03	37	9,229

MF Building Central Ventilation Duct Sealing

First-Year Energy Impacts Per Dwelling Unit – Low-Rise Loaded Corridor

Climate Zone	Electricity Savings (kWh)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms)	TDV Energy Savings (TDV kBtu)
1	43	(0.02)	34	2,624
2	22	0.05	23	4,605
3	(4)	0.01	17	1,175
4	12	0.04	17	1,629
5	(5)	(0.01)	19	1,209
6	(23)	0.04	8	476
7	(45)	0.02	3	(104)
8	(4)	0.08	6	666
9	26	0.08	9	1,297
10	35	0.09	10	1,468
11	83	0.10	21	2,784
12	55	0.10	21	2,503
13	82	0.08	19	2,622
14	74	0.11	20	2,594
15	176	0.15	5	2,503
16	19	0.03	37	2,944

MF Building Central Ventilation Duct Sealing

First-Year Energy Impacts Per Dwelling Unit – Mid-Rise Mixed Use

Climate Zone	Electricity Savings (kWh)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms)	TDV Energy Savings (TDV kBtu)
1	43	(0.02)	34	7,421
2	22	0.05	23	13,021
3	(4)	0.01	17	3,322
4	12	0.04	17	4,607
5	(5)	(0.01)	19	3,419
6	(23)	0.04	8	1,346
7	(45)	0.02	3	(294)
8	(4)	0.08	6	1,883
9	26	0.08	9	3,668
10	35	0.09	10	4,151
11	83	0.10	21	7,873
12	55	0.10	21	7,077
13	82	0.08	19	7,414
14	74	0.11	20	7,333
15	176	0.15	5	7,077
16	19	0.03	37	8,324

MF Building Central Ventilation Duct Sealing

Nominal TDV Energy Cost Savings – Per Dwelling Unit – New Construction – High-Rise Mixed Use

Climate Zone	30-Year TDV Electricity Cost Savings (2023 PV$)	30-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 30-Year TDV Energy Cost Savings (2023 PV$)
1	$98	$1,169	$1,267
2	$3,405	-$1,181	$2,223
3	($34)	$601	$567
4	$175	$612	$787
5	($85)	$668	$584
6	($60)	$290	$230
7	($174)	$124	($50)
8	$84	$238	$322
9	$308	$318	$626
10	$328	$381	$709
11	$596	$749	$1,344
12	$445	$763	$1,208
13	$581	$685	$1,266
14	$504	$748	$1,252
15	$1,038	$170	$1,208
16	$118	$1,303	$1,421

MF Building Central Ventilation Duct Sealing

30-Year Cost-Effectiveness Summary Per Dwelling Unit – High-Rise Mixed Use

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings (2023 PV$)	Costs Total Incremental PV Costs (2023 PV$)	Benefit-to-Cost Ratio
1	$1,267	$78	16.2
2	$2,223	$84	26.6
3	$567	$84	6.7
4	$787	$83	9.4
5	$584	$78	7.4
6	$230	$78	2.9
7	$(50)	$82	(0.6)
8	$322	$80	4.0
9	$626	$77	8.1
10	$709	$79	9.0
11	$1,344	$78	17.2
12	$1,208	$80	15.2
13	$1,266	$78	16.2
14	$1,252	$78	16.0
15	$1,208	$87	14.0
16	$1,421	$78	18.2

MF Building Central Ventilation Duct Sealing

First-Year Statewide GHG Emissions Impacts

Electricity Savings (GWh/yr)	Reduced GHG Emissions from Electricity Savings (Metric Tons O2e)	Natural Gas Savings (million therms/yr)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced CO_2e Emissions (Metric Tons CO2e)
0.29	69	0.2	1,077	1,146

MF Building Central Ventilation Duct Sealing

Technical feasibility:

- Duct sealing procedures required for this measure are consistent with existing construction practices.
- Duct leakage testing required for this measure utilizes industry standard field instruments that are used with existing Title 24 duct leakage protocols.
- Duct leakage testing for this measure uses the same pressurization procedures utilized for other Title 24 duct leakage testing protocols.

MF Building Central Ventilation Duct Sealing

Cost Effectiveness:

- This measure provides cost-effective energy savings through reduced fan energy and reduced loss of conditioned air.

IAQ benefits:

- Provides IAQ benefits by improving the reliability of supply and exhaust rates and reducing the leakage of exhausted air into other interior spaces including other dwelling units, air which can include various pollutants such as PM2.5, NO2, volatile organic compounds (VOCs), and relative humidity (which can cause mold).

MF Building Central Ventilation Duct Sealing

Staff Questions:

- Should performance of verification testing be restricted to ATT and/or HERS professionals?

MF Building Central Ventilation Duct Sealing

Questions?

Kitchen Range Hood Minimum Capture Efficiency

Kitchen Range Hood Minimum Capture Efficiency

How do we know if range hoods are effective?

Capture Efficiency (CE) is the fraction removed by the range hood of the total pollutants emitted at the cooktop.

Expressed as a percent.

The range hood in this graphic indicates a CE of 40%, which allows 60% of the cooktop pollutants to be mixed into the air in the dwelling.

Source LBNL

Kitchen Range Hood Minimum Capture Efficiency

Previous and current range hood performance requirements (2019 Title 24 standards) use only airflow performance ratings.

Why propose a capture efficiency (CE) requirement now?

- CE is a performance measurement of range hood pollutant removal effectiveness.
- Range Hoods can now be rated for CE using a new test method ASTM E3087-18.
- Under these proposed requirements, the manufacturer would be responsible for having CE tested using ASTM method E3087-18. The ratings are expected to be published in the HVI and AHAM directories.
- To accommodate market transition, the 2022 update proposal allows compliance based on either a CE rating or an airflow rating. Future updates are expected to require only CE ratings.

Sections Affected

Sections affected by proposed measure:

- For high-rise MF
  120.1(b)2Avi, 141.0(a), 141.0(b);
- For low-rise MF
  150.0(o)1G
- Nonresidential Appendix 2.2.4.1.3,
- Residential Appendix 3.7.4.3

Kitchen Range Hood Minimum Capture Efficiency

Proposed minimum range hood capture efficiency (CE) requirements, and proposed alternative airflow compliance requirements for demand-controlled range hoods

Dwelling Unit Floor Area (ft^2)	Hood Over Electric Range	Hood Over Natural Gas Range
>1500	50% CE or 110 cfm	70% CE or 180 cfm
1000 - 1500	50% CE or 110 cfm	80% CE or 250 cfm
750 - 1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm

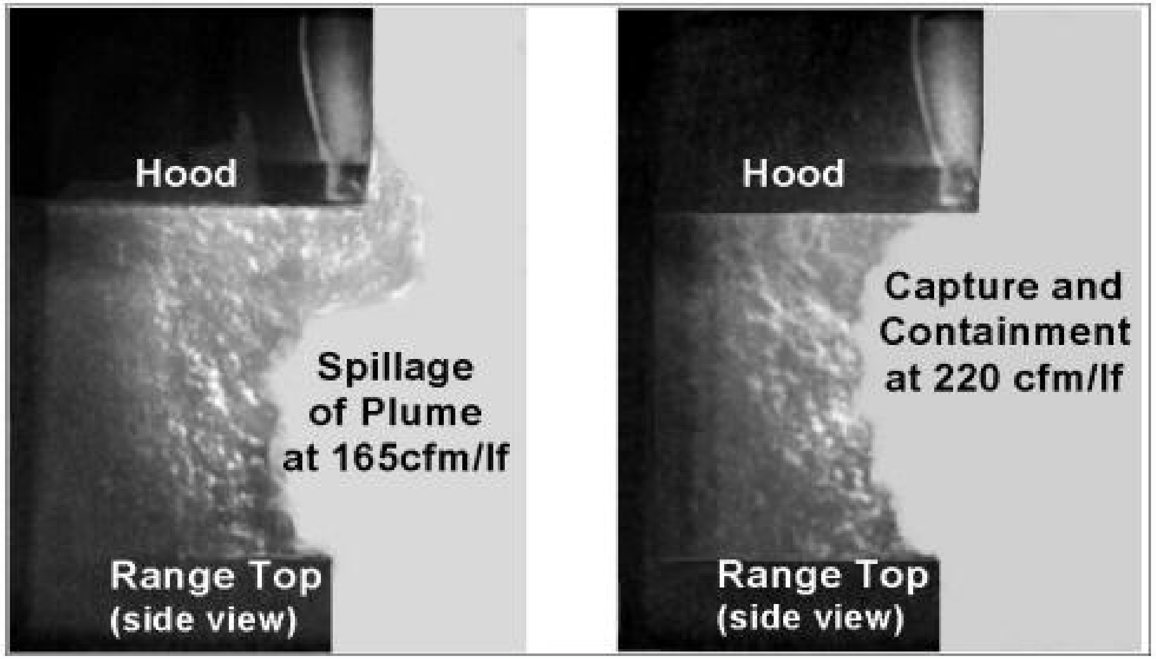
Or

Downdraft exhaust with minimum of 300 cfm (no change from 2019 requirements)

Or

Continuous exhaust at 5 kitchen ACH50 (applies to enclosed kitchens only – no change from 2019 requirements)

Kitchen Range Hood Minimum Capture Efficiency

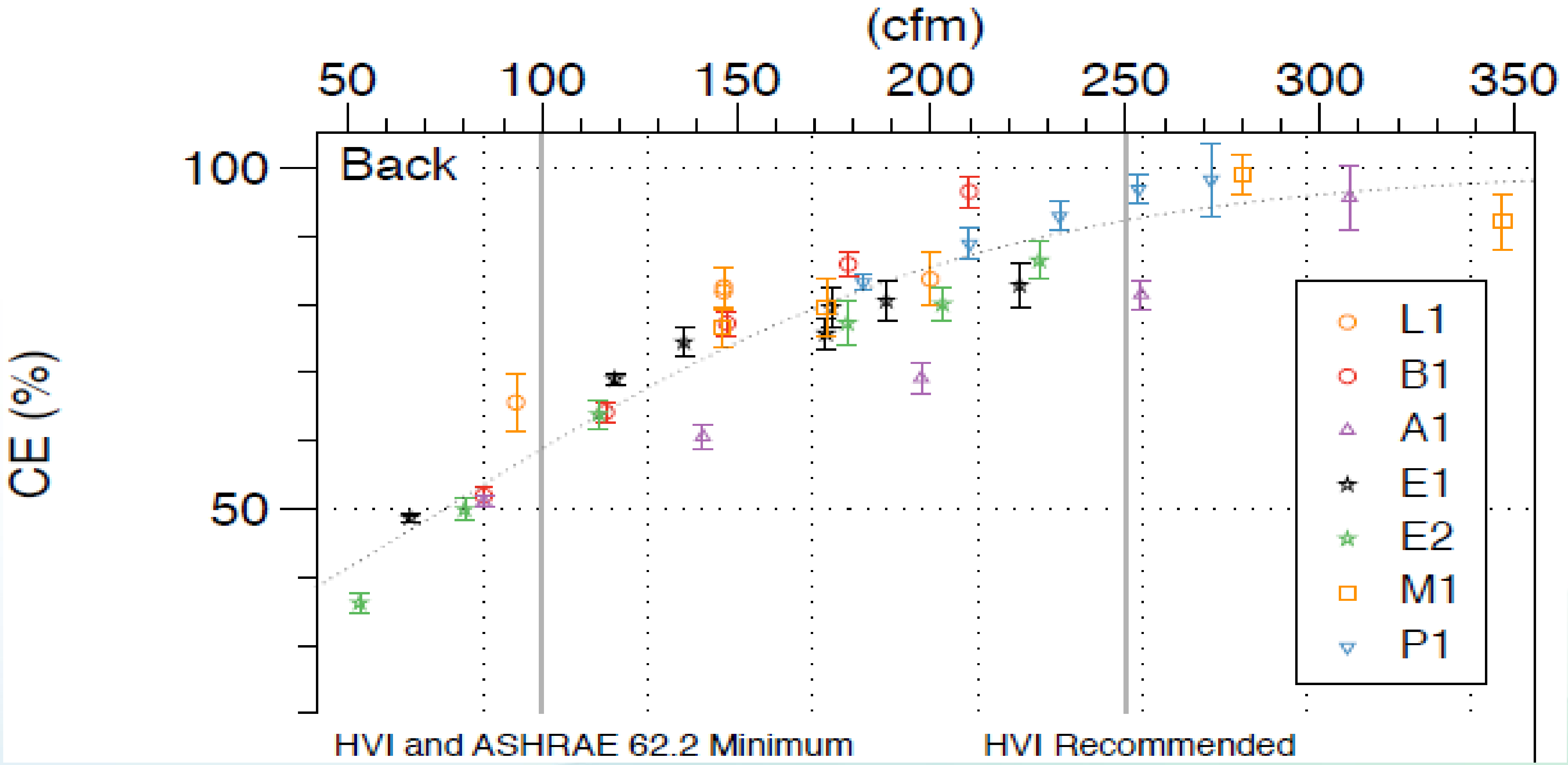


Source: ASHRAE

- CE generally increases with increased airflow for any hood, but airflow alone is not a reliable predictor of pollutant removal performance for all hoods.
- The relationship between range hood airflow and CE depends on:
  - Hood design (i.e the size and depth of the hood sump)
  - Distance from the cooktop to the hood
  - Whether front or back burners are used
  - Type cooking procedure

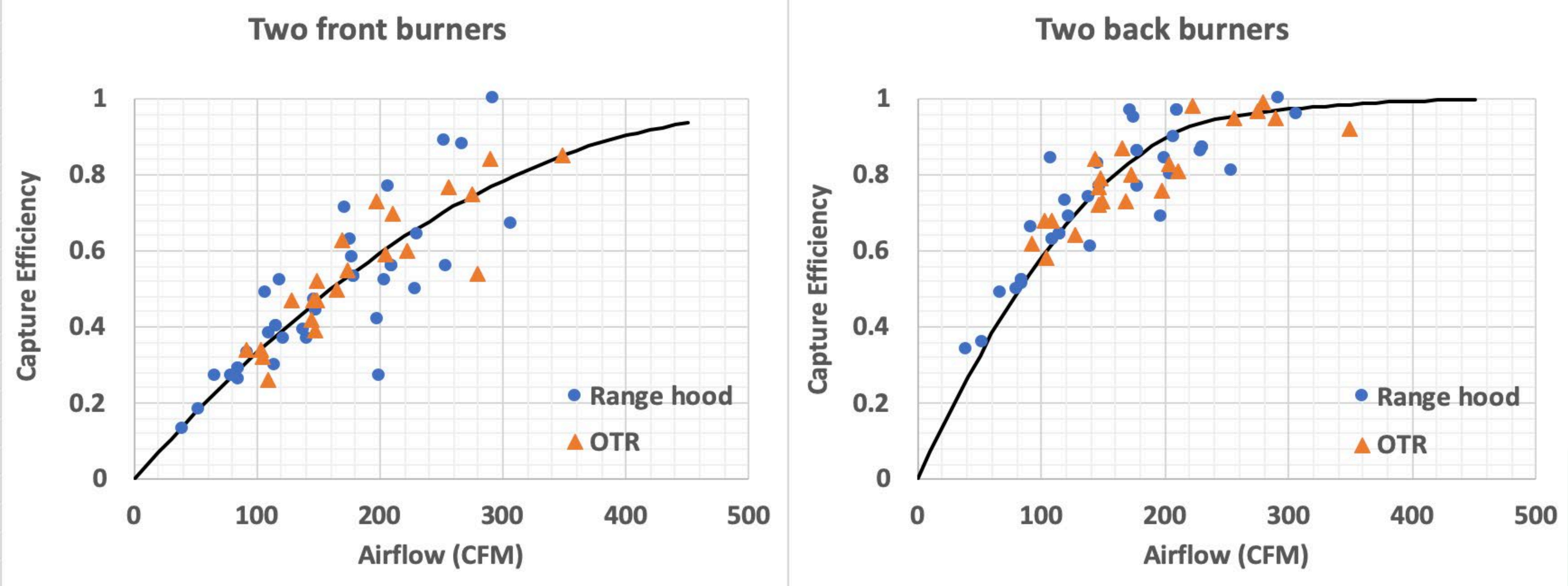
Kitchen Range Hood Minimum Capture Efficiency

Capture efficiency and range hood airflow from past LBNL studies shows that some range hood models provide higher CE at lower airflows.



Kitchen Range Hood Minimum Capture Efficiency

Capture efficiency and range hood airflow from past LBNL studies showed that CE is generally higher when the back burners are used. OTR = over-the-range microwave.



Kitchen Range Hood Minimum Capture Efficiency

Why are requirements more stringent for hoods over natural gas than electric ranges?

- $PM_{2.5}$ is released from all general cooking processes.
- Natural gas cooking appliances also release NO_2 (in addition to $PM_{2.5}$).
- LBNL conducted laboratory testing, and computer modeling and determined that a higher CE is required to maintain NO_2 within acceptable levels as compared to the CE required to maintain $PM_{2.5}$ within acceptable levels.

Kitchen Range Hood Minimum Capture Efficiency

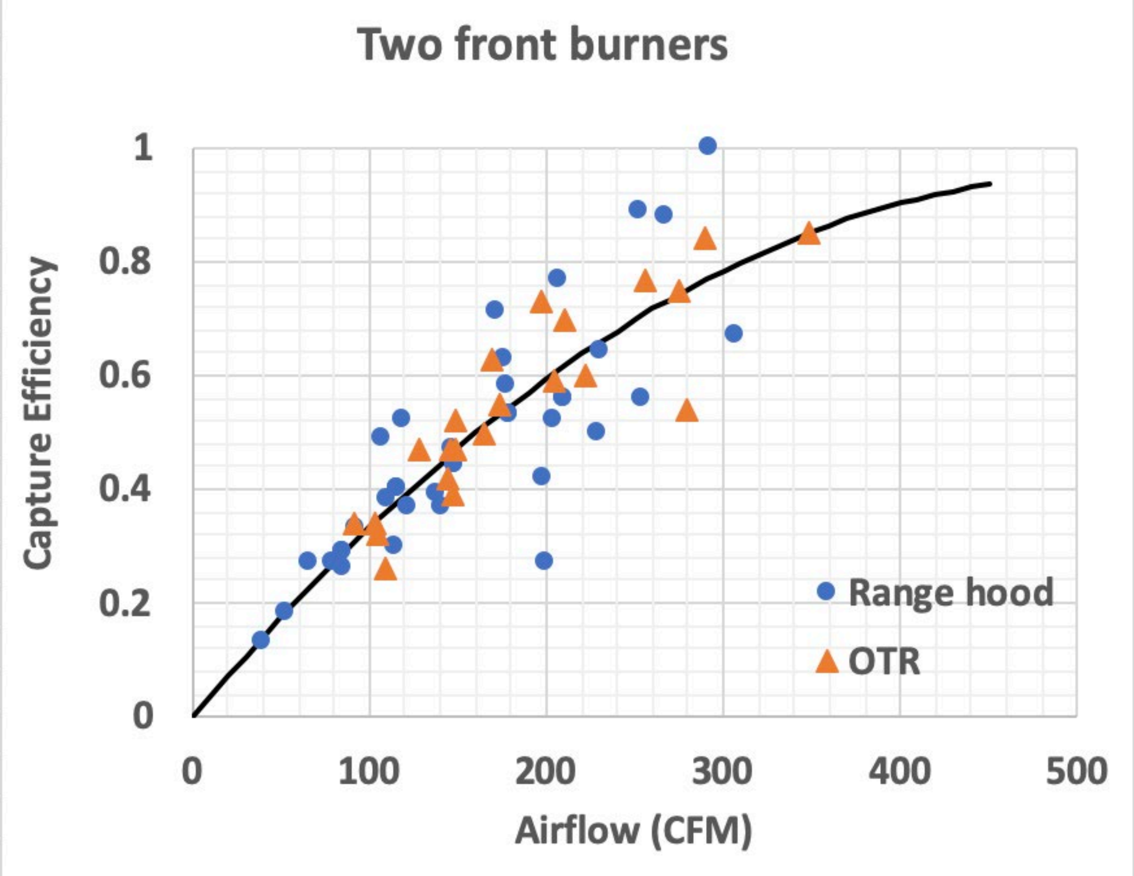
Why do CE and airflow compliance targets differ based on dwelling unit size?

According to LBNL research (Chan et al, 2020):

- Conducted a physics-based simulation model to calculate air pollutant concentrations in homes from cooking
- Ran simulations to vary aspects of the dwelling, including dwelling size, housing type characteristics, outdoor conditions, and indoor pollutant dynamics
- Found that a smaller dwellings (due to their smaller indoor air volume) could not dilute pollutants to the same degree as larger dwellings could. Thus smaller dwellings had higher concentrations in the kitchen and higher concentrations in the whole dwelling when pollutants were generated by the cooktop.

Kitchen Range Hood Minimum Capture Efficiency

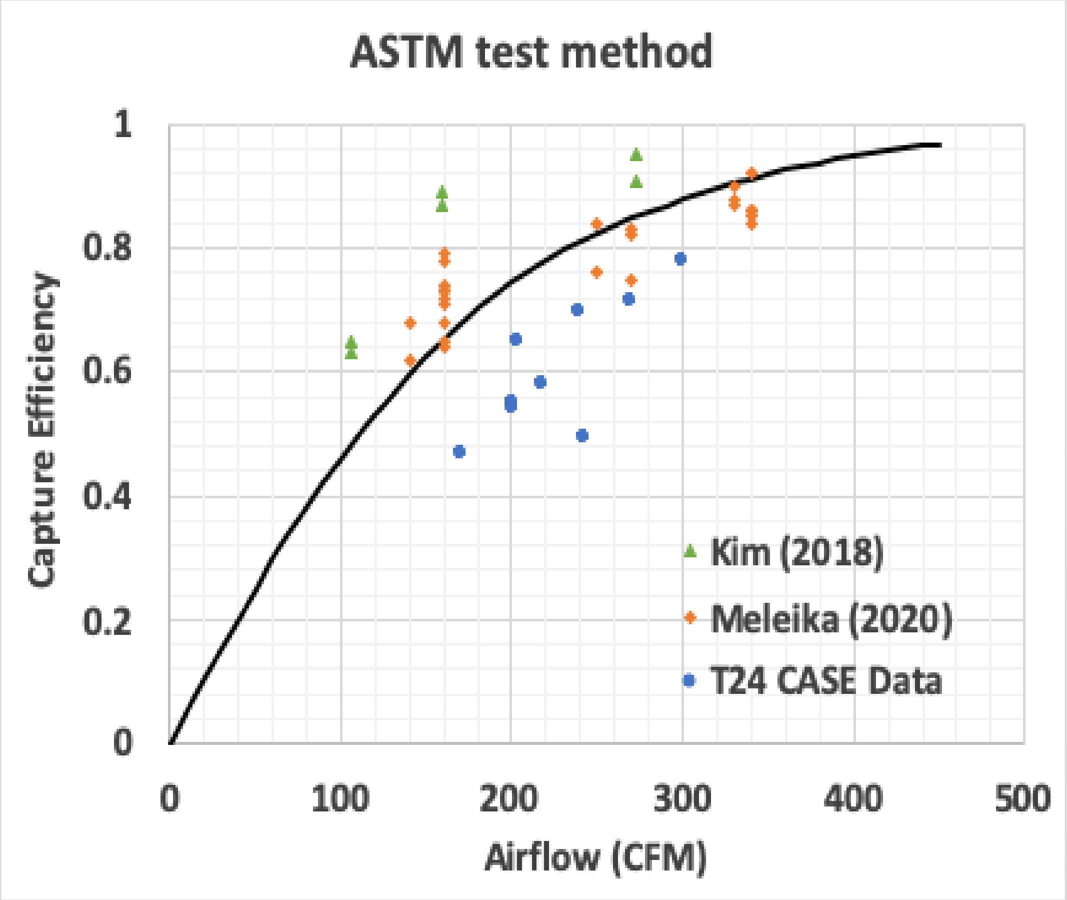
- **How did you set the CE and airflow requirements?**



- LBNL studies in 2012 and 2015 measured CE from burners of gas cooktops.
- Since CE is lower when cooking on the front burners, research data from performance of front burners was used for setting protective requirements.

Kitchen Range Hood Minimum Capture Efficiency

- **How did you set the CE and airflow requirements?**



- Research was conducted using alternate test methods that were developed into ASTM test method E3087.
- Research that utilized ASTM E3087 was conducted including results at multiple temperatures.
- Additional testing of capture efficiency and range hood airflow was conducted by 2022 Title 24 CASE team. Note the CASE tests report lower CE. However these tests are being redone to better align with the ASTM E3087 specification. New test results may have 10% higher CE. Updated results will be posted to the docket soon.

Kitchen Range Hood Minimum Capture Efficiency

How did you set the CE and airflow requirements?

- The LBNL March 2020 simulation report (Chan et al, 2020) reported indoor pollutant levels based on CE only at 200 cfm.

- Additional recent research used CE with varied values for airflow in new simulations that extended the results of the LBNL March 2020 CE simulation report. Refer to LBNL Tech memo posted to docket: TN235477. https://efiling.energy.ca.gov/getdocument.aspx?tn=235477

Kitchen Range Hood Minimum Capture Efficiency

How did you set the CE and airflow requirements?

- The extended modeling described in TN 235447 also added a proximity factor to account for higher short-term (average over 1-hour) exposure to emissions from cooking burners, for the person who is in the kitchen and cooking.
- The extended modeling results described in TN 235447 provide the ASTM capture efficiency required and corresponding installed range hood airflow required to avoid exceeding World Health Organization 24-h PM2.5 guideline level when cooking three meals in a day (meals that all emit substantial quantities of particles); or to avoid exceeding NAAQS 1-h NO_2 threshold value when cooking a full meal with gas cooktop and oven.

Kitchen Range Hood Minimum Capture Efficiency

Summary of ASTM capture efficiency or range hood airflows needed to meet 24-h PM2.5 and 1-h NO2 threshold value.

Threshold Value	Floor Area (ft^2)	ASTM Capture Efficiency	Airflow as installed (cfm)
24-h $PM_{2.5}$ 25 ug/m^3 .	>1500 ft^2	0.50	110
	1000 - 1500 ft^2	0.50	110
	750 - 1000 ft^2	0.55	130
	<750 ft^2	0.65	160
1-h NO_2 100 ppb	>1500 ft^2	0.70	180
	1000 - 1500 ft^2	0.80	250
	750 - 1000 ft^2	0.85	280
	<750 ft^2	0.85	280

Kitchen Range Hood Minimum Capture Efficiency

How many products meet the proposed requirements?

Minimum Airflow (cfm)	Compliant (n=104)	Brand Count (n=17)
175	86%	17
200	82%	17
250	30%	14
290	8%	4

OTRs meeting proposed requirements

Minimum Airflow (cfm)	Compliant (n=32)	Brand Count (n=7)
175	91%	7
200	91%	7
250	69%	7
290	56%	5

Undercabinet range hoods meeting proposed requirements

- All results reflect horizontal configurations. Percent compliant increases for vertical configuration
- (Not shown above): All chimney hoods reviewed would comply (had high speed >=290 cfm)

Kitchen Range Hood Minimum Capture Efficiency

Are compliant products more expensive?

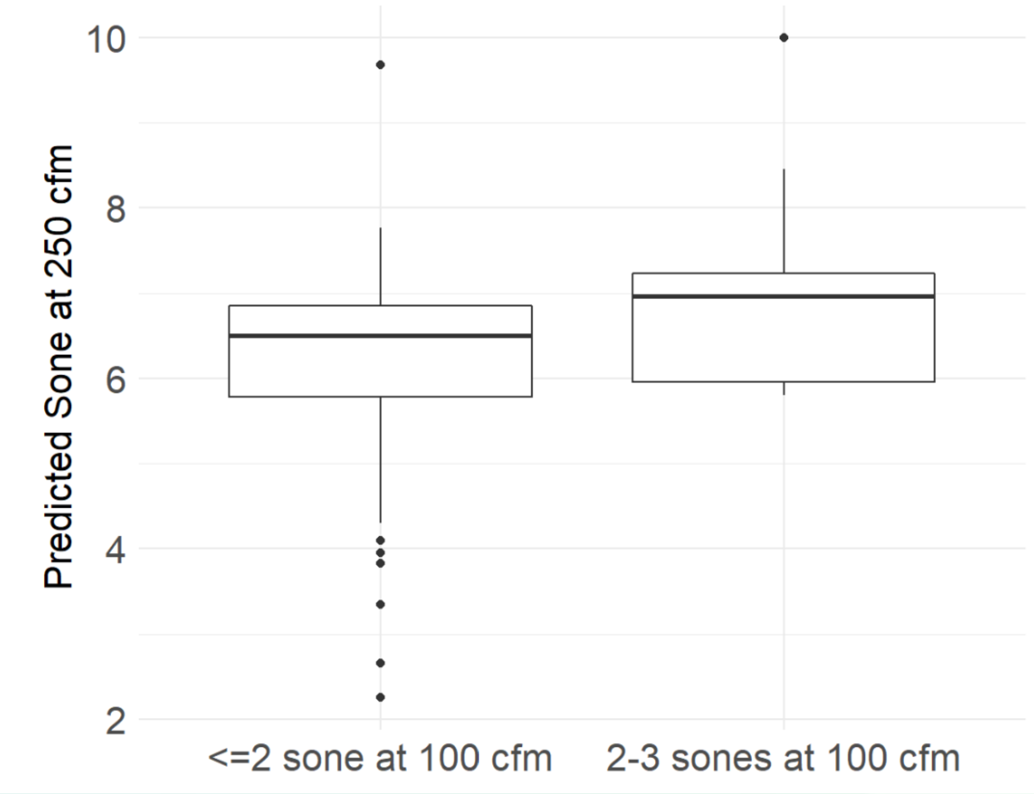
In general:

- Microwave-range hoods (OTRs) ≥ 250 cfm were more expensive (compared to 100-250 cfm OTRs)
  - By ~$140 on average
- Undercabinet hoods ≥ 290 cfm were more expensive (compared to 100-290 cfm undercabinet hoods)
  - By ~$270 on average (low precision, since most products have airflow >290 cfm)

Kitchen Range Hood Minimum Capture Efficiency

Why not tighten the sound requirement?

- Surveys indicate noise deters range hood use
- Title 24-2019, part 6 requires demand-controlled range hoods meet ≤ 3 sones at 100 cfm
- Originally considered adding a sound requirement at the proposed new required airflow (e.g., 250 cfm)
  - Would require product re-testing, and
  - Industry is moving away from current test points
- More recently considered tightening the sound to ≤ 2 sone at 100 cfm
  - Data did not clearly show that a low sone at low cfm correlated with a low sone at high cfm



Kitchen Range Hood Minimum Capture Efficiency

Statewide Energy and Energy Cost Savings:

The Statewide CASE Team did not calculate energy savings from this measure, because they estimate there would be no significant difference in energy use from the proposed requirement.

Statewide Greenhouse Gas (GHG) Emissions Reductions:

The Statewide CASE Team did not calculate GHG emissions reductions from this measure, because they estimate there would be no significant difference in energy use from the proposed requirement.

Kitchen Range Hood Minimum Capture Efficiency

Technical Feasibility:

- The proposal allows for compliance using existing range hood models.
- The proposal allows for compliance using an improved rating metric - Capture Efficiency (CE).
- Models that will comply with the airflow alternative are widely available which will assist the industry to transition to CE ratings for future Title 24 standards updates.
- Range hood installations and equipment required by this measure are consistent with existing construction practices.
- Research has determined that use of range hoods with improved CE will provide improved IAQ, thus be more protective of the heath and safety of dwelling occupants.

Kitchen Range Hood Minimum Capture Efficiency

Staff Questions:

- Keeping in mind that research has determined the proposed values for CE and airflow are necessary to protect the health of dwelling occupants, should CEC nevertheless consider temporary reductions of the CE or airflow compliance targets to help the range hood industry transition to more efficient range hood designs?
- Should range hoods have lower sound levels at the higher airflow rates necessary for adequate CE?
- Should range hoods turn on and off automatically in response to pollution emittance from a cooktop?
- Should ovens that are in a different location than the cooktop have dedicated exhaust?
- Should makeup air be provided in kitchens when range hoods are operating?

Kitchen Range Hood Minimum Capture Efficiency

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Kitchen Range Hood Minimum Capture Efficiency

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- Zhao H, Delp WW, Chan WR, Walker IS, Singer BC. 2020. Measured Performance of Over the Range Microwave Range Hoods. Lawrence Berkeley National Laboratory, Berkeley, CA. LBNL-2001351. https://eta.lbl.gov/publications/measured-performance-over-range
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Kitchen Range Hood Minimum Capture Efficiency

Questions?

Comments for Today's Workshop

Due Date: November 17, 2020 By 5:00 PM

Comments to be submitted to:
https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-BSTD-03

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Thank You!