DOCKETED

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Laboratory Fume Hoods: Automatic Sash Closure Systems

RJ Wichert
Building Standards Office
Efficiency Division

Pre-Rulemaking Workshop
Art Rosenfeld Hearing Room
June 6th, 2017

Acknowledgements

Codes and Standards Enhancement (CASE) Initiative

2019 California Building Energy Efficiency Standards

High Efficiency Fume Hoods in Laboratory Spaces

Measure Number: 2019-NR-MECH4-D

Nonresidential Covered Processes

Authors:

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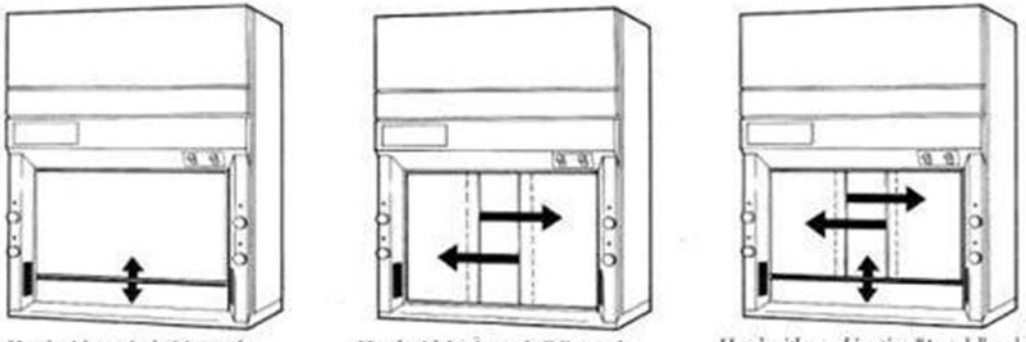
Alternative Energy Systems Consulting Inc.

Overview

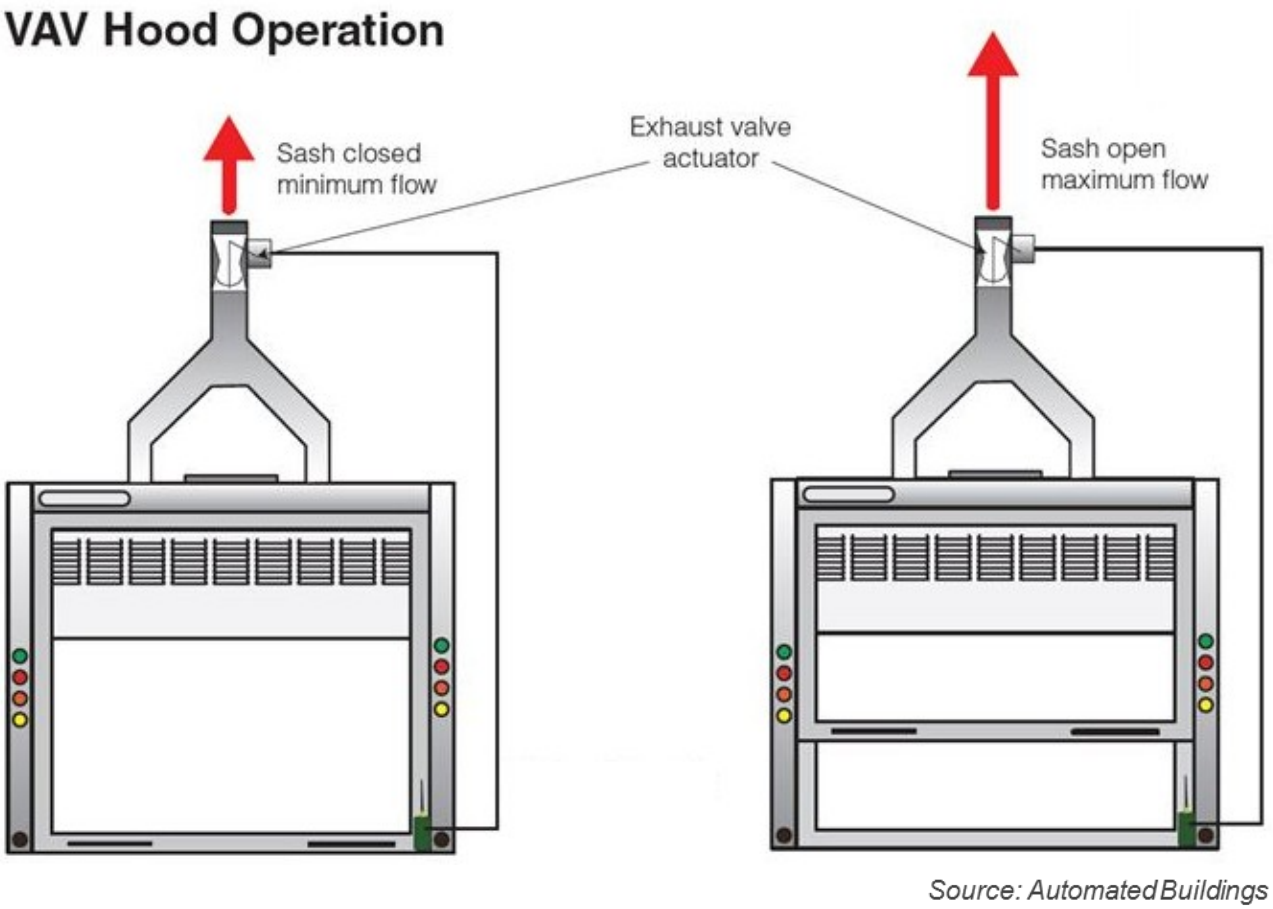
- Laboratory Fume Hood Definition from Title 8 (Industrial Regulations) of the California Code of Regulations:
  - Laboratory-Type Hood is a device enclosed except for necessary exhaust purposes on three sides and top and bottom, designed to draw air inward by means of mechanical ventilation, operated with insertion of only the hands and arms of the user, and used to control exposure to hazardous substances.



Hood with vertical-rising sash *Hood with horizontal-sliding sashes* *Hood with combination "A-style" sash*

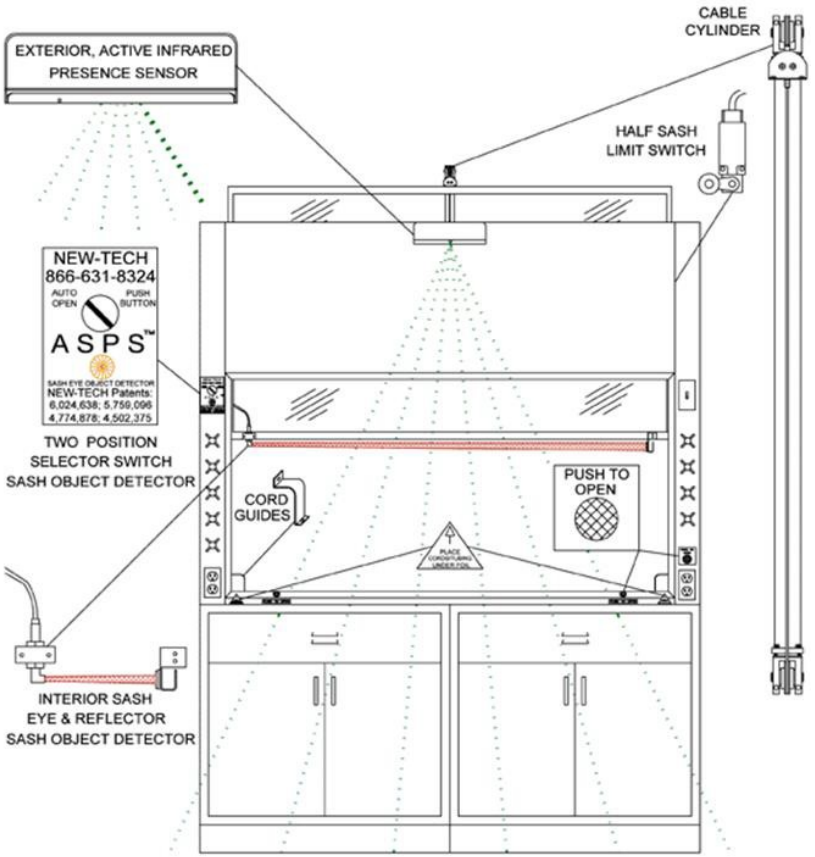
Source: Labconco, Inc.

Background: VAV Hood Operation

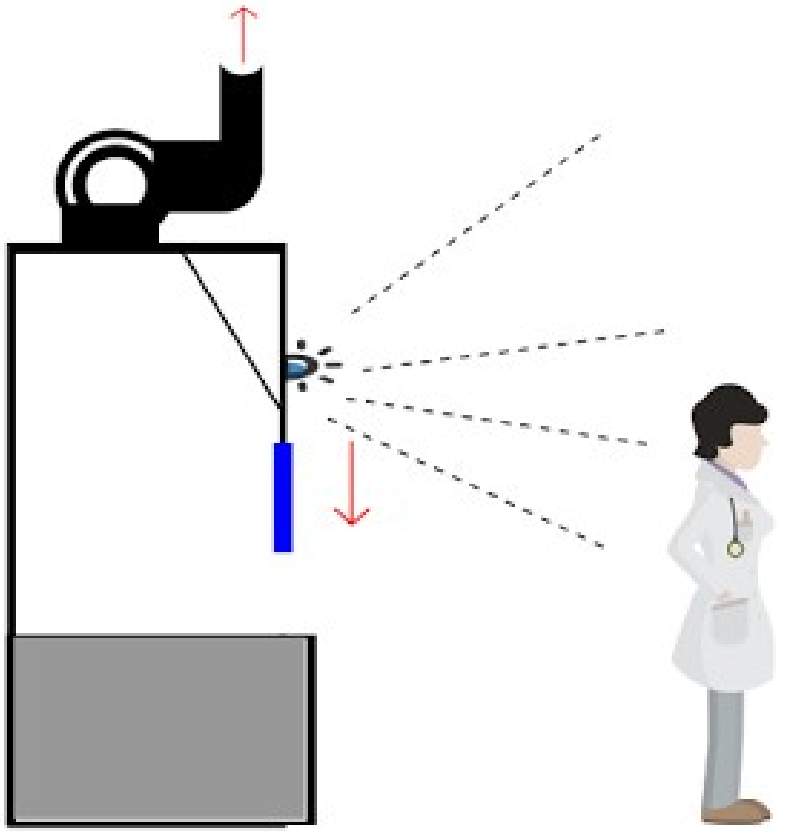


Source: Automated Buildings

Background: VAV Hood Operation



Source: New Tech



Source: Nano Fume Hoods

Background: Relevant Code History

- There are no existing requirements for automatic sash closure systems in Title 24, Part 6
- Other Relevant Code Requirements:
  - Title 24, Part 6, Section 140.9(c): prescriptive requirement for VAV laboratory exhaust systems
  - California Mechanical Code (CMC) Title 24, Part 4, Section 503.5.11.3: requirement for VAV laboratory exhaust and room supply systems for labs
  - CMC Title 24, Part 4, Section 410.1: codes for health care facilities mostly relating to air change and pressurization for health and safety in hospitals
  - CMC Title 24, Part 4, Section 410.3: establishes average face velocities for laboratory fume hoods

Background: Relevant Code History

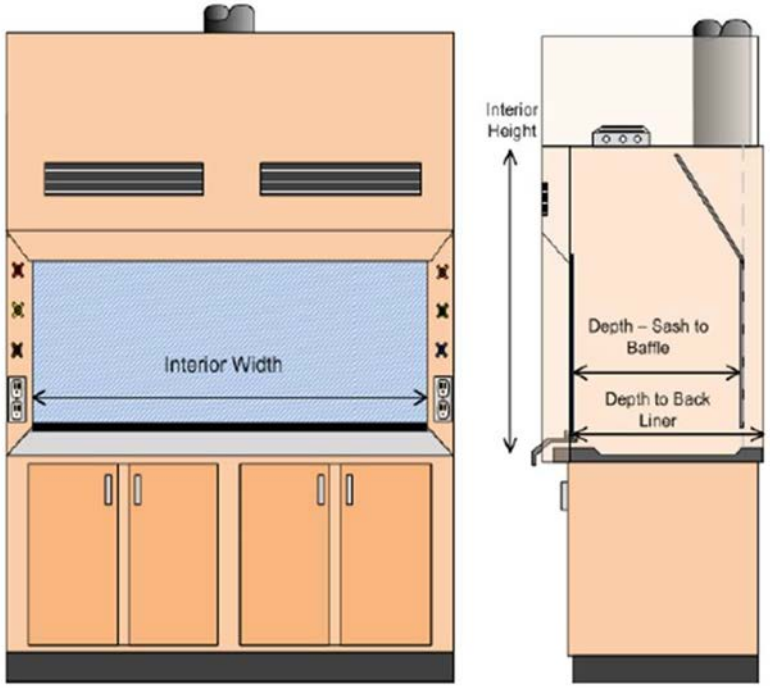
- Other Relevant Code Requirements:
  - Code of Federal Regulations Volume 29 Part 1950.1450 - requires employers to actively manage safety in the laboratories
  - Title 8 (Industrial Regulations) of the California Code of Regulations (CCR), Section 5154.1 - includes ventilation requirements for laboratory-type hood operations
  - American National Standards for Laboratory Ventilation (ANSI/AIHA) Z9.5-2003, Section 3.1.1.4 – specifies conditions for use of automatic sash closing devices
  - ANSI/ASHRAE 110-1995 Method of Testing Performance of Laboratory Fume Hoods - specifies quantitative and qualitative test methods for evaluating fume containment of laboratory fume hoods
  - The National Fire Protection Agency (NFPA) 45 – standard for fume hood sash operating practices

Proposed Code Change Overview

- What's being proposed for 2019?
  - New mandatory requirement for covered processes
  - Would require automatic sash closure systems on VAV fume hoods in fume hood driven labs
  - Building types impacted: Nonresidential Laboratory, Scientific spaces
  - Applies to additions and alterations
  - Aligns with all existing relevant codes and standards
  - Does not modify existing code language, but rather appends to it to ensure savings are achieved from the VAV exhaust system
  - Would require a new compliance form

Proposed Definition of Fume Hood Driven Lab

- Spaces sharing a common exhaust system with fume hood density greater than 1 square foot of hood work surface per 35 gross ft^2 of laboratory
- Based on sensitivity analysis
- Work surface (ft^2) = W_i x D_b



Source: UC Irvine. "Reducing Minimum Exhaust Flow for Laboratory Fume Hoods at the University of California, Irvine: A Case Study." 2012

Methodology for Savings Analysis

Energy Savings Methodology

- Baseline Conditions
  - Defined by best practices and literature review of laboratory design
  - 5,140 ft^2 for fume hood driven prototype lab
  - Central plant, VAV, & hot water reheat
  - Operates 24/7 for safe ty controls
  - Occupancy is 8AM-6PM on weekdays and 10AM-2PM on weekends
  - Utilizes 100% outside air
  - 6 ACH (occ) and 4 ACH (unocc)
  - Sash stops are installed at 18 inches
  - Fume hood diversity is 0.46 (occ) and 0.38 (unocc)
  - Minimum face velocities of 100 fpm
  - Fume hood airflow is minimum 25 CFM/ft^2 of workspace when closed
  - Sash closed height is 6 inches

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  - Occupancy is 8AM-6PM on weekdays and 10AM-2PM on weekends
  - Utilizes 100% outside air
  - 6 ACH (occ) and 4 ACH (unocc)
  - Sash stops are installed at 18 inches
  - Fume hood diversity:
    - Occupied: 0.43
    - Unoccupied: 0.36
  - Minimum face velocities of 100 fpm
  - Fume hood airflow is minimum 25 CFM/ft^2 of workspace when closed
  - Sash closed height is 6 inches
- Proposed Conditions
  - Compliant with proposed code
  - Fume hood active use diversity:
    - Occupied: 0.11
    - Unoccupied: 0.0

Energy and Cost Savings Data

Incremental Costs

- Incremental First Cost
  - Automatic Sash Closure System: $3,250
  - **Total Incremental First Cost: $3,250**
- Incremental Maintenance First Cost
  - 15-year period of analysis
  - Failed Sensor at 6 years: $100
  - Failed Sensor at 12 years: $100
  - **Total Incremental Maintenance Cost: $200**

- **Total Incremental Cost over 15-year period: $3,450**

Incremental Costs Savings

- Energy Cost Savings: 15 – year period:
  - Total Energy Cost Savings Per Fume Hood: $11,991 to $15,418

First-Year Energy Impacts Per Fume Hood New Construction and Alterations

Climate Zone	Electricity Savings (kWh/year)	Peak Electricity Demand Reduction (kW)	Natural Gas Savings (therms/year)	TDV Energy Savings (TDV kBtu/year)
1	3,251.20	0.31	296.6	144,903.80
2	3,687.20	0.62	275.7	158,914.90
3	3,453.00	0.6	221.5	139,047.90
4	3,746.60	0.64	265.5	160,897.20
5	3,486.50	0.57	251.8	143,956.70
6	3,787.80	0.66	202.5	146,415.10
7	3,706.20	0.66	152.2	134,732.40
8	3,913.60	0.63	184.2	147,216.20
9	3,939.90	0.71	189.4	152,137.40
10	3,982.40	0.61	213.8	156,229.00
11	4,027.30	0.63	258.6	169,300.20
12	3,877.30	0.64	251.7	163,975.90
13	4,142.20	0.65	248.3	173,232.80
14	3,892.00	0.56	267.3	163,942.10
15	4,651.40	0.6	192.6	172,156.60
16	3,594.10	0.57	311.7	161,689.50

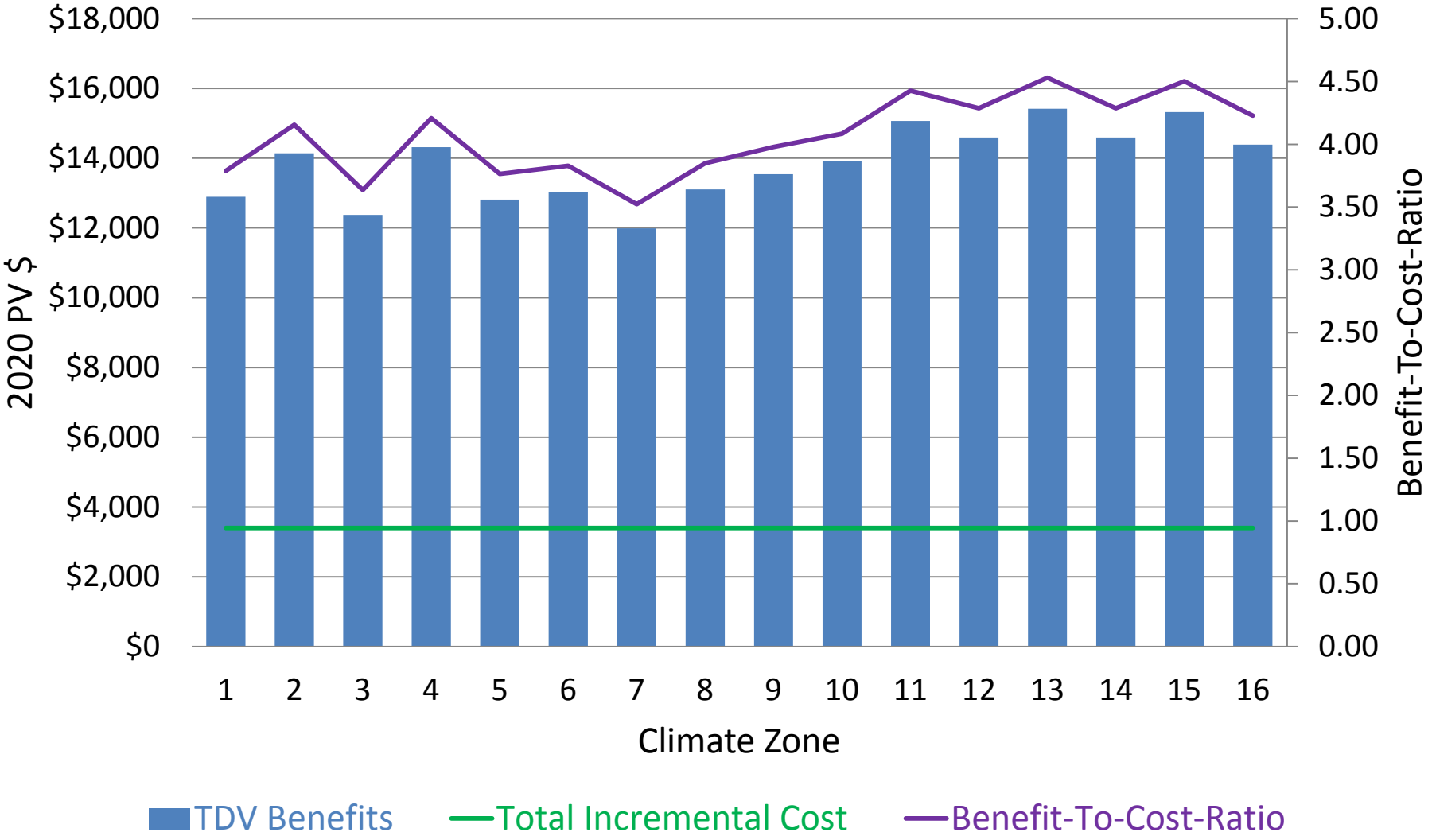
TDV Energy Cost Savings Per Fume Hood
15-Year Period: New Construction and Alterations

Climate Zone	15-Year TDV Electricity Cost Savings (2020 PV $)	15-Year TDV Natural Gas Cost Savings (2020 PV $)	Total 15-Year TDV Energy Cost Savings (2020 PV $)
1	$8,055	$4,842	$12,896
2	$9,635	$4,508	$14,143
3	$8,729	$3,646	$12,375
4	$9,964	$4,356	$14,320
5	$8,701	$4,111	$12,812
6	$9,694	$3,337	$13,031
7	$9,508	$2,483	$11,991
8	$10,080	$3,022	$13,102
9	$10,427	$3,113	$13,540
10	$10,388	$3,517	$13,904
11	$10,803	$4,265	$15,068
12	$10,437	$4,157	$14,594
13	$11,323	$4,095	$15,418
14	$10,122	$4,468	$14,591
15	$12,215	$3,107	$15,322
16	$9,153	$5,237	$14,390

Lifecycle Cost-Effectiveness Summary

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings (2020 PV $)	Costs Total Incremental Present Valued (PV) Costs (2020 PV $)	Benefit-to-cost-ratio
1	$12,896	$3,404	3.79
2	$14,143	$3,404	4.16
3	$12,375	$3,404	3.64
4	$14,320	$3,404	4.21
5	$12,812	$3,404	3.76
6	$13,031	$3,404	3.83
7	$11,991	$3,404	3.52
8	$13,102	$3,404	3.85
9	$13,540	$3,404	3.98
10	$13,904	$3,404	4.08
11	$15,068	$3,404	4.43
12	$14,594	$3,404	4.29
13	$15,418	$3,404	4.53
14	$14,591	$3,404	4.29
15	$15,322	$3,404	4.50
16	$14,390	$3,404	4.23

Lifecycle Cost Effectiveness



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Proposed Changes to Code Language

- Building Energy Efficiency Standards
  - New prescriptive requirements for fume hoods
    - Limited to VAV fume hoods
    - Provisions for manual overrides (ANSI Z9.5-2012, 3.1.1.4)
    - Occupant sensor requirements; Section 110.9(b)4 and other fume hood specific language
    - Control logic requirements
    - Obstruction sensing requirements (ANSI Z9.5-2012, 3.1.1.4)
    - Acceptance requirements
    - Exception for non fume hood driven laboratories
  - Reference Appendices
    - New section with acceptance test documentation in support of the proposed prescriptive requirements
  - Nonresidential ACM Reference Manual
    - Modifications describing, performance method calculations, Standard Design, and Proposed Building restrictions

Proposed Code Language (slide added for posting)

SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

140.9(c)2 Prescriptive Requirements for Fume Hoods

1. Variable air volume fume hoods in scientific laboratories shall have an automatic sash closure system that complies with the following:
   a) Have an accessible manual override of positioning with forces of no more than 10 lbs (45 N) mechanical, as specified by ANSI/AIHA Z9.5-2012, 3.1.1.4;
   b) Occupant sensors shall meet the requirements in Section 110.9(b)4 and shall have suitable coverage and placement to detect occupants in front of the fume hoods. Each occupant sensor shall control no more than one fume hood;
   c) Automatically close the sash after a maximum of 5 minutes of inactivity;
   d) Have obstruction sensing capabilities that stop travel during sash closing operations, as specified by ANSI/AIHA Z9.5-2012, 3.1.1.4;
2. Acceptance for fume hoods: Before an occupancy permit is granted for fume hoods subject to 140.9(c)2, the equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.16.

EXCEPTION 1 to Section 140.9(c)2: Scientific laboratories not determined to be fume hood driven per TABLE 140.9-B.

TABLE 140.9-B FUME HOOD DRIVEN LABORATORY SPACE DETERMINATION

Fume Hood Density	Ceiling Height < 10ft					Ceiling Height ≥ 10ft and < 15ft					Ceiling Height ≥ 15ft				
Hood linear ft/ 1,000 ft² lab area	Occupied Dilution Ventilation Setpoint (ACH)					Occupied Dilution Ventilation Setpoint (ACH)					Occupied Dilution Ventilation Setpoint (ACH)				
	≤8	9-10	11-12	13-14	≥15	≤8	9-10	11-12	13-14	≥15	≤8	9-10	11-12	13-14	≥15
<15.5	EXEMPT					EXEMPT					EXEMPT				
15.5 to <16.9															
16.9 to <18.3															
18.3 to <19.7															
19.7 to < 21.1															
21.1 to <22.5	FUME HOOD DRIVEN					FUME HOOD DRIVEN									
22.5 to ≤25.3															
>25.3											FUME HOOD DRIVEN				

Key Web-Links/Resources

2019 Title 24 Utility-Sponsored Stakeholder Info

http://www.title24stakeholders.com/

Building Energy Efficiency Program

http://www.energy.ca.gov/title24/

Docket for Comments

https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=17-BSTD-01

Compliance Software

http://www.bwilcox.com/BEES/BEES.html

Energy Standards Hotline

title24@energy.ca.gov or (800)-772-3300 or (916)-654-5106

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Questions?