CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Notes from 2019 Title 24 Part 6 Code Development Cycle Utility-Sponsored Stakeholder Meeting for Laboratory Topics

Posted May 23, 2017

Meeting Information

Meeting Date: March 7, 2017

Topics Discussed: Laboratory Topics

Meeting Time: 9:00am – 12:00pm

Meeting Host: California Statewide Utility Codes and Standards Team

Attendees

First Name	Last Name	Contact	Organization
Statewide Utility Codes and Standards Team			
Utility Staff			
Kelly	Cunningham	KACV@pge.com	Pacific Gas and Electric Company (PG&E)
Marshall	Hunt	MBH9@pge.com	Pacific Gas and Electric Company (PG&E)
Jim	Kemper	James.Kemper@ladwp.com	Los Angeles Department of Water and Power
Bach	Tsan	Bach.Tsan@SCE.com	Southern California Edison (SCE)
Daniela	Garcia	DGarcia3@semprautilities.com	SoCalGas
David	Roland	David.Roland@smud.org	Sacramento Municipal Utility District (SMUD)
John	Barbour	JBarbour@semprautilities.com	San Diego Gas & Electric (SDG&E)
Christopher	Romen		San Diego Gas & Electric (SDG&E)
Kate	Zeng	KZeng@semprautilities.com	San Diego Gas & Electric (SDG&E)
Bryan	Cope	bcope@scppa.org	Southern California Public Power Authority (SCPPA)
Codes and Standards Enhancement (CASE) Team Members			
Briana	Rogers	brogers@aesc-inc.com	Alternative Energy Systems Consulting (AESC)
M M (Val)	Valmiki	MMValmiki@aesc-inc.com	Alternative Energy Systems Consulting (AESC)
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Jon	McHugh	jon@mchughenergy.com	McHugh Energy Consultants
California Energy Commission Participants (Building Codes Team)			
Mark	Alatorre	Mark.Alatorre@energy.ca.gov	California Energy Commission (CEC)
Joe	Loyer	Joe.Loyer@energy.ca.gov	California Energy Commission (CEC)
Peter	Strait	Peter.Strait@energy.ca.gov	California Energy Commission (CEC)
RJ	Wichert	RJ.Wichert@energy.ca.gov	California Energy Commission (CEC)
Other Participants			
Gordon	Sharp		Aircuity
Veronica	Martinez		California Energy Commission

Javier	Perez		California Energy Commission (CEC)
Brad	Cochran		CPP Wind Engineering & Air Quality Consultants
Tom	Checksfield		Exposure Control Technologies
Dr. Bob	Haugen		Flow Sciences
Gina	Rodda		Gable and Associates
Mel	Levan		Genie Scientific
Mike	Wolf		Greenheck
Brian	Wilde		Kloppenberg
Robert	DeLuca		Lab Crafters
Victor	Neuman		Laboratory Exhaust Certification
Kyra	Weinkle		NORESCO
Gerald	Buydos		Riverside Public Utilities
Steven	Slayzak		Seeley International
Hwakong	Cheng		Taylor Engineering
Beth	Braddy		Trane
Ingrid	Castro-Rodriguez		University of California (UC) Berkeley
Debbie	Decker		University of California (UC) Davis
Chris	Jakober		UC Davis
Justin	Lewis		UC Davis
Stanley	Howell		University of California (UC) Irvine
Stephen	George		University of California (UC) San Diego
Todd	Gottshall		Western Allied Mechanical

Meeting Agenda

Time	Topic	Presenter
9:00 – 9:25	Introduction	Kelly Cunningham (PG&E)
9:25 – 10:40	Variable Exhaust Flow Control	Jared Landsman (Integral Group)
10:40 – 11:55	High Efficiency Fume Hoods	Briana Rogers (AESC Inc.)
11:55 – 12:00	Review and wrap-up, next steps	Kelly Cunningham (PG&E)

Key Takeaways and Action Items

1. **Introduction**
   a. The Statewide Utility Codes and Standards Team is seeking input and feedback on proposed code changes for the 2019 Title 24, Part 6 standards.
   b. Provide feedback by contacting CASE Authors, emailing info@title24stakeholders.com, or getting in contact with Energy Commission staff.
   c. Draft CASE Reports will be released in April/May 2017 and will include draft code change proposals.

2. **Variable Exhaust Flow Control**

a. **Maintenance** costs used for analysis are probably too low. More accurate maintenance costs are necessary to do final cost/benefit analysis.
b. We must be more specific with the exhaust criteria with regard to wind responsive control and contaminant control.
c. We must account for the increased education/training associated with this measure.

3. High Efficiency Fume Hoods

a. Many stakeholders contend that the proposed measure should not be a mandatory measure. A prescriptive measure would likely be more effective by not pushing building owners and designers away from VAV designs and leaving space for other hood energy saving options.
   i. Action item: Utility CASE Team will investigate options for a prescriptive measure and the impacts of this alternative, especially in order to allow for alternative fume hood energy saving technologies.
b. Stakeholders are concerned about the measure for several primary reasons:
   i. User resistance to a measure that may impede their research work (anecdotal, but there are also anecdotes with the opposite position).
   ii. Proposed measure has upfront cost to building owners.
      1. Action item: Utility CASE Team will use cost-effectiveness to guide fume-hood driven definition.
   iii. Proposed measure would not achieve savings in labs that have good user behavior.
      1. Action item: Utility CASE Team will research literature documenting sash closure behavior.
   iv. Lab designs are so complicated and non-standard that sash closures and energy models cannot accurately capture building performance.
      1. Action item: Investigate the possibility of a more robust definition of fume-hood driven that captures the most influential lab parameters to ensure cost-effectiveness in covered buildings.
c. The proposed measure is a technological solution to a behavioral problem, which is similar to code measures, such as lighting occupancy sensors.
d. Cal/OSHA face velocity requirement is an impediment to lab designers and Environmental Health and Safety (EH&S) from both safety and energy management perspectives.
e. A more robust explanation and definition of fume-hood driven labs is needed.
   i. Action Item: Develop methodology for determining fume-hood driven labs using driving building parameters and outline approach in CASE Report.
f. Stakeholders agree that there is significant opportunity for fume hood energy savings, albeit there are multiple ways to achieve them. Sash closure controls are simply one of those effective ways.

Meeting Notes

Introduction

- Kelly Cunningham (Pacific Gas & Electric Company) presented.
- Presentation available here.

Comments and Feedback

1. No comments or questions.

Variable Exhaust Flow Control

- Jared Landsman (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Victor Neuman (Laboratory Exhaust Certification): I was one of the authors of the ANSI standards. The requirements in ANSI should not be considered the only options. ANSI can be a starting point, but you can stray from those requirements.
    a. Jared Landsman (Utility CASE Team): Thank you.
2. Debbie Decker (UC Davis): You had mentioned wanting to monitor exhaust. What would you be monitoring?
    a. Jared Landsman (Utility CASE Team): The chemicals that will be monitored are specific to the activities taking place in the lab. Aircuity is the main manufacturer who offers exhaust sensors. Sensors will decide how fast the fans run based on the chemical concentration.
    b. Debbie Decker (UC Davis): I am concerned about this option of monitoring exhaust stream. I have no idea what is going up the stack at our facilities. We have a lot of activities occurring in our labs, so how do I know what to monitor? The sensors also require significant maintenance.
    c. Debbie Decker (UC Davis): We have Strobic fans on our roof at UC Davis, and we replaced five of nine fans and saw that this project saved energy.
3. Debbie Decker (UC Davis): Will there be guidance on wind tunnel studies and wind speed? This study shows one building in isolation. In many locations, buildings are dense and the building density can affect dispersion.
    a. Jared Landsman (Utility CASE Team): ANSI 90.5 requires a dispersion analysis, and the best way to do this is a wind tunnel study. If we do incorporate ANSI, there will be an expectation that the designers will perform a wind analysis. It is necessary to design these systems properly.
    b. Debbie Decker (UC Davis): There is not a lot of guidance within ANSI on how you interpret the results from the wind analysis.
4. Justin Lewis (UC Davis): A project needs to complete due diligence on any exhaust system. A wind analysis should be completed on all exhaust systems to make sure they are designed correctly. Wind tunnels are not that "costly" – less than $40,000 per building roughly. We can combine sensing technology of the exhaust stream as well as dynamic exhaust stack control with wind speed feedback.
5. Dr. Bob Haugen (Flow Sciences): What is your low point for the analysis of the wind study analysis? What happens when you model with zero wind?
    a. Jared Landsman (Utility CASE Team): If there is zero cross wind, then the plume can move up rather than horizontally.
    b. Robert DeLuca (Lab Crafters): Has this condition been studied? I'm worried that there won't be enough momentum to make the plume rise.

6. Victor Neuman (Laboratory Exhaust Certification): Not all wind tunnel consultants are experts in labs. You may need to certify relevant wind tunnel firms for expertise in labs.
7. Debbie Decker (UC Davis): Cal/OSHA has requirements for exhaust discharge and minimum stack height. From Cal/OSHA Title 8, 5154.1: "Exhaust stacks extending at least 7 feet above the roof and discharging vertically upward." We require 10 feet to make sure workers on the roof are protected. Understanding, as Justin points out, wind conditions can create other issues.
8. Victor Neuman (Laboratory Exhaust Certification): As the author of the relevant section of ANSI Z9.5 on lab exhaust design, there are virtually no mandatory measures to guide designers.
    a. Debbie Decker (UC Davis): There is a new ASHRAE document under development that will offer guidance for lab planners to determine ventilation parameters at the lab level.
9. Justin Lewis (UC Davis): I believe that Aircuity tests more on the lab level as opposed to the combined total exhaust stream from a building. We should be considering if/how code should reflect the nuances of dispersion modeling and how safety relates to energy efficiency.
    a. Gordon Sharp (Aircuity): At Aircuity although we do mostly lab-level monitoring, we also have done a fair amount of combined exhaust monitoring in the exhaust plenum.
        i. Hwakong Cheng (Taylor Engineering): As far as I know, the Aircuity product would be a proprietary application. Do you know of other competitors?
        ii. Debbie Decker (UC Davis): With all due respect to Aircuity, their sensors are expensive and ongoing maintenance and replacement are also expensive.
10. Hwakong Cheng (Taylor Engineering): Is there a proposed performance approach as well to be defined in the ACM Reference Manual?
    a. Jared Landsman (Utility CASE Team): If someone chooses the performance approach, the primary prescriptive pathway towards compliance (fan system power demand shall not exceed specified watts per cfm) will be used for the baseline. CBECC-Com will need to be updated to allow the user to choose which pathway they are using for code compliance.
11. Gina Rodda (Gable and Associates): Who is going to be the workforce with the knowledge to inspect and enforce the requirements?
    a. Jared Landsman (Utility CASE Team): We will likely add a new acceptance test. Those technicians will need to gain new knowledge about lab exhaust system. We suspect that there are entities who have this knowledge as compliance forms are currently required. We will be looking at this further as we move forward with the code change proposal.
    b. Gina Rodda (Gable and Associates): You are creating a whole new audience that needs to be trained on Title 24 compliance. This has notable impacts on code compliance.
12. Debbie Decker (UC Davis): Will this requirement apply retroactively? Or will it only apply to new construction?
    a. Jared Landsman (Utility CASE Team): This will apply to any existing lab that is replacing an exhaust system or any new lab that is designing an exhaust system. If a lab retrofit is not altering the exhaust system, they will not need to comply with this measure.
13. Jon McHugh (McHugh Energy Consultants): Inspection and design of lab exhausts systems already require specialist skills regardless of fan speed control measure, right?
14. Hwakong Cheng (Taylor Engineering): The requirements to vary motor speed based on wind speed or contaminant measurement is vague. How will motor speed vary? The requirement needs to be much more specific to ensure safe operation.
    a. Justin Lewis (UC Davis): I agree with Hwakong Cheng.

15. Kyra Weinkle (NORESCO): How many projects of this type are typically completed in any given year?
    a. Jared Landsman (Utility CASE Team): We do not currently have this data, but are in touch with wind consultants, and Aircuity and will have this data in our final report.
16. Justin Lewis (UC Davis): From my experience with wind turn down, this brings up the need for a requirement for education of chemical inventory and even enforce a level of inventory management. Even if wind turn down requirements are not adopted, inventory requirements could be useful. Every mechanical system has its limitations, and those limitations should be well known to stakeholders.
17. Meeting Participant: Contaminant sensors may not work for all labs.
    a. Jared Landsman (Utility CASE Team): We are still trying to work out the specifics of the contaminant sensor option. We might only allow it for labs used for specific applications.
18. Debbie Decker (UC Davis): Will this regulation track with LEED standards, so they don't conflict with each other?
    a. Jared Landsman (Utility CASE Team): Good question. We will consider this.
19. Dr. Bob Haugen (Flow Sciences): In this code, who is legally responsible for what? Who is responsible for doing the wind testing? Who checks plans? Who confirms systems have been installed as designed? It is complicated to coordinate between the building designer and the various entities responsible for designing the system and providing equipment. Equipment manufacturers are familiar with adherence to the code requirement that impact the components they manufacture. You are more interested in compliance on the whole-building level. There could be a risk to the manufacturer, because the manufacturer is not responsible for the entire system operation.
    a. Gina Rodda (Gable and Associates): Agreed.
    b. Jared Landsman (Utility CASE Team): This is a good comment. We will consider this concern. Manufacturers will remain responsible for their components. They are not responsible for the entire system operation.
        i. Dr. Bob Haugen (Flow Sciences): It would help to clarify that manufacturers are only responsible for their components. What is the point of the wind study – to assure proper safety of the surrounding community. Who take responsibility for the wind study to be completed correctly? We need to clarify who assumes the risk.
        ii. Jared Landsman (Utility CASE Team): There should not be a big impact for fan manufacturers. There will potentially be increased demand for sensor technologies (anemometers, contaminant sensors, etc.).
        iii. Dr. Bob Haugen (Flow Sciences): There is no liability for what happens two miles away?
        iv. Jared Landsman (Utility CASE Team): The lab is liable for any chemicals that go downstream.
        v. Dr. Bob Haugen (Flow Sciences): Wind tunnel studies are for safety in nearby communities. There is a big risk for whomever will be responsible for this.
        vi. Jared Landsman (Utility CASE Team): We will take this into consideration as we determine how we write this code change.
        vii. Victor Neuman (Laboratory Exhaust Certification): The facility is responsible for chemical releases downstream of their facility. Chemicals disperse very rapidly.

Unless you are in a very dense urban facility, you are mostly exposing your own building and premise.

viii. Chris Jakober: But Victor, in academic research chemical use can vary greatly over time. How can we design an effective system for flexibility of future research need?

20. Debbie Decker (UC Davis): Here's a resource I worked on with the American Chemical Society that has an entire chapter devoted to control banding in laboratories. https://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety/hazard-assessment.html.
21. Justin Lewis (UC Davis): What is turned down at 40 percent unoccupied, and what are the controls that turn down?
    a. Jared Landsman (Utility CASE Team): During unoccupied hours, the exhaust airflow turns down to 40 percent of the occupied airflow rate (i.e., from 10 ACH to 6 ACH).
22. Debbie Decker (UC Davis): Will this apply to L occupancies?
    a. Jared Landsman (Utility CASE Team): No. Title 24, Part 6 does not cover L occupancies.
23. Justin Lewis (UC Davis): What is the best recommendation for exhaust entrainment/dilution criteria at nearby intakes or roof top works, etc? ASHRAE seems to recommend 400 ug/m3 per g/s or 1/5000 cfm per 100 cfm of dilution. ANSI z9.5 seem to recommend something slightly less stringent. Which one should we adopt, and how do we make room for a custom engineered criterion?
    a. Victor Neuman (Laboratory Exhaust Certification): Proper risk assessment is to look at MSDS risk for each chemical used in the laboratory and construct a credible spill scenario to determine what the exposure risk is at different points in the system.
    b. Justin Lewis (UC Davis): Does that imply a need to understand future uses, or are there some rules of thumb if the future chemical use is not known?
    c. Gordon Sharp (Aircuity): Similar to the wind tunnel studies and their characterization of chemicals of interest, the same can be done with contaminant sensors to achieve 100 percent coverage either through sensing or adjustment of the permitted levels of the chemical. Current practice places limits on chemicals that are very hazardous or odorous.
24. Hwakong Cheng (Taylor Engineering): Wind tunnel modeling needs to include surrounding features and buildings to account for how the plume disperses. What if a new building is constructed downstream one year after the project is completed? That may negatively impact dispersion or introduce new receptors. To account for safely, the wind tunnel work may need to be updated.
    a. Justin Lewis (UC Davis): I agree with Hwakong. New assessment of exhaust systems need to be done when new buildings are built nearby, not just when new exhaust systems are installed.
    b. Tom Checksfield (Exposure Control Technologies): I can provide information on developing a risk assessment associated with control banding for managing air change rates.
25. Hwakong Cheng (Taylor Engineering): Do first cost estimates include installation cost? First costs seem low.
    a. Jared Landsman (Utility CASE Team): The cost does not include installation. We only included the cost of the product.
    b. Gina Rodda (Gable and Associates): Needs to include installation and inspection costs, in addition to ongoing maintenance costs to be realistic.

26. Debbie Decker (UC Davis): What about the ongoing costs of maintenance, training, calibration, inspection, monitor replacement, monitoring the system, etc?
    a. Victor Neuman (Laboratory Exhaust Certification): Anemometer maintenance is minimal. Can calibrate sensors without lost time in laboratories by maintaining exhaust fans at constant volume during calibration.
    b. Debbie Decker (UC Davis): We always underestimate maintenance costs. Rule of thumb is to add a zero to the maintenance cost.
27. Dr. Bob Haugen (Flow Sciences): Did you include lost productivity when maintenance is being conducted?
    a. Jared Landsman (Utility CASE Team): No, we did not include that cost.
28. Brad Cochran (CPP Wind Engineering & Air Quality Consultants): The analysis should include cost impacts of operating fans with variable air volume control, which will reduce wear and tear on fans relative to constant volume and thus reduce maintenance costs.
29. Justin Lewis (UC Davis): I think the greatest cost is better education of the skilled operators to understand the system.
30. Kelly Cunningham (PG&E, Utility CASE Team): If anybody is willing to contribute cost analysis data, this would be very valuable. Please contact Jared if you can contribute data to the cost analysis.
31. Hwakong Cheng (Taylor Engineering): In general, a big concern of mine is that this proposed measure relies on technology to ensure safety. As a prescriptive approach, this measure targets lab buildings that may not have much infrastructure and budget for careful maintenance (not like a big university campus that has Environment, Health & Safety and full time operators). How will these buildings be operated in real life?
    a. Debbie Decker (UC Davis): Big universities may have full-time operators and EH&S staff, but those folks are spread really thin.
    b. Victor Neuman (Laboratory Exhaust Certification): Staged fans are not new technology. It is new to code, but not new technology.

High Efficiency Fume Hoods

- Briana Rogers (AESC Inc., Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Todd Gottshall (Western Allied Mechanical): Section 410 of the California Mechanical Code (Title 24, Part 4) only applies to OSHPD 1, 2, 3, and 4.
    a. Briana Rogers (Utility CASE Team): CMC Title 24, Part 4, Section 410.1 relates to air change and pressurization for health and safety in hospitals and Section 410.3 establishes average face velocities for laboratory fume hoods. OSHPD 1, 2, 3, and 4 include acute care hospitals, skilled nursing facilities, licensed clinics, and correctional treatment centers. Is your comment that Section 410 does not cover Group I occupancy?
2. Victor Neuman (Laboratory Exhaust Certification): The presentation references the incorrect version of ANSI Z9.5. The current version is ANSI Z9.5-2012.
3. Hwakong Cheng (Taylor Engineering): This should not be a mandatory requirement.
    a. Debbie Decker (UC Davis): I agree with Hwakong. Room occupancy sensors, user education and outreach, and administrative controls have been effective. We are

constrained in California in that there are no options to reduce face velocity. Cal/OSHA sets the face velocity requirements, and are seemingly not interested in revisiting the requirements that are too restrictive.

b. Victor Neuman (Laboratory Exhaust Certification): I agree with Debbie on freshman chemistry using room occupancy sensors.
    i. M M Valmiki (Utility CASE Team): Generally, teaching labs will have different schedules and usage patterns than a research lab. They will have regular periods of constant use instead of random research use. Therefore, a teaching lab might achieve great savings with a cheaper solution, such as occupancy sensors, if the fume hoods don't need to be on all the time. We feel we cannot recommend anything other than the automatic sash closure system measure due to safety concerns of using occupancy sensors as an on/off mechanism. The only recourse would be to include an exception for teaching labs, but we would need more stakeholder feedback and justification along those lines.
c. Robert DeLuca (Lab Crafters): Debbie's comments are 100 percent correct. More face velocity is not better, it actually causes more turbulence and spillage. I think there are other options – high performance fume hoods that work at higher velocities.
a. Briana Rogers (Utility CASE Team): We considered an exception for high-performance.
b. Hwakong Cheng (Taylor Engineering): Face velocity setback (down to 60 fpm) is an option, or good manual sash practices might be another. Low-flow fume hoods. At this point, lowering face velocity value was not something we were able to achieve in this code cycle.
d. Robert DeLuca (Lab Crafters): Look into combination sashes. Automatic sash closures are not the answer and are more costly.

4. Justin Lewis (UC Davis): I have heard some resistance to auto closures: some on the maintenance side, some on the user side. I am not familiar with either concern. Is anyone else?
    a. Tom Checksfield (Exposure Control Technologies): I have had experience with them. Users do not like them for several reasons. Also, when installed on old hoods with restricted sash movement, they can cause maintenance issues.
    b. Justin Lewis (UC Davis): This is a good point. Unless the lab air change rate is 4 ACH or less, very little savings for this complication to the fume hoods.
5. Gina Rodda (Gable and Associates): What are prescriptive alternatives if you had to trade-off?
    a. Justin Lewis (UC Davis): I like terribly annoying buzzers and alarms instead.
    b. Robert DeLuca (Lab Crafters): As chairman of the Scientific Equipment and Furniture Association (SEFA) fume hood committee, I wrote a letter in response to the automatic sash closure and offered many alternative options to achieve the energy savings looking to be achieved. Have the comments compiled by the fume hood committee been considered?
        i. Briana Rogers (Utility CASE Team): We will be considering this. We incorporated SEFA's formal comments into our presentation, and we also plan to include the comments in the draft CASE report. Based on SEFA's comments, the Statewide CASE Team also considered allowing an exception to the required automatic sash closure controls if a high performance/low flow VAV fume hood is installed instead. However, the energy savings analysis showed that under no circumstances would a high performance/low flow fume hood achieve savings greater than or equal to the automatic sash closure controls when the fume hood

is unoccupied. However, the Utility CASE Team recognized that there were certainly situations in which the high performance/low flow fume hoods would achieve equal or greater savings than the proposed measure, especially in lab spaces with greater than typical operating hours and fume hood diversity usage rates. This is ultimately addressed in the draft CASE Report with the modification of the proposed measure from mandatory to prescriptive.

   c. Debbie Decker (UC Davis): There are other way to achieve savings. For example, reducing face velocity.
   d. Chris Jakober (UC Davis): I echo the comments of Debbie and Justin.
   e. Victor Neuman (Laboratory Exhaust Certification): Automatic sash closing should only be mandatory if the facility does not have acceptable user sash closing.
   f. Debbie Decker (UC Davis): Combination sashes may be an option for some institutions, but not at my institution. Vertical rising sashes are the default.
   g. Robert DeLuca (Lab Crafters): There are a quite a few labs that have received variances from Cal/OSHA on the face velocity requirement. One option would be to look at those labs and see how they are operating
      i. Debbie Decker (UC Davis): I would say there are some hoods operating under the variance, not a lot though.
      ii. Briana Rogers (Utility CASE Team): We did look into opportunities to work with Cal/OSHA to modify minimum face velocity requirements, but that is unlikely to be achievable during this code cycle. Cal/OSHA would need to change the face velocity requirement.

6. Victor Neuman (Laboratory Exhaust Certification): Based on a quick calculation, the minimum fume hood flow per ANSI Z9.5-1012 may be high as 25 cfm per square feet.
   a. Justin Lewis (UC Davis): There are some labs at UC Davis that we could use as prototype tests, but not sure they are representative to other labs as a "prototype." We are open to discussing this further. I'm in Facilities Management at UC Davis.
7. Justin Lewis (UC Davis): Maintenance of the motorized closures is a concern to me.
8. Jon McHugh (McHugh Energy Consultants): This measure has significant savings. To put the savings presented in the presentation into context, 574 MW is around the power output of one medium sized power plant.
9. Jon McHugh (McHugh Energy Consultants): What are fume hood driven lab spaces? The 35:1 ration means one square foot of hood work surface per 35 square feet of gross floor area.
10. Robert DeLuca (Lab Crafters): What is the science behind the definition of fume hood driven lab space? A 35:1 ratio seems a bit removed from what dictates “fume hood driven.” Whether a space is fume hood driven has more to do with ACH and fume hood density.
    a. Briana Rogers (Utility CASE Team): We developed this threshold by evaluating hood layouts for prototype buildings.
    b. Hwakong Cheng (Taylor Engineering): The cost-effective balance for hood density will depend on the minimum ACH rate. You could consider an ACH threshold.
    c. Victor Neuman (Laboratory Exhaust Certification): The formula may be assuming ceiling height for assumed air change rate.
    d. M M Valmiki (Utility CASE Team): The 35:1 ratio is based on iterative calculation of varying parameters. One of those parameters is how many hood feet per lab area, which can be manipulated in a model. There is no one best way to go about it, and there are many arguments for and against the many approaches considered. The definition of a

fume hood driven lab exhaust system for code language purposes will be updated in the draft CASE Report. It is similar to the 35:1 ratio, but takes into account several driving parameters that may vary across lab designs. These include ventilation ACH setpoint, ceiling height, and fume hood density (linear hood feet per lab area). A sensitivity analysis was performed across these parameters (and others) for each climate zone. Cost-effectiveness of the measure was used as a criterion for defining the variable space that was considered "fume-hood driven." This approach was taken to require the measure at labs that will see a material benefit from the measure due to their particular set of building parameters. This lab parameter matrix may need updating as the report is refined and cost-effectiveness criteria for code measures is clarified.

e. Bach Tsan (SCE, Utility CASE Team): Is this a consideration for applying a possible exception?
f. Victor Neuman (Laboratory Exhaust Certification): Let's table how we are defining "lab-hood driven space" and concentrate on the fume hood sash closers requirement. If there is no requirement for sash closures, then there is no need to define the appropriate threshold.
g. Victor Neuman (Laboratory Exhaust Certification): In architectural terms, 1.5 fume hoods of 6-foot width in a prototypical architectural lab module.
h. Jon McHugh (McHugh Energy Consultants): Documenting the basis of the 35:1 ratio would be helpful.
    i. Key takeaway: Stakeholders would like a better explanation of the 35:1 ratio to better understand the logic and may also wish to see consideration of other metrics to define "fume hood driven" space.

11. Justin Lewis (UC Davis): I have also heard that some people really like the automatic opening and do not mind the automatic closing. I believe UC Irvine had positive feedback.
    a. Jon McHugh (McHugh Energy Consultants): Some have not liked automatic opening, because of the safety problem caused by automatic opening.
    b. Debbie Decker (UC Davis): I have heard mixed reactions – some love it, while some hate it.
    c. Jon McHugh (McHugh Energy Consultants): Automatic closing increases safety, but auto opening does not increase safety.
12. Justin Lewis (UC Davis): I like the centrally-monitored sash positions and making that available to facility operators and occupants. Use education and conversation to ensure fume hoods stay closed, and variances are documented with a "sunset" date in place. To be clear, I like a process of monitoring and admin controls instead of automatic closures.
    a. Debbie Decker (UC Davis): I agree with Justin. Having the technology to monitor sash height would be helpful.
13. Gina Rodda (Gable and Associates): Building departments do not want more forms, and they oppose complex codes.
14. Debbie Decker (UC Davis): Automatic sash closures are currently after-market installation. Some manufacturers will claim automatic closure; however, it is a decay to an approximate 18-inch sash height. This will add significant cost to an already expensive system.
    a. Hwakong Cheng (Taylor Engineering): Kewaunee and Labconco have factory-installed automatic sash closers that do fully open or close sashes.
    b. Jon McHugh (McHugh Energy Consultants): This looks like it is OEM https://www.nycominc.com/wp-content/uploads/2015/02/LV-Sash-Operator.pdf

    c. Jon McHugh (McHugh Energy Consultants): Kawanee has a product they make, that they apply to their hoods.
    d. Justin Lewis (UC Davis): An aftermarket solution being required by code is not a wise choice.
15. Jon McHugh (McHugh Energy Consultants): What are you finding installed cost is for after-market add-one products?
    a. Debbie Decker (UC Davis): $2,000 to $3,000 per hood, based on some rather old numbers.
    b. Hwakong Cheng (Taylor Engineering): I have seen for approximately $5,500 for field installed, $3,000 to $5,000 for factory-installed.
16. Victor Neuman (Laboratory Exhaust Certification): Energy savings are zero if fume hood user closes sash as they are required to do by safety regulations.
17. Kyra Weinkle (NORESCO): Does the incremental first cost include installation and cost of testing?
    a. M M Valmiki (Utility CASE Team): Yes, it does include commissioning.
    b. Jon McHugh (McHugh Energy Consultants): What should the commissioning and set up costs be?
18. Victor Neuman (Laboratory Exhaust Certification): Cannot verify proper operation of fume hood sash closer on each individual fume hood in the factory. Verification must occur in the field.
19. Justin Lewis (UC Davis): Are we moving towards control banding, which is different ventilation rates for different hazard level labs?
    a. Tom Checksfield (Exposure Control Technologies): Yes. A lab ventilation risk assessment will allow you to achieve this.
    b. Justin Lewis (UC Davis): If that happens, and the building has good occupancy based controls, the building will likely beat the model most of the time.
    c. M M Valmiki (Utility CASE Team): I believe you are referring to how labs are designed and ventilation rates are specified for different lab types, which does not impact the measure since the fume-hood definition has an ACH parameter in it. Occupancy based controls for the exhaust flow rates could reduce the cost-effectiveness of sash closure controls, but that impact should be captured in the current fume hood driven definition in the code language if implemented correctly.
20. Chris Jakober (UC Davis): The occupancy times used in the analysis are not even close to reflecting typical graduate student occupancy schedules.
    a. Justin Lewis (UC Davis): True. Occupancy hours should be widened a lot. I would recommend 7:00 AM – 9:00 PM. The energy models should reflect close to actual operation.
    b. Chris Jakober (UC Davis): I would say 7:00 AM to at least 10:00 PM on weekdays and 9:00 AM to 9:00 PM on weekends.
    c. Debbie Decker (UC Davis): Agreed. Classroom laboratories operate from approximately 7:30 AM to 10:00 PM
    d. Justin Lewis (UC Davis): I don't think majority occupancy is consistent every weekend for all laboratories, right? This is for baseline modeling.
    e. Chris Jakober (UC Davis): Maybe not teaching, but many research labs will have some percentage of weekend occupancy. Synthesis labs will be on the higher end.

   f. Chris Jakober (UC Davis): During the winter there is a tendency for graduate student to work weekends and take time off during the week.
   g. Justin Lewis (UC Davis): 9:00 AM to 9:00 PM for entire building energy modeling every weekend sounds like too much to me.
   h. Justin Lewis (UC Davis): This is for baseline energy, not for available occupancy.
   i. Gina Rodda (Gable and Associates): Changing baseline will only increase savings, so as is, it is conservative.
      i. Justin Lewis (UC Davis): We are not in agreement that it is conservative.
   j. Joe Loyer (Energy Commission): Is it possible to perform a sensitivity analysis based on the variable of occupancy schedule?
      i. M M Valmiki (Utility CASE Team): Yes, it is. We did a sensitively analysis and did not find occupancy was a driving factor. We can consider occupancy further.

21. Debbie (UC Davis): Automatic sash closures could close on somebody's petri slides.
22. Hwakong Cheng (Taylor Engineering): Labs are a complex beast. There is no typical scenario or baseline, so I think that it is hard to accept a single set of energy savings numbers. More work should be done to address the sensitivity to different variables to demonstrate the cost-effectiveness.
23. Victor Neuman (Laboratory Exhaust Certification): The Utility CASE Team may be interested to review lab exhaust standard 24 on www.labexhaust.com.
24. UC laboratory design guide is in the process of being revised and updated. You can access the latest edition on http://lsdm.ucop.edu/.