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Comments on variable lab exhaust flow control

Additional submitted attachment is included below.

TAYLOR
ENGINEERING

To: Statewide Codes and Standards Team
From: Hwakong Cheng
Subject: Comments on Title 24 2019 CASE Report, Variable Exhaust Flow Control, Draft Report
Date: June 23, 2017

We have reviewed the draft CASE report for Variable Exhaust Flow Control. We are concerned that cost effectiveness is not accurately represented and that this measure poses unacceptable safety risks. The cost effectiveness evaluation uses an inappropriate baseline and relies on unrealistically low first costs. Though plume dispersion analysis and wind-responsive exhaust fan control can potentially be excellent energy efficiency measures, there are too many site-specific factors to generalize the cost effectiveness, and these measures may pose significant risks to public safety if not properly implemented and maintained. One of the options is also a proprietary technology. These are simply not appropriate as a code requirement. We recommend that the Energy Commission reject this CASE measure.

Below are detailed comments on the draft CASE report:

1. Section 2.1 Measure Overview. The description suggests that only B occupancy would be impacted by this measure, but it would also apply to laboratories that are H occupancy.
2. Section 2.1 Measure Overview and Section 7.1 Standards. The CASE report repeatedly refers to “certified” wind consultant and engineers but there is no such designation as far as we are aware. Requiring this in the proposed code language would be confusing and unenforceable.
3. Section 2.1 Measure Overview. The CASE report goes into extensive detail on induction exhaust fans (IEF), despite clearly demonstrating that they are more expensive, use more energy, some have less effective plume dispersion, and only represent a small market share, compared to conventional exhaust systems. IEFs really are not relevant to this discussion and are not appropriate as baseline condition. Delete this discussion on IEFs.
4. Section 2.1 Measure Overview. The description of the proposed code change language suggests that bypass air is excluded from the requirement for the fan power limit. This cannot be correct. Makeup dampers allow bypass air to enter on the suction side of the fan, so the bypass air still has to be moved through the fan and needs to be accounted in the design flow and fan power. Only entrained (induced) air associated with IEFs would be excluded.
5. Section 2.1 Measure Overview. Some designers separate fume hood exhaust systems from general exhaust. Is this measure intended to apply to exhaust systems that are dedicated to general exhaust? Minimum stack velocities and dispersion requirements are often not applied to general exhaust.

6. Section 2.2 Measure History. There is also currently no code requirement for dispersion analysis, which itself is a big change to first cost and energy cost compared to current practice as required by code.
7. Section 2.4.4 Relationship to Industry Standards. Please clarify that the NFPA 45 reference on exhaust discharge are from an informative appendix in that standard and though NFPA 45 may be a model code, it is not adopted at the state level in California codes.
8. Section 2.5 Compliance and Enforcement. The single sentence describing the impact to mechanical designers is greatly oversimplified. If meeting the fan power allowance, exhaust ducts would likely need to be oversized and/or fans selected for much higher efficiency than typical. The former may require coordination with architects and structural engineers and larger floor to floor heights. If using wind-speed control, a costly plume dispersion analysis is required along with coordination with a wind tunnel consultant. Contaminant control would require careful coordination with vendor and building occupants on anticipated chemical use.
9. Section 3.1 Market Structure. The contaminant control measure is a proprietary technology that is only offered by Aircuity, Inc. There are no other manufacturers of contaminant sensors for lab exhaust applications. This proposed requirement does not meet the basic restriction for non-proprietary technologies.
10. Section 3.2 Technical Feasibility, Market Availability and Current Practices. The discussion states that wind-speed control and contaminant-control are safe, as long as there is periodic calibration. Relying on sensor calibration to maintain public safety is a big leap of faith. Preventative maintenance and manufacturer-recommended sensor calibration intervals are nearly universally neglected by facilities operators, often due to lack of resources and knowledge.

    Other safety concerns relating to wind-speed control include the fact that a wind tunnel study is based on a static condition of the building and its surroundings. If the surroundings change after the fact (e.g. a new building constructed downwind by a different building owner), the plume dispersion may be impacted and new sensitive receptors may be introduced resulting in unsafe conditions. This is a significant safety risk that would be outside of the scope of the Title 24 requirement. Plume dispersion analysis and wind-responsive control are both potentially very good energy efficiency measures but they require an informed and responsible building owner to ensure effective and safe operation over the long term.

    Safety concerns relating to contaminant sensing include the fact that PID sensors only detect volatile organic compounds. How does this approach guarantee safety if other hazardous (but non-VOC) chemicals are used, such as acids, radioisotopes, particulates, biohazards? Different chemicals may have different thresholds for unacceptable concentrations. Even if all chemicals used on day one can be sensed, chemical uses often change but continued safe operation would require that the lab users communicate these changes to safety managers and that they in turn communicate these changes to a responsible party that is able to evaluate the impact to the exhaust control. There are simply too many risks associated with this technology to make it a requirement in the energy code.

11. Section 3.3.1 Impact on Builders. Another impact that is not listed is significantly increased HVAC cost.
12. Section 3.4.3 Competitive Advantages or Disadvantage for Businesses within California. By significantly increasing the HVAC construction cost of labs, institutions in CA may be at a competitive disadvantage. Consider a biotech startup firm that has limited funding and may potentially operate for 2 to 3 years. This measure may add prohibitive cost and time to design and build a lab. Or a retrofit to a single research laboratory room within a large academic building, which may require that the entire building's exhaust system be retrofitted just to implement an alteration to a small portion of the building.
13. Section 4.1 Key Assumptions for Energy Saving Analysis. It is not clearly stated in this section but it appears that the main analysis assumes a baseline condition with induction exhaust fans operating at a fixed fan speed and exit velocity of 3000 fpm and a proposed condition using a conventional stack with reduced exit velocities based on a simplified wind-responsive calculation. This section should be revised to clarify assumptions that apply to the baseline vs the proposed condition – the assumptions currently appear to be mixed among each other. As noted above, the baseline condition should not be an induction exhaust fan. They cost more, use more energy, and represent a small fraction of the lab exhaust market share, as clearly stated in this report. Therefore, they are not representative, and will exaggerate the savings associated with these measures. The baseline should simply be a conventional stack with fixed speed fan maintaining 3000 fpm. The assumption states typical static pressures for IEFs between 3 and 5 inches. Please be more specific in exactly what value is assumed in the analysis.

    Plume dispersion, particularly when accounting for wind-responsive control, is highly dependent on local factors. Wind profiles at the building may be significantly impacted by the building itself, surrounding buildings and terrain, whereas wind data from TMY weather stations are often distant and based on flat, wide open terrain (i.e. airports). The generalized calculation method used here also really only pertains to exhaust systems with simple surrounding environments, which is likely not a typical assumption. Dispersion analysis is also highly dependent on the location of receptors, which can include the roof, air intakes, operable windows and doors, and those on adjacent buildings. There are simply too many site specific factors to develop generalized savings for a measure like this. It is not clear from the description whether wind direction was accounted for in the calculation. It is also not clear that cost effectiveness has been demonstrated for each of the three independent options: fan power limit, wind-speed control, and contaminant control. First costs are described for the first two options later in Section 5.3 (but not the third) but only a single set of cost effectiveness data is presented.

14. Section 5.2 Energy Cost Savings Results. The conclusions described in the second paragraph appear to be counterintuitive. Typically, large lab exhausts have increased momentum, which means that plume dispersion analysis can show them to be safely operated at much lower exit velocities than 3000 fpm. We would therefore expect to see more savings from larger labs.
15. Section 5.3 Incremental First Cost. The hardware costs for wind-speed control appear to be limited to the actual parts costs, but don't include installation, commissioning, training, and incremental cost for larger DDC controller. It also does not include the cost of VFDs on the exhaust fans (the baseline condition should be a fixed speed fan, where there generally would not be an existing VFD). The assumed wind tunnel cost also appears to be very low. From our actual past projects, wind tunnel study fees from projects on a campus with pre-existing models of surrounding building and historical wind data (but not including wind-responsive control) have been: $17,500, $22,500, and $26,000. Three other studies on campuses with existing models (also not including wind-responsive control) have been $26,000, $26,000 and $55,000. Another analysis cost $35,000 including wind-responsive control on a campus with previous studies. A fee breakdown on one project listed an added cost of $8000 to determine wind-responsive setpoint, $12,000 to develop a proximity model for surrounding terrain/buildings where those were not existing, and $3000 for climate analysis where not previously done. Based on these numbers, in the worst case scenario, for a building where no previous analysis has been completed, a wind tunnel study for wind responsive control is likely to be at least double the assumed cost, if not more.

    This section does not address the incremental cost of oversized ducts and exhaust fans to meet the very aggressive W/cfm limit.
16. Section 5.5 Lifecycle Cost-Effectiveness. This section does not address the cost effectiveness and practicality of extending the prescriptive requirement to apply to alterations and additions. A small lab TI in a large building may trigger a requirement to retrofit an entire centralized lab exhaust system, which could potentially dwarf the cost of the TI project. Such a negative cost impact might drive those TI projects to build small dedicated fixed-speed exhaust systems that fall under the 10,000 cfm threshold, rather than utilize available capacity under existing centralized exhaust systems.
17. Section 7.1 Standards, 140.9(c). What is a "process facility"? It is not currently defined in the standard.
18. Section 7.1 Standards, 140.9(c)1. Adding the reference to ANSI Z9.5 means that stacks will be required to be 10 feet high instead of 7 feet high. How does this relate to energy efficiency under Title 24, Part 6? Taller exhaust stacks are primarily for safety and turndown, but are likely to increase fan power consumption at full load. This reference should be deleted.
19. Section 7.1 Standards. Fan power limitation, 140.9(c)1.A. A typical system lab exhaust may be designed for 3 inches of static pressure. That would work out to 0.67 W/cfm for a 60% efficient fan (3"/6345/0.6*746/0.9/0.97 = 0.67 W/cfm). To reduce the fan power to

0.45 W/cfm, the static pressure would need be reduced to 2” or a 90% efficient fan used (no such fan exists), or an aggressive combination of reduced static and increased fan efficiency. This option is neither practical nor cost effective.

20. Section 7.1 Standards, 140.9(c)2.A. What if an anemometer fails or communication is lost. The contaminant control option requires a failsafe option in the case of sensor failure – why isn’t there a similar requirement for wind-speed control?
21. Section 7.1 Standards, 140.9(c)2.C. Delete this requirement. There is nothing added here that is not already required under 140.9(c)1.C.
22. Section 7.1 Standards, 141.1(f). This requirement is simply too broad and impractical. It should be deleted. The CASE report does not specifically address any of the issues and impacts relating to this requirement for additions and alterations.