DOCKETED

Docket Number:	17-BSTD-02
Project Title:	2019 Title 24, Part 6, Building Energy Efficiency Standards Rulemaking
TN #:	222596
Document Title:	Hwakong cheng Comments Laboratory Exhaust Fan Power
Description:	N/A
Filer:	System
Organization:	Taylor Engineering/Hwakong cheng
Submitter Role:	Public
Submission Date:	2/16/2018 5:32:16 PM
Docketed Date:	2/20/2018

Comment Received From: Hwakong cheng
Submitted On: 2/16/2018
Docket Number: 17-BSTD-02

Laboratory Exhaust Fan Power

Additional submitted attachment is included below.

TAYLOR ENGINEERING

To:	CEC
From:	Hwakong Cheng
Subject:	Comments on Prescriptive Requirements for Laboratory Exhaust Fan Power
Date:	February 16, 2018

Though we agree with the need to address laboratory exhaust fan power in the energy standard, we have strong concerns that the proposed requirements in Section 140.9(c)3 are inappropriate for the energy code, impractical, not cost effective, and/or pose unacceptable safety risks. We recommend revising the language to:

3. Fan System Power Consumption. All newly installed fan exhaust systems serving a laboratory or factory greater than 10,000 CFM shall comply with the requirements of 140.4(c).

Rationale:

The proposed fan power limitations in 140.4(c) have been included in ASHRAE Standard 90.1 for many years and have already been demonstrated to be cost effective. Importantly, those requirements include adjustments to establish varying fan power limits based on the system components, including for common laboratory components such as fume hoods and exhaust treatment. Laboratory exhaust systems can face widely varying duties that have a significant impact on total fan power – having a single threshold limit of 0.65 W/cfm as currently proposed in 140.9(c)3.B is not practical or appropriate. Use of this established fan power limitation calculation addresses a wider range of unique circumstances that may occur, which creates a more practical path to compliance and obviates the need for the other alternative compliance paths, which have many issues. Note that revising the requirement as recommended above would also require:

- Deleting or revising the proposed Exception 1 to 140.4(c) for fan system power caused solely by process loads and
- Retaining the adjustment credit of "(2.15 in. of water for laboratory and vivarium systems)" and other adjustments from 90.1 in Table 140.4-B.

Detailed Comments:

Appropriateness:

The proposed Section 140.9(c)3.A adds a requirement for laboratory exhaust to comply with the discharge requirements in ANSI Z9.5-2012. These requirements relate to safety and generally align with common industry standard of care. Nevertheless, the reference does not relate to energy use and is not appropriate to be included in the building energy efficiency standards and should be deleted.

Cost Effectiveness:

The proposed Section 140.9(c)3.B sets a single threshold fan power limit of 0.65 W/cfm for any new lab exhaust system greater than 10,000 cfm. Though this limit has been relaxed from the originally proposed 0.45 W/cfm, this threshold may still be impractical to achieve in practice for many laboratory exhaust systems. A survey of more than a dozen laboratory exhausts with utility set fans and conventional exhaust stacks show that the majority would exceed this limit, and many by a large margin. Modifying the designs from these exhaust systems would add significant cost that is not represented in the CASE report.

DESIGN CFM	TSP	ESP	BHP	DESIGN W/cfm
11,400	3.5		11.3	**0.74**
11,400	3.5		11.3	**0.74**
5,500	3		4.15	**0.56**
5,500	3		4.15	**0.56**
14,000	4		14.5	**0.77**
14,000	4		14.5	**0.77**
30,000	5		32	**0.80**
10,500	5.5		13	**0.92**
10,500	5.5		13	**0.92**
55,000		3	37.8	**0.51**
40,000		3	29.03	**0.54**
21,286		3.5	21.57	**0.76**
75,000	5.25		90.75	**0.90**
21,000	5		25.6	**0.91**

Section 5.3 of the CASE report describes an overly simplistic cost exercise that does not reflect the true incremental first cost of this requirement. The authors appeared to have compared the budget pricing listed in the manufacturer's selection software for a range of fans operating a design duty near the threshold limit (near 3.5 inches of pressure). Budget pricing was compared for fans that just barely met the fan power limit against the cheapest fan from each set to establish the incremental increase in first cost. There are two issues with this approach. The fan selection software will suggest any fans that can strictly meet the user-input duty. However, the largest fans (which typically have the highest efficiencies) generally have an operating point at the top of the curve near the "do not select" line where there may be surge issues. These are not practical fan selections because any reduction in airflow may cause the fan to go into surge. The report does not clearly show the selections evaluated but it does not appear that this factor was considered. Below we have replicated fan selections and W/cfm calculations for two fan duties:

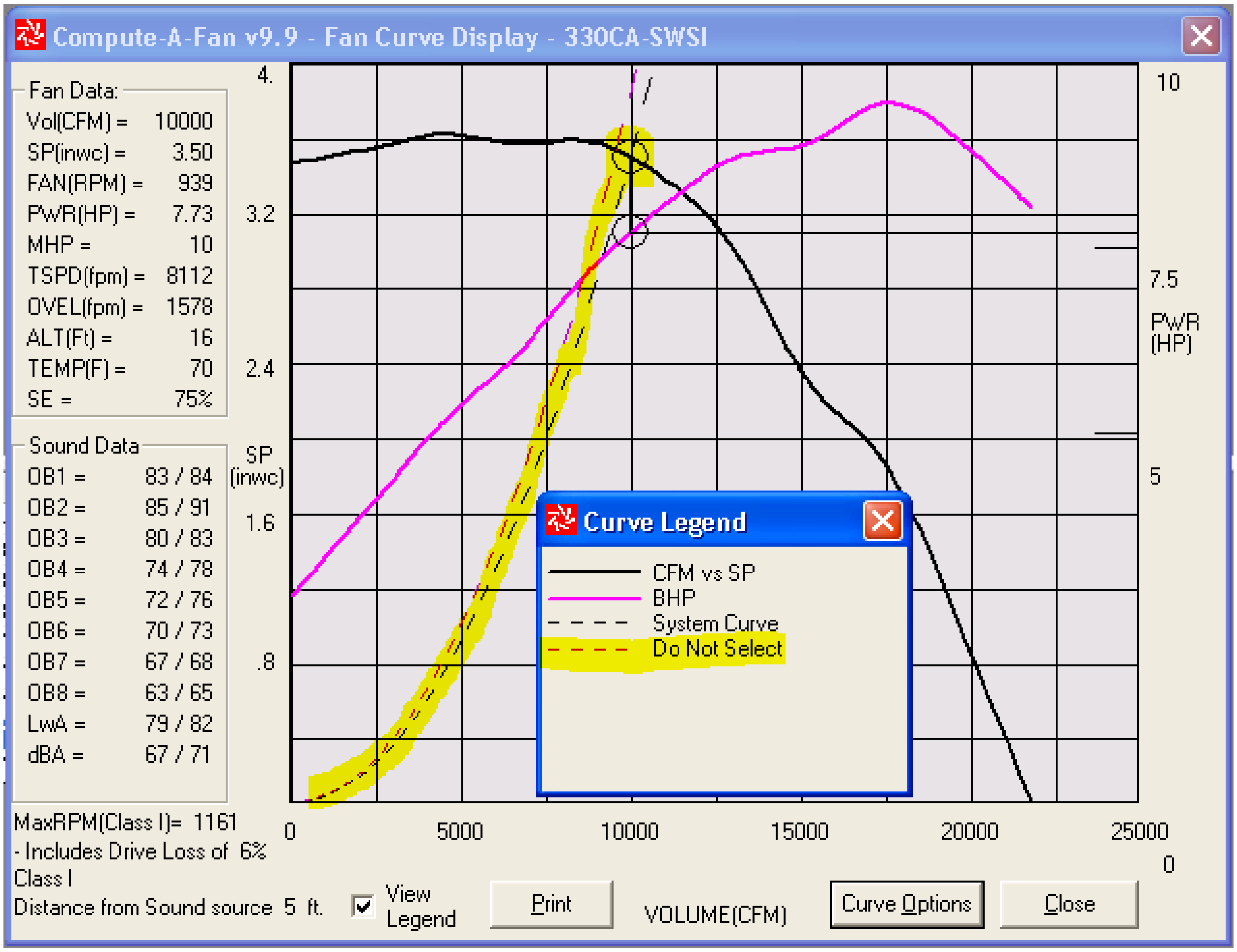
Utility fan selections for 10,000 CFM, 4" SP (as described in CASE report as baseline), assuming 90% motors and 97% VFDs. None of the fans can meet the 0.65 W/cfm limit.

Model	Drive	Volume CFM	SP inwc	SE	Budget Price	Static Eff	W/cfm	Budget $
180CA-SWSI	Belt	10000	4	42%	$6,400	0.42	1.28	6400
195CA-SWSI	Belt	10000	4	50%	$6,500	0.5	1.08	6500
210CA-SWSI	Belt	10000	4	57%	$5,100	0.57	0.95	5100
225CA-SWSI	Belt	10000	4	64%	$5,400	0.64	0.84	5400
245CA-SWSI	Belt	10000	4	70%	$5,300	0.7	0.77	5300
270CA-SWSI	Belt	10000	4	75%	$5,500	0.75	0.72	5500
300CA-SWSI	Belt	10000	4	76%	$6,300	0.76	0.71	6300

Utility fan selections for 10,000 CFM, 3.5" SP (lower than baseline described in CASE report), assuming 90% motors and 97% VFDs. Three of the fans can meet the 0.65 W/cfm limit.

Model	Drive	Volume CFM	SP inwc	SE	Budget Price	Static Eff	W/cfm	Budget $
180CA-SWSI	Belt	10000	3.5	39%	$6,000	0.39	1.21	6000
195CA-SWSI	Belt	10000	3.5	46%	$6,500	0.46	1.02	6500
210CA-SWSI	Belt	10000	3.5	54%	$5,100	0.54	0.87	5100
225CA-SWSI	Belt	10000	3.5	60%	$4,850	0.6	0.79	4850
245CA-SWSI	Belt	10000	3.5	68%	$4,950	0.68	0.69	4950
270CA-SWSI	Belt	10000	3.5	73%	$5,500	0.73	0.65	5500
300CA-SWSI	Belt	10000	3.5	76%	$6,300	0.76	0.62	6300
330CA-SWSI	Belt	10000	3.5	75%	$6,900	0.75	0.63	6900
365CA-SWSI	Belt	10000	3.5	70%	$7,700	0.7	0.67	7700

The fan curve for one of the selections that meets the 0.65 W/cfm limit is shown below – the design operating point and fan system curve fall right on the "Do Not Select" line. This is not a practical fan selection.



Also, the described approach to estimate first costs overlooks cases with higher design static pressure. For example, for a baseline condition of 4 inches or higher, there is no fan that can achieve 0.65 W/cfm. Achieving this fan power limit would require increasing duct sizes to reduce static pressure, and could be many orders of magnitude more costly than represented here.

The proposed Section 140.9(c)3.C provides an alternative compliance option to use wind responsive control. Though this can potentially be a very cost effective measure, the energy savings are strongly dependent on local wind conditions, the relative location of downwind receptors, and the amount of turndown in exhaust demand. An exhaust stack with a taller building in the predominant downwind direction may not be able to achieve any setback. Stacks in high wind areas may also have more limited opportunity for turndown. Many labs are also designed with constant minimum ACH rates that may not allow for 40% turndown in exhaust airflow. The energy cost savings presented in the CASE Report present an optimistic case which may not be broadly applicable. On the first cost side, the analysis does not include the cost for a wind tunnel study, which can range from $30,000 to $50,000 (on the higher end if including wind-responsive control and there is no pre-existing model for surround terrain/buildings, which is likely for prescriptive compliance projects), by the rationale that it is a design cost. This is not a reasonable justification to ignore such a significant first cost that would not otherwise be needed. The first costs also do not include variable speed drives on the exhaust fans by the explanation that they are already required by code. There is no such requirement in T24 for variable speed process exhaust fans. Section 140.9(c) requires variable flow in some cases, but most laboratory exhaust fans operate at a fixed speed with makeup bypass damper to maintain discharge requirements. And most lab exhausts have two fans for redundancy so the cost of two variable speed drives should be included. The control integration cost of $2500 for wind responsive control also appears unrealistically low. Section 3.2 suggests that periodic calibration is required for safety, but yet that cost is not included in Section 5.4 on incremental maintenance costs.

Safety:

The proposed Section 140.9(c)3.C would require use of an aggressive energy saving measure that may pose an unacceptable safety risk for several reasons. The CASE Report suggests that wind responsive control is safe as long as there is periodic calibration. Relying on sensor calibration to maintain public safety is a big leap of faith, particularly considering that preventative maintenance and manufacturer-recommended sensor calibration intervals are nearly universally neglected by facility operators, often due to lack of resources and knowledge. For a typical prescriptive-approach building, the building engineer may be too busy unclogging toilets to get up on the roof to evaluate the condition of the anemometer. Though the proposed requirement includes a safety in the case of sensor or communication failure, it does not address sensor drift or fouling (i.e. bird poop). Since the anemometer accuracy is critical for safety, a common approach is to install two anemometers so that the readings can be compared.

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. Though the same risk could apply for a conventionally operated stack maintaining 3000 fpm exit velocity, this measure exacerbates the risk by constantly reducing the stack velocity and reducing the effective plume height. 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 – it is not universally appropriate and should not be incorporated as a minimum code requirement.

The proposed Section 140.9(c)3.D would require use of contaminant sensing to allow for reduction in exhaust fan power when no hazards are detected. This commercial product utilizes a photoionization detector, which is only capable of detecting volatile organic compounds. This approach CANNOT detect many hazardous laboratory chemicals, including acid fumes, particulates, and radioisotopes. It is not uncommon for laboratory research interests to change over time, chemicals used in a lab today may differ significantly from those used in the future. Use of such a system requires a diligent and effective laboratory safety manager that tracks and limits chemical usage and understands the limitations of the contaminant sensing system. In our professional opinion, reliance on a contaminant sensing system to save fan energy poses an unacceptable compromise in safety – we will not ever employ such a system in our designs and do not think it is appropriate to be made a minimum code requirement.

Other

There is a spelling mistake in section 140.9(c)3.C.iii. Please revise as follows:

"Wind speed/direction sensors shall be certified by the manufacturer to be accurate…"

Sections 140.9(c)3.C and 140.9(c)3.D refer to maintaining "downwind concentrations below health and odor limits for all detectable contaminants". The "health and odor limits" must be based on a specific reference to be meaningful. The word "detectable" should be deleted – that effectively means that the controls do not need to address contaminants that are not detectable.