Proposal Summary

Laboratory Airflow

Updated: January 26, 2023
Prepared by: DJ Joh, Energy Solutions
Jeff Stein, Taylor Engineers

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) discussed during a utility-sponsored stakeholder meeting on January 31, 2023. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by February 14, 2023

Measure Description

L Occupancy

This measure would add the L (Laboratory) occupancy group to the list of occupancy groups covered by Title 24. Most labs are either B (Business) or E (Educational) or H (Hazardous), all of which are already covered by Title 24.

Nighttime Setback

Currently Title 24 prescriptively requires most labs to have variable air volume controls and be capable of reducing occupied airflow rates to the minimum needed for ventilation, pressurization, EH&S, etc. This measure would expand that requirement by saying labs must use occupancy sensors or other means to further reduce airflow rates when spaces are unoccupied. This measure also expands the VAV requirement to labs with a required minimum ≥ 10 air changes if the maximum rate exceeds the minimum required rate.

Exhaust Air Heat Recovery

This measure would prescriptively require exhaust air heat recovery for most large labs in most climate zones. A sensible recovery ratio of 45% would be required, which can be achieved with run-around coils.

New Exhaust Fan Control Option

Currently 140.9(c)3 prescriptively requires lab exhaust systems greater than 10,000 cfm to meet one of B, C, or D below. This measure would add option E to that list. This measure would also say that lab exhaust systems do not have to meet 140.9(c)3 if they meet 140.4(c) and do not have to meet 140.4(c) if they meet 140.9(c)3 C, D, or E. 140.4(c) is the prescriptive Fan Power Budget that was added in 2022 and is typically lower than Option B below.

140.9(c) 3B	**Low power**, 0.65 W/cfm or 0.85 W/cfm with filtration
140.9(c) 3C	Fan speed control mapped to **wind speed and direction**
140.9(c) 3D	Fan speed control based on **contaminant sensing**
140.9(c) 3E	1.30 W/cfm but VAV exhaust without using a bypass damper at the exhaust fan

Reheat Limitations

Many labs incur very large reheat penalties because they have a central air handler that cools large quantities of outside air that is then sent to multiple zones, many of which then reheat this large volume of air with 2-pipe hot water reheat coils. This measure would prescriptively require lab spaces to include both heating and cooling capacity at each zone in order to minimize reheat. The central air handler would then do little or no heating/cooling thus largely eliminating reheat. 4-pipe zone coils piped to accept hot or chilled water would meet this requirement.

Data Needs/Stakeholder Information Requests

Technical Feasibility

Are there any reasons to exempt certain labs from any of the above requirements?

Standard Design Practices

Please share your experiences (good or bad) with night setback, exhaust air heat recovery, exhaust stacks without bypass dampers, and zonal systems with heating and cooling capacity.

Costs

Are there are any special cost considerations that are specific to laboratories related to implementing nighttime setback?

Can you provide incremental cost information for exhaust air heat recovery or 4-pipe vs 2-pipe systems?

Data may be provided anonymously. To participate or provide information, please email DJ Joh, djoh@energy-solution.com directly and cc info@title24stakeholders.com.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2022 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions).

SECTION 100.0 – SCOPE

(a) Buildings Covered. The provisions of Part 6 apply to all buildings:

1. That are of Occupancy Group A, B, E, F, H, I, **L,** M, R, S, or U; and

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(c) **Fan systems.** Each fan system moving air into, out of or between conditioned spaces or circulating air for the purpose of conditioning air within a space shall meet the requirements of Items 1, 2 and 3 below.

a. **Fan power budget.** For each fan system that includes at least one fan or fan array with fan electrical input power ≥ 1 kW, fan system electrical input power (Fan $kW_{design,system}$) determined per Section 140.4(c)1(B) at the fan system design airflow shall not exceed Fan kW_{budget} as calculated per Section 140.4(c)1(A).

EXCEPTION 1 to Section 140.4(c)1: Laboratory or factory fan exhaust systems greater than 10,000 CFM complying with 140.9(c)3 C, D or E.

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(d) Space-conditioning zone controls. Each space-conditioning zone shall have controls designed in accordance with 1 or 2:

a. Each space-conditioning zone shall have controls that prevent:

i. Reheating; and

ii. Recooling; and

iii. Simultaneous …

b. Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or ….

~~**Exception 1 to Section 140.4(d):** Zones with special pressurization relationships or cross-contamination control needs.~~

Exception 2 to Section 140.4(d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site- solar energy source.

~~**Exception 3 to Section 140.4(d):** Zones in which specific humidity levels are required to satisfy exempt process loads. Computer rooms or other spaces where the only process load is from IT equipment may not use this exception.~~

~~**Exception 4 to Section 140.4(d):** Zones with a peak supply air quantity of 300 cfm or less.~~

~~**Exception 5 to Section 140.4(d):** Systems serving healthcare facilities.~~

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(q) **Exhaust air heat recovery**. Fan systems designed to operate to the criteria listed in either Table 140.4-J or Table 140.4-K shall include an exhaust air heat recovery system that meets the following:

1. A sensible energy recovery ratio of at least 60 percent or an enthalpy recovery ratio of at least 50 percent for both heating and cooling design conditions and a rating in accordance with AHRI 1060.
2. Energy recovery bypass or control to disable energy recovery and to directly economize with ventilation air based on outdoor air temperature limits specified in Table 140.4-G. For energy recovery systems where the transfer of energy cannot be stopped, bypass shall prevent the total airflow rate of either outdoor air or exhaust air through the energy recovery exchanger from exceeding 10 percent of the full design airflow rate.

Exception 1 to Section 140.4(q): ~~Systems meeting Section 140.9(c), Prescriptive requirements for~~ laboratory and factory exhaust systems with a sensible energy recovery ratio of at least 45% for both heating and cooling design conditions.

Exception 2 to Section 140.4(q): Systems serving spaces that are not cooled and that are heated to less than 60°F.

Exception 3 to Section 140.4(q): Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy in Climate Zone 16.

Exception 4 to Section 140.4(q): Sensible recovery ratio requirements at heating design conditions are exempted for Climate Zone 15.

Exception 5 to Section 140.4(q): Sensible recovery ratio requirements at cooling design conditions are exempted for Climate Zone 1.

Exception 6 to Section 140.4(q): Systems not serving laboratories or factories where the sum of the airflow rates exhausted and relieved within 20 feet of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is either:

1. used for another energy recovery system,
2. not allowed by the California Mechanical Code (Title 24, Part 4) (CMC) for use in energy recovery systems with leakage potential, or
3. of Class 4 as specified in Section 120.1(g).

Exception 7 to Section 140.4(q): Systems expected to operate less than 20 hours per week.

SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

(c) **Prescriptive requirements for laboratory and factory exhaust systems.**

140.9(c)1 Airflow reduction requirements. ~~For buildings with~~ laboratory exhaust systems ~~where the minimum circulation rate to comply with code or accreditation standards is 10 ACH or less, the design exhaust airflow~~ shall be capable of reducing ~~zone~~ space and fume hood exhaust and makeup airflow rates to the greater of

a) 6 ACH or lower,

b) the regulated minimum occupied circulation rate to comply with code, accreditation, or facility environmental health & safety department requirements~~, or~~

c) the minimum required to maintain occupied pressurization requirements~~, whichever is larger.~~

Variable exhaust and makeup airflow shall be ~~coordinated~~ automatically controlled to achieve the required space pressurization at varied levels of demand and fan system capacity.

Laboratory exhaust systems shall also include occupancy sensors, and/or other controls as necessary, to further reduce zone exhaust and makeup airflow rates to unoccupied rates of either:

a) 4 ACH or lower,

b) the regulated minimum unoccupied circulation rate to comply with code, accreditation, or facility environmental health & safety department requirements, or

c) the minimum required to maintain unoccupied pressurization requirements.

~~**Exception 1 to Section 140.9(c)1:** Laboratory exhaust systems serving zones where constant volume is required by the authority having jurisdiction, facility environmental health & safety department or other applicable code.~~

140.9(c)3 Fan System Power Consumption. All newly installed fan exhaust systems serving a laboratory or factory greater than 10,000 CFM, shall meet subsection A and either B, C, D, or E:

A. System shall meet all discharge requirements in ANSI Z9.5-2012.
B. The exhaust fan system power shall not exceed 0.85 watts per cfm of exhaust air for systems with air filtration, scrubbers, or other air treatment devices. For all other exhaust fan systems the system power shall not exceed 0.65 watts per cfm of exhaust air. Exhaust fan system power equals the sum of the power of all fans in the exhaust system that are required to operate at normal occupied design conditions in order to exhaust air from the conditioned space to the outdoors. Exhaust air does not include entrained air, but does include all exhaust air from fume hoods, hazardous exhaust flows, or other manifolded exhaust streams. **EXCEPTION to Section 140.9(c)3B:** Laboratory exhaust systems where applicable local, state, or federal exhaust treatment requirements specify installation of air treatment devices that cause more than 1 in. of water pressure drop.

C. The volume flow rate at the stack shall vary based on the measured 5-minute averaged wind speed and wind direction obtained from a calibrated local anemometer.
   i. At least two anemometers shall be installed in a location that experiences similar wind conditions to the free stream environment above the exhaust stacks and be at a height that is outside the wake region of nearby structures.

EXCEPTION to Section 140.9(C) 3Ci. Only one sonic anemometer capable of reading wind speed and direction shall be installed in a location that experiences similar wind conditions to the free stream environment above the exhaust stacks and be at a height that is outside the wake region of nearby structures.

ii. Look-up tables shall be used to define the required exhaust volume flow rate, as a function of at least eight wind speeds and eight wind directions, to maintain downwind concentrations below health and odor limits, as defined by the 2018 American Conference of Governmental Industrial Hygienists Threshold Limit Values and Biological Exposure Indices, for all detectable contaminants, or as defined by applicable local, state, or federal jurisdictions, if more stringent.

iii. Wind speed/direction sensors shall be certified by the manufacturer to be accurate within plus or minus 40 fpm (0.2 m/s) and 5.0 degrees when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years.

iv. Upon detection of anemometer and/or signal failure, the system shall reset the exhaust volume flow rate to the value needed to maintain downwind concentrations below health and odor limits for all detectable contaminants at worst-case wind conditions and shall report the fault to an Energy Management Control System or fault management application which automatically provides notification of the fault to a remote system provider. The system shall have logic that automatically checks for anemometer failure by the following means.

a) If any anemometer has not been calibrated within the manufacturer's recommended calibration period, the anemometer has failed.

b) During unoccupied periods the system compares the readings of all anemometers. If any anemometer is more than 30% above or below the average reading for a period of 4 hours, the anemometer has failed.

c) Wind speed and wind direction readings shall be sampled at least 10 times per minute. If the difference between the maximum and minimum readings from the average of either the wind direction or the wind speed over a one minute period is less than 10% of the average value, the measurements shall be considered a signal failure.

d) Other error signals sent by the anemometer.

v. Before an occupancy permit is granted for a laboratory or process facility subject to Section 140.9(c)3C, the applicable equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.16. 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.

D. The volume flow rate at the stack shall vary based on the measured contaminant concentration in the exhaust plenum from a calibrated contaminant sensor installed within each exhaust plenum.

i. A contaminant-event threshold shall be established based on maintaining downwind concentrations below health and odor limits for all ~~detectable~~ chemicals at worst-case wind conditions, as defined by the 2018 American Conference of Governmental Industrial Hygienists Threshold Limit Values and Biological Exposure Indices, or as defined by applicable local, state, or federal jurisdictions, if more stringent.

ii. At least two contaminant concentration sensors shall be Photo Ionization Detectors (PID) certified by the manufacturer to be accurate within plus or minus 5% when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 6 months.

iii. Upon detection of sensor and/or signal failure, the system shall reset the exhaust volume flow rate to the value needed to maintain downwind concentrations below health and odor limits all ~~detectable~~ contaminants at worst-case wind conditions and shall report the fault to an Energy Management Control System or fault management application which automatically provides notification of the fault to a remote system provider. The system shall have logic that automatically checks for sensor failure by the following means.

a) If any sensor has not been calibrated within the manufacturer's recommended calibration period, the sensor has failed.

b) During unoccupied periods the system compares the readings of all sensors. If any sensor is more than 30% above or below the average reading for a period of 4 hours, the sensor has failed.

iv. Measured contaminate control systems shall have the following information readily available to the users and operators as part of the operating documentation required by Section 10-103(b)2:
   a) The TVOC trigger concentration (ppm);
   b) Minimum volume flow rate through the exhaust fans(s) when TVOC concentrations are below the trigger threshold;
   c) Minimum volume flow rate through the exhaust fans(s) when TVOC concentrations are above the trigger threshold;
   d) Maximum release rates for all chemicals (including those that can not be detected by a PID) that may be present in the exhaust stream.

v. Before an occupancy permit is granted for a laboratory or process facility subject to Section 140.9(c)3D, the applicable equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.16. 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.

E. The exhaust fan system shall have variable speed controls capable of varying the volume flow rate at the stack safely (i.e., maintain downwind concentrations below health and odor limits, as defined by the 2018 American Conference of Governmental Industrial Hygienists Threshold Limit Values and Biological Exposure Indices) down to 50 percent or less of the systems designed flow rate based on variable air volume zone controls and a system static pressure control and meet the following criteria:
   i. Fan system power shall not exceed 1.3 watts per cfm at full load design conditions.
   ii. Standard operations shall maintain exhaust volume flow rate without the use of bypass dampers. **EXCEPTION 3(E) ii:** Any bypass dampers shall only be utilized to maintain acceptable static pressure during non-standard operational conditions such as fan startup, shutdown, or emergency modes of operation.
   iii. Exhaust stack height and placement shall be sufficient to minimize the maximum downwind concentrations of exhaust associated emission scenario to less than the applicable health and odor limits for wind speed conditions at or below the ASHRAE 1% design wind speed condition when the exhaust fan(s) are at system minimum flow rate.

EXCEPTION 1 to Section 140.9(c)3: Fan exhaust systems complying with 140.4(c)1

140.9(c)5 Reheat Limitation. Each space condition zone shall include heating and cooling capacity, such as 4-pipe VAV, so the volume of primary air that is reheated, recooled or mixed air supply shall not exceed the design zone outdoor airflow rate as specified by Section 120.1(c)3