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Taylor comments on Title 24 2019 CASE Nonresidential Ventilation & Indoor Air Quality (IAQ) Draft Report

Additional submitted attachment is included below.

TAYLOR ENGINEERING

To:	Statewide Codes and Standards Team
From:	Steve Taylor
Subject:	Comments on Title 24 2019 CASE Nonresidential Ventilation & Indoor Air Quality (IAQ) Draft Report
Date:	June 23, 2017

I have reviewed the draft CASE Title 24 2019 CASE Nonresidential Ventilation & Indoor Air Quality (IAQ) Draft Report. I am supportive of the basic change to align Title 24 ventilation rates with ASHRAE Standard 62.1 rates, although with some reluctance: the procedure for calculating ventilation rates for multiple zone systems, and in particular variable air volume (VAV) systems, is extremely complex under Standard 62.1, so complex that it 1) will not be well enforced since code officials will have little hope of understanding how it works; and 2) can result in extremely inflated outdoor air rates if designers choose to use conservative assumptions, as many will due to liability concerns. I am also not supportive of exactly how the revised rates have been incorporated into Title 24.

Let me preface my comments by noting my experience in commercial ventilation:

- I was on the CEC TAG that developed the current Title 24 ventilation requirements back in 1991 and I was one of the primary authors of these sections, including the building component rate table. The wording of the section and the ventilation rates are largely unchanged since I co-wrote them in 1991.
- I was chair of SSPC 62.1 when the current rate calculation methodology was developed in the late 90s (published as an addendum in 2002) and one of the primary authors of the method and the ventilation rate tables. The wording and ventilation rates are largely unchanged since I co-wrote them in 1997.
- I coauthored the Standard 62.1 User's Manual for the 2004, 2007, and 2010 versions, the text of which is largely unchanged in the 2013 and 2016 versions. This includes developing the 62MZCalc spreadsheet used to determine ventilation rates for multiple zone systems. (The complexity of this spreadsheet exemplifies the complexity of the multiple spaces procedure in general.)
- I wrote the work statements for several ASHRAE research projects relating to multiple space ventilation systems and was either the chair of the monitoring committee or co-principle investigator:
    - 1276-RP. A Study of Multiple Space Effects on Ventilation System Efficiency in Standard 62.1 – 2004 and Experimental Validation of the Multiple Spaces Equation
    - 1547-RP. CO2-based Demand Controlled Ventilation For Multiple Zone HVAC Systems
    - 1747-RP, Implementation of RP-1547 CO2-based Demand Controlled Ventilation for Multiple Zone HVAC Systems in Direct Digital Control Systems

  - 1819-TRP. CO2 Demand Controlled Ventilation in Multiple Zone VAV Systems with Multiple Recirculation Paths
- I have publically spoken on and written peer reviewed papers on ventilation and Standard 62,1 (see http://www.taylor-engineering.com/articles for instance).
- I was the engineer-of-record for the ventilation and control systems for millions of square feet of commercial building space, which includes developing the ventilation system design and controls needed to meet ventilation codes.

I think I can safely say that few engineers, if any, know commercial ventilation standards, the underlying science, and the details of mechanical system implementation and control than I. I point this out so that it is clear my comments are not random backlash to change.

Below are some detailed comments on the draft CASE report:

1. The proposal extracts Standard 62.1 mechanical ventilation requirements into Part 6 of Title 24. But these same requirements are already in Part 4 California Mechanical Code Chapter 4, which is also based on the Uniform Mechanical Code, which in turn was extracted from Standard 62.1. I am opposed to this approach because it almost ensures we will once again have conflicts with Part 6 and Part 4 with respect to mechanical ventilation requirements. The proposal also pulls in natural ventilation requirements into Part 6. This will not only create potential conflicts with Part 4, which is extracted from an older version of Standard 62,1, but it also creates conflicts with the CBC Chapter 12, which is based on the International Building Code, which in turn is based on a much older version of Standard 62. They all conflict and it is not at all clear what requirements apply to what buildings. We have pointed out these very serious conflicts to the CEC and the Building Standards Commission for years, and the conflicts are never properly fixed. It is easy to say that it is the BSC's job to make the different codes mesh, but a better way is to not create the conflicts in the first place. My recommendation is for the CEC to work with the Building Standards Commission in much the same was as other agencies like OSHPD, DSA, etc. and suggest change proposals to the model codes adopted for the CBC and CMC. This would allow the Energy Standards to have no ventilation requirements whatsoever, avoiding all of these potential conflicts.
2. References to high rise residential buildings, residential kitchens, etc. should be removed since these spaces are now covered by Standard 62.2, not Standard 62.1. The residential ventilation sections should be modified accordingly.
3. The exception to 120.1(a)1: could be eliminated if ventilation requirements are limited to "occupiable spaces" using the definition in Standard 62.1 and the CMC.
4. Section 120.1 (f) has a circular reference: it says. "Each space that is not naturally ventilated" must be mechanically ventilated, but section (e) requires both mechanical ventilation as well as natural ventilation.
5. The prescriptive TABLE 120.1-C for Ev determination for multiple zone systems should be replaced with a new proposed addendum to Standard 62.1. See attached Continuous Maintenance change proposal (CMP) to Standard 62.1-2016. This is really essential in order for ventilation calculations to be reasonable with respect to complexity and

enforcement for multiple zone systems. This addendum was just approved by the Ventilation Subcommittee of SSPC 62.1 at the ASHRAE meeting in Long Beach and I expect it to be approved for public review by the full SSPC on Sunday. If so, it will go through public review on the same timeframe as this CEC proposed revisions. I cannot express more strongly how important this is. The problems with the multiple spaces approach in Standard 62.1 have been known for years and simplified procedures have been proposed in the past but rejected for various reasons. I think this latest version will be accepted. It is as easy to use as the current Title 24 Part 6 ventilation requirements and would be well received by design engineers in California.

6. TABLE 120.1-A does not match Standard 62.1 and the CMC rate tables. I strongly recommend that reference simply be made to the CMC table. As noted in comment 1 above, duplicating the table will almost certainly lead to conflicts and requires that the CEC maintain the table as SSPC 62.1 makes changes to its table (IAPMO already does this for the UMC/CMC.) Examples of discrepancies:
   a. All Others. No such category in 62.1/CMC. They require that if a space type is not listed, the closest type listed shall be used.
   b. Multiple assembly spaces are listed and not all are consistent with 62.1/CMC. For instance "theater" is misinterpreted as being the stage area rather than the seating area.
   c. Electrical, Mechanical, Telephone Rooms are ventilated. 62.1/CMC treats these as non-occupiable spaces and no ventilation is required.
   d. Parking Garage areas are supplied with outdoor air despite being exhausted in TABLE 120.1-D at much higher rates. This is unnecessary.
   e. Etc., etc.
7. The body of the report says the revised code will require that 62.1 rates be multiplied by 130 percent as a compromise to those who feel 62.1 rates are too low. But I don't see that in the proposed code language. I strongly suggest providing an alternative to this: either increase Vot from what is calculated per the code by 130%, or include an outdoor air economizer. The economizer will provide outdoor air rates annually that will be about 400% above minimum rates. While it is true that there will be times that only 62.1 minimum rates are supplied when the economizer is disabled, Standard 62.1 recognizes time averaging (about 8 hours for offices) and because CA climates are so mild, economizers are seldom disabled for longer than the averaging period so daily average ventilation rates will usually be maintained. Even where they may not be, there is evidence that long term exposures are more important than short-term exposures with respect to health impact. Given 62.1 rates are used in all other States with no apparent evidence of acute under-ventilation and associated IAQ problems in the short-term, I believe that using economizers with minimum rates will improve overall indoor air quality vs. no economizer with 30% larger minimum rates. This seems like an ideal compromise: acceptable IAQ is provided along with lower cooling peaks due to lower minimum outdoor air, with the energy savings provided by the economizer.

NOTICE

INSTRUCTIONS FOR SUBMITTING A PROPOSED CHANGE TO THIS STANDARD UNDER CONTINUOUS MAINTENANCE

This standard is maintained under continuous maintenance procedures by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. SSPC consideration will be given to proposed changes within 13 months of receipt by the Senior Manager of Standards (SMOS).

Proposed changes must be submitted to the MOS in the latest published format available from the MOS. However, the MOS may accept proposed changes in an earlier published format if the MOS concludes that the differences are immaterial to the proposed change submittal. If the MOS concludes that a current form must be utilized, the proposer may be given up to 20 additional days to resubmit the proposed changes in the current format.

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An electronic version of each change, which must comply with the instructions in the Notice and the Form, is the preferred form of submittal to ASHRAE Headquarters at the address shown below. The electronic format facilitates both paper-based and computer-based processing. Submittal in paper form is acceptable. The following instructions apply to change proposals submitted in electronic form.

Use the appropriate file format for your word processor and save the file in either a recent version of Microsoft Word (preferred) or another commonly used word-processing program. Please save each change proposal file with a different name (for example, “prop01.doc,” “prop02.doc,” etc.). If supplemental background documents to support changes submitted are included, it is preferred that they also be in electronic form as word-processed or scanned documents.

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Submit an e-mail containing the change proposal files to:
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1791 Tullie Circle, NE
Atlanta, GA 30329-2305

Or fax them to:
Attn: Senior Manager of Standards
404-321-5478

The form and instructions for electronic submittal may be obtained from the Standards section of ASHRAE’s Home Page, www.ashrae.org, or by contacting the Standards Section via phone (404-636-8400), fax (404-321-5478), e-mail (change.proposal@ashrae.org), or mail (1791 Tullie Circle, NE, Atlanta, GA 30329-2305).

FORM FOR SUBMITTAL OF PROPOSED CHANGE TOAN ASHRAE STANDARD UNDER CONTINUOUS MAINTENANCE

NOTE: Use a separate form for each comment. Submittals (Microsoft Word preferred) may be attached to e-mail (preferred), or submitted in paper by mail or fax to ASHRAE, Senior Manager of Standards, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: change.proposal@ashrae.org. Fax: +1-404/321-5478.

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2. Number and year of standard:

3. Page number and clause (section), subclause, or paragraph number:

4. I propose to: [X] Change to read as follows [ ] Delete and substitute as follows
(check one) [ ] Add new text as follows [ ] Delete without substitution

Use underscores to show material to be added (added) and strike through material to be deleted (deleted). Use additional pages if needed.

5. Proposed change:

Modify 6.2.5 as follows:

6.2.5 Multiple-Zone Recirculating Systems. For ventilation systems wherein one or more air handlers supply a mixture of outdoor air and recirculated air to more than one ventilation zone, the outdoor air intake flow (V_{ot}) shall be determined in accordance with Sections 6.2.5.1 through 6.2.5.4.

~~**6.2.5.1 Primary Outdoor Air Fraction.** Primary outdoor air fraction~~ ~~(Z_{pz}) shall be determined for ventilation zones in accordance with Equation 6.2.5.1.~~

$$\cancel{Z_{pz} = V_{oz}/V_{pz}} \qquad \cancel{(6.2.5.1)}$$

~~where~~ ~~V_{pz}~~ ~~is the zone primary airflow, i.e., the primary airflow rate to the ventilation zone from the air handler, including outdoor air and recirculated air.~~

~~***Notes:***~~
~~1. For VAV-system design purposes, V_{pz} is the lowest zone primary airflow value expected at the design condition analyzed.~~
~~2. In some cases, it is acceptable to determine these parameters for only selected zones as outlined in Normative Appendix A.~~

~~**6.2.5.2 System Ventilation Efficiency.** The system ventilation efficiency (E_v) shall be determined in accordance with Table 6.2.5.2 or Normative Appendix A.~~

~~**TABLE 6.2.5.2 System Ventilation Efficiency**~~

~~**Max (Z_P)**~~	~~**E_v**~~
~~≤0.15~~	~~1.0~~
~~≤0.25~~	~~0.9~~
~~≤0.35~~	~~0.8~~
~~≤0.45~~	~~0.7~~
~~≤0.55~~	~~0.6~~
~~>0.55~~	~~Use Appendix A~~

~~1. "Max (Z_{pz})" refers to the largest value of Z_{pz}, calculated using Equation 6.2.5.1, among all the ventilation zones served by the system.~~
~~2. For values of Max (Z_{pz}) between 0.15 and 0.55, the corresponding value of E_v may be determined by interpolating the values in the table.~~
~~3. The values of E_v in this table are based on a 0.15 average outdoor air fraction for the system (i.e., the ratio of the uncorrected outdoor air intake [V_{ou}] to the total zone primary airflow for all the zones served by the air handler). For systems with higher values of the average outdoor air fraction, this table may result in unrealistically low values of E_v and the use of Normative Appendix A may yield more practical results.~~

6.2.5.~~3~~1 Uncorrected Outdoor Air Intake. The uncorrected outdoor air intake (V_{ou}) flow shall be determined in accordance with Equation 6.2.5.~~3~~1.

$$V_{ou} = D\sum_{all\ zones}(R_p \times Pz) + \sum_{all\ zones}(R_a \times A_z)\ (\qquad (6.2.5.\cancel{3}1)$$

6.2.5.~~3~~1.1 Occupant Diversity. The occupant diversity ratio (D) shall be determined in accordance with Equation 6.2.5.~~3~~1.1 to account for variations in population within the ventilation zones served by the system.

$$D = P_s / \sum_{all\ zones} P_z \qquad (6.2.5.\cancel{3}1.1)$$

where the system population (P_s) is the total population in the area served by the system.

Exception: Alternative methods to account for occupant diversity shall be permitted, provided the resulting V_{ou} value is no less than that determined using Equation 6.2.5.~~3~~1.

~~***Note:*** The uncorrected outdoor air intake (V_{ou}) is adjusted for occupant diversity, but it is not corrected for system ventilation efficiency.~~

6.2.5.~~3~~1.2 Design System Population. Design system population (P_s) shall equal the largest (peak) number of people expected to occupy all ventilation zones served by the ventilation system during typical usage.

Note: Design system population is always equal to or less than the sum of design zone population for all zones in the area served by the system, since all zones may or may not be simultaneously occupied at design population.

6.2.5.2 System Ventilation Efficiency. The system ventilation efficiency (E_v) shall be determined in accordance with ~~Table 6.2.5.2~~ Section 6.2.5.3 Simplified Procedure or Normative Appendix A Alternative Procedure.

6.2.5.3 Simplified Procedure

6.2.5.3.1 System Ventilation Efficiency. System Ventilation Efficiency (E_v) shall be determined in accordance with Equation 6.2.5.4.1A or B.

$$E_v = 0.88*D + 0.22 \qquad \text{for } D<0.60 \qquad (6.2.5.3.1A)$$

$$E_v = 0.75 \qquad \text{for } D\geq 0.60 \qquad (6.2.5.3.1B)$$

6.2.5.3.2 Zone Minimum Primary Airflow. For each zone, the minimum system primary airflow (V_{pz},) shall be determined in accordance with equation 6.2.5.3.2.

$$V_{pz}, = V_{oz},*1.5 \qquad (6.2.5.3.2)$$

6.2.5.4 Outdoor Air Intake. The design outdoor air intake flow (V_{ot}) shall be determined in accordance with Equation 6.2.5.4.

$$V_{ot} = V_{ou}/E_v \qquad (6.2.5.4)$$

Modify Appendix A introduction as follows:

NORMATIVE APPENDIX A
MULTIPLE-ZONE SYSTEM~~S~~ VENTILATION EFFICIENCY – ALTERNATIVE PROCEDURE

This appendix presents an alternative procedure for calculating the system ventilation efficiency (E_v) for multiple zone recirculating systems that must be used when ~~Table 6.2.5.2 values are~~ Section 6.2.5.3 is not used. In this alternative procedure, E_v is equal to the lowest calculated value of the zone ventilation efficiency (E_{vz}) (see Equation A1.2.2-6 below). Figure A-1 contains a ventilation system schematic depicting most of the quantities used in this appendix.

Modify Appendix A A1.1 introduction as follows:

A1.1 Average Outdoor Air Fraction. The average outdoor air fraction (X_s) for the ventilation system shall be determined in accordance with Equation A1.1.

$$X_s = V_{ou}/V_{ps} \qquad (A1.1)$$

where the uncorrected outdoor air intake (V_{ou}) is found in accordance with Section 6.2.5.~~3~~1, and the system primary airflow (V_{ps}) is found at the condition analyzed.

Modify Appendix A1.2.1 as follows:

A1.2.1 Single-Supply Systems. For single-supply systems, wherein all of the air supplied to each ventilation zone is a mixture of outdoor air and system-level recirculated air, zone ventilation efficiency (Evz) shall be determined in accordance with Equation A1.2.1. Examples of single-supply systems include constant-volume reheat, single-duct VAV, single-fan dual-duct, and multizone systems.

$$E_{vz} = 1 + X_s - Z_{pz} \qquad (A1.2.1\text{-}1)$$

where the average outdoor air fraction for the system (X_s) is determined in accordance with Equation A1.1-1 and the primary outdoor air fraction for the zone (Z_{pz}) is determined in accordance with ~~Section 6.2.5.1~~ Equation A1.1-2.

$$Z_{pz} = V_{oz}/V_{pz} \qquad (A1.2.1\text{-}2)$$

Modify Appendix A definitions as follows:

E_v system ventilation efficiency: the efficiency with which the system distributes air from the outdoor air intake to the breathing zone in the ventilation-critical zone, which requires the largest fraction of outdoor air in the primary air stream. ~~E_v may be determined in accordance with Section 6.2.5.2 or Section A1.~~

V_{ou} uncorrected outdoor air intake: see Section 6.2.5.~~3~~1.

6. Reason and substantiation:

The current Table 6.2.5.2 procedure has several disadvantages:

- It is seldom used since the Zp values are so high. Few VAV systems fall under this table, or at least the efficient ones do not. So designers are forced to use the very complex Appendix A approach, or the Addendum 62.1b approach if it is approved.
- It implies that it addresses VAV systems under all conditions but it does not directly address how low VAV box minimums can be.

This proposal uses the same basic procedure as Addendum 62.1b (Appendix C) (which I helped develop) but with these changes:

- Diversity is included, but Ev is adjusted when there is very extremely low diversity.

- Ez is included. Addendum 62.1b essentially includes a fixed Ez factor of 0.8, i.e. it uses a Voz multiplier of 1.8 to determine minimum Vpz vs. my multiplier of 1.5 (1.8 ~ 1.5/0.8). Include Ez allows penalties/credit for bad/good air distribution designs. (Most VAV systems have an Ez of 0.8 in heating mode so the Vpz will be basically the same between the two.)

This proposal is not inconsistent with the approach in Addendum 62.1b; it is intended to provide yet another approach that is perhaps a bit more complicated but also improved by including the two variables above. Ventilation efficiency can be higher and lower than the 0.7 assumption built into Addendum 62.1b depending on diversity. But in most cases, ventilation rates will be a bit lower than Addendum 62.1b but consistent with the Appendix A procedure for the test buildings used to create the Addendum 62.1b procedure.

Addendum 62.1b (Appendix C) has other disadvantages:

- It can only be used when occupancy is equal to the default occupancy.
- It is not transparent as to how the values were calculated.
- If changes are made to Table 6.2.2.1, changes are also required to Appendix C tables.
- It is apparently limited to a subset of occupancies based on the way the wording is phrased (although I cannot find which occupancies are missing).
- It requires a separate table for demand controlled ventilation. Moreover, it is not clear from this DCV section what happens when a zone is partially occupied. So it seems it can only be used for occupancy sensors, not CO2 sensors.

The alternative approach I propose here has none of these disadvantages. It results in similar minimum Vp rates where Ez ~ 0.8. It results in lower overall rates when D>0.6 since it has a higher Ez and lower occupant component since D is included. Yes, it does require that Voz and Vou be calculated but these are not difficult equations and not the source of complaints. It is calculating Ev that is the source of complaints.

Note that if this CMP is accepted, Addendum 62.1b would need to be withdrawn or modified to only include the informative appendix.

7. Will the proposed change increase the cost of engineering or construction? If yes, provide a brief explanation as to why the increase is justified.

[ ] Check if additional pages are attached. Number of additional pages: _______
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