ADDENDA

ANSI/ASHRAE Addendum aa to
ANSI/ASHRAE Standard 62.1-2019

Ventilation for Acceptable Indoor Air Quality

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FOREWORD

The Indoor Air Quality Procedure (IAQP) has a long history going back to the 1981 standard. It has flexibility.

For design, it requires the following (simplified version):

1. *Identifying contaminants of concern*
2. *Determining indoor and outdoor sources*
3. *Identifying a concentration limit and exposure period*
4. *Specifying percentage of building occupants to be satisfied with perceived IAQ*
5. *Performing a mass balance analysis for selected compounds*

Weaknesses in current requirements exist in items 1, 3, and 4 above. The percentage in item 4 may be specified to any quantity, i.e., the percentage of satisfied occupants can be set to zero. No measurement of any resulting concentration is currently required, so the effectiveness of any design is not measured or verified.

Addendum aa adds a minimum requirement of percentage of people satisfied and requirements for designing to specific limits for design compounds and particulate matter. The design compounds are specifically identified. Mixtures are specifically identified. Objective and subjective testing are added.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum aa to Standard 62.1-2019

Add new definitions in Section 3 as shown. The remainder of Section 3 is unchanged.

1. DEFINITIONS (SEE FIGURE 3.1)

design compounds (DCs): chemical compounds found in the indoor environment that have the potential to reduce acceptability of the air and are considered in designing to the IAQ Procedure (IAQP) method.

particulate matter 2.5 (PM2.5): aerosol particles with an aerodynamic diameter less than or equal to a nominal 2.5 µm.

Revise Section 6.1.2 as shown.

6.1.2 IAQ Procedure. ~~This performance-based design procedure presented in Section 6.3, in which the building outdoor air intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concentration limits, and level of perceived indoor air acceptability, shall be permitted to be used for any zone or system.~~ The IAQ Procedure (IAQP) is an alternative to the Ventilation Rate Procedure used to determine the design rate of outdoor airflow to maintain concentrations of design compounds (DCs) and PM2.5 in the indoor environment to be less than design limits, based on indoor and outdoor sources, air cleaning, and other variables. These outdoor air requirements shall be calculated with mass balance equations. Verification of occupant satisfaction and indoor design compounds concentrations shall be performed after the building is completed.

Revise Section 6.3 as shown.

6.3 Indoor Air Quality (IAQ) Procedure. Breathing zone outdoor airflow (V_{bz}) shall be determined in accordance with Sections 6.3.1 through 6.3.5.

~~**6.3.1 Contaminant Sources.** Each contaminant of concern, for purposes of the design, shall be identified. For each contaminant of concern, indoor sources and outdoor sources shall be identified, and the emission rate for each contaminant of concern from each source shall be determined.~~

~~Where two or more contaminants of concern target the same organ system, these contaminants shall be considered to be a contaminant mixture.~~

~~***Informative Note:*** Informative Appendix C provides information for some potential contaminants of concern, including the organs they affect.~~

6.3.1 Design Compounds and PM2.5 Sources. The system design shall be based on the design compounds (DCs) and PM2.5 specified in Table 6-5. If there are additional outdoor sources identified from completing the process in Section 4.3, or if there are unusual sources, the compounds associated with those sources shall be determined and documented. The compounds from those additional sources shall be added to the DC list if a design limit from a cognizant authority exists. For each DC and PM2.5, the emission rates from indoor sources from occupants, building materials, furnishings, equipment, and other sources and the outdoor concentrations shall be determined.

Informative Notes:

1. Indoor emission rate information for some compounds is provided in Appendix E.
2. Outdoor concentrations can be determined from Section 4.

~~**6.3.2 Contaminant Concentration.** For each contaminant of concern, a concentration limit and its corresponding exposure period and an appropriate reference to a cognizant authority shall be specified. For each contaminant mixture of concern, the ratio of the concentration of each contaminant to its concentration limit shall be determined, and the sum of these ratios shall be not greater than one.~~

~~**Exception to 6.3.2:** Consideration of odors in determining concentration limits shall not be required.~~

~~***Informative Notes:***~~

1. ~~Odors are addressed in Section 6.3.4.2.~~
2. ~~Informative Appendix C includes concentration guidelines for some potential contaminants of concern.~~

6.3.2 Design Compounds and PM2.5 Concentration. The concentration limits, referred to as *design limits*, shall be as specified in Table 6-5. Design ventilation shall be such that the calculated concentration of each DC, mixture of DCs, and PM2.5 does not exceed its Limit. For any compounds added to the DC list in Table 6-5, data from cognizant authorities shall be used to determine if the compound causes the effects listed in Table 6-6, and compounds having one or more of the mixture effects shall be added to the mixture list for that effect. For each mixture, the mixed exposure sum (E_m), as determined by Equation 6-12, shall be less than 1.0:

$$E_m = \frac{C_1}{\mathrm{DL}} + \frac{C_2}{\mathrm{DL}_2} + \frac{C_i}{\mathrm{DL}_i} \qquad (6\text{-}12)$$

where

E_m = mixed exposure sum

C_i = mass balance model calculated airborne peak concentration for the i^{th} DC

DL_i = design limit for the i^{th} DC

Exceptions to 6.3.2:

1. Benzene, phenol, and tetrachloroethylene shall not be included in the mixture calculation for upper respiratory tract irritation, eye irritation, and CNS depression. Outside the U.S., if the outdoor concentrations of carbon monoxide, PM2.5, or ozone exceed the design limit, the design limit shall be the applicable ambient air standards where the project is located or as accepted by the AHJ.
2. Ammonia shall be included only for spaces that include nonhuman animals.

~~**6.3.3 Perceived Indoor Air Quality.** The design level of indoor air acceptability shall be specified in terms of the percentage of building occupants, visitors, or both expressing satisfaction with perceived IAQ.~~

6.3.3~~6.3.4~~ Design Approach. Zone and system outdoor airflow rates shall be the larger of those determined in accordance with Section ~~6.3.4.1~~ 6.3.3.1 and 6.3.3.2 ~~and either 6.3.4.2 or 6.3.4.3, based on emission rates, concentration limits, and other relevant design parameters~~.

6.3.3.1~~6.3.4.1~~ Mass Balance Analysis. Using a steady-state or dynamic mass-balance analysis, the minimum outdoor airflow rates required to avoid exceeding the design limit specified in Sec-

Table 6-5 Design Compounds, PM2.5, and Their Design Limits

Compound or PM2.5	Cognizant Authority	Design Limit
Acetaldehyde	Cal EPA CREL (June 2016)	140 µg/m^3
Acetone	AgBB LCI	1,200 µg/m^3
Benzene	Cal EPA CREL (June 2016)	3 µg/m^3
Dichloromethane	Cal EPA CREL (June 2016)	400 µg/m^3
Formaldehyde	Cal EPA 8-hour REL (2004)	33 µg/m^3
Naphthalene	Cal EPA CREL (June 2016)	9 µg/m^3
Phenol	AgBB LCI	10 µg/m^3
Tetrachloroethylene	Cal EPA CREL (June 2016)	35 µg/m^3
Toluene	Cal EPA CREL (June 2016)	300 µg/m^3
1,1,1-trichloroethane	Cal EPA CREL (June 2016)	1000 µg/m^3
Xylene, total	AgBB LCI	500 µg/m^3
Carbon monoxide	USEPA NAAQS	9 ppm
PM2.5	USEPA NAAQS (annual mean)	12 µg/m^3
Ozone	USEPA NAAQS	70 ppb
Ammonia	Cal EPA CREL (June 2016)	200 µg/m^3

Table 6-6 Mixtures of Compounds

Upper Respiratory Tract Irritation	Eye Irritation	Central Nervous System
Acetaldehyde	Acetaldehyde	Acetone
Acetone	Acetone	Dichloromethane
Xylene, total	Formaldehyde	Xylene, total
Ozone	Xylene,total	1,1,1-trichloroethane
	Ozone	Toluene

Informative Note: *Source: ACGIH, 2017 (See Informative Appendix M, "Informative References").*

tion 6.3.2 shall be determined for each ~~contaminant or contaminant mixture of concern~~ DC, mixture of DCs, and PM2.5 within each zone served by the system.

Informative Note~~s~~:

~~1. Informative Appendix E includes steady-state mass-balance equations that describe the impact of air cleaning on outdoor air and recirculation rates for ventilation systems serving a single zone.~~

~~2.~~In the completed building, measurement of the concentration of contaminants or contaminant mixtures of concern may be useful as a means of checking the accuracy of the design mass-balance analysis, but such measurement is not required for compliance.

6.3.3.2 Perceived Indoor Air Quality. Zone outdoor airflow rates shall be sufficient to ensure that 80% or more of the people exposed do not express dissatisfaction with the quality of the air when tested as required in Section 7.3.2.

6.3.~~5~~4 Combined IAQ Procedure and Ventilation Rate Procedure. The IAQ Procedure in conjunction with the Ventilation Rate Procedure shall be permitted to be applied to a zone or system. In this case, the Ventilation Rate Procedure shall be used to determine the required zone minimum outdoor airflow, and the IAQ Procedure shall be used to determine the additional outdoor air or air

cleaning necessary to achieve the concentration limits of the contaminants and contaminant mixtures of concern.

6.3.6~~5~~ Documentation. Design documentation shall include the list of PM2.5, DCs, and DLs and mixtures thereof; outdoor source data; emission rates, including citations; cognizant authorities for any additional DCs; mass balance calculations for each zone; and specifications for verification required by Section 7.3. ~~Where the IAQ Procedure is used, the following information shall be included in the design documentation: the contaminants and contaminant mixtures of concern considered in the design process, the sources and emission rates of the contaminants of concern, the concentration limits and exposure periods and the references for these limits, and the analytical approach used to determine ventilation rates and air-cleaning requirements. The contaminant monitoring and occupant or visitor evaluation plans shall also be included in the documentation.~~

Add new Section 7.3 as shown. The remainder of Section 7 is unchanged.

7. CONSTRUCTION AND SYSTEM START-UP

Compliance with Sections 7.1 and 7.2 is required for all buildings. Section 7.3 is required for buildings designed under the IAQ Procedure in Section 6.3.

[. . .]

7.3 IAQP Verification

7.3.1 Objective Evaluation. Perform DC and PM2.5 measurement in the completed building to verify that designlLimits (DLs) are met. The peak concentration over an 8-hour occupied period shall not exceed the design limit for CO.

For ozone and PM2.5, the average concentration measured over an 8-hour occupied period shall not exceed the design limit.

For all other compounds, the concentration measured over the maximum period allowed by the test method up to 8 hours shall not exceed the design limit for each DC. For DC mixtures, the mixture calculation shall be less than 1.0. The concentrations shall be measured using the relevant laboratory methods specified in Table 7-1. Inorganic compounds and PM2.5 may be measured instead using direct-read instruments that are calibrated in accordance with the device manufacturer's recommendations, are capable of measuring below the design limit, and that follow the performance requirements specified in Table 7-2.

7.3.1.1 Design Compounds and PM2.5 Measurement Test. The measurement equipment shall be positioned in the breathing zone. The measurement shall be conducted with the HVAC system in normal operation and lowest outdoor air intake setting expected during the year. The number of measurement points shall be specified according to Table 7-3.

~~6.3.4.2~~7.3.2 Subjective Evaluation. Using a subjective occupant evaluation conducted in the completed building, the survey test results shall demonstrate occupant level of acceptability of 80% or more within each zone served by the system.

Informative Note: Informative Appendix N presents one approach to subjective occupant evaluation. ~~Level of acceptability often increases in response to increased outdoor airflow rates, increased level of indoor or outdoor air cleaning, or decreased indoor or outdoor contaminant emission rate.~~

~~6.3.4.3 Similar Zone~~ Exception to 7.3.1 and 7.3.2: Objective and subjective evaluation are not required for every substantially similar zone. The minimum outdoor airflow rates shall be not less than those found in accordance with Section ~~6.3.4.2~~ 7.3.1 and 7.3.2 for a substantially similar zone.

Informative Note: For example, in a building with 100 single-person private offices of the same area, it is not necessary to perform an objective and subjective evaluation in each office as long as the minimum outdoor airflow for each office is greater than or equal to the airflow in the office that is tested according to Section 7.3.2. A ventilation zone is similar by definition if it has the same occupancy category (see Table 6-1), occupant density, zone air distribution effectiveness (see Section 6.2.1.2), and design zone primary airflow (see Section 6.2.4.3.2 and Normative Appendix A) per unit area.

7.3.3 Documentation. Documentation shall include methodology of testing, test results and any adjustments to design outdoor air from the values determined in Section 6.3, if applicable.

Table 7-1 Allowed Laboratory Test Methods

Compound	Allowed Test Methods
VOCs except formaldehyde, acetaldehyde and acetone	ISO 16000-6[YY]; EPA IP-1[GG], EPA TO-17[EE]; ISO 16017-1[AA]; ISO 16017-2[BB]; ASTM D6345-10[KK]
Formaldehyde, acetaldehyde and acetone	ISO 16000-3[ZZ]; EPA TO-11[FF]; EPA IP-6[II]; ASTM D5197[LL]
Carbon monoxide	ISO 4224[DD]; EPA IP-3[HH]

Table 7-2 Direct Reading Instruments Minimum Specifications

	Ozone	$PM_{2.5}$	CO
Accuracy (±)	5 ppb	Greater of 5 µg /m^3 or 20% of reading	Greater of 3 ppm or 20% of reading
Resolution (±)	1 ppb	5 µg/m^3	1 ppm

Table 7-3 Number of Measurements Points

Total Occupied Floor Area ft^2 (m^2)	Number of Measurements
≤25,000 (2500)	1
>25,000 (2500) and ≤50,000 (5000)	2
>50,000 (5000) and ≤100,000 (10,000)	4
>100,000 (10,000)	6

Add the following references to Section 9. The remainder of Section 9 is unchanged.

9. REFERENCES

XX. ASHRAE. 2016. ANSI/ASHRAE Standard 145.2, *Laboratory Test Method for Assessing the Performance of Gas-Phase Air-Cleaning Systems: Air-Cleaning Devices*. Atlanta: ASHRAE.

YY. ISO. 2011. ISO Standard 16000-6, *Indoor air—Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID.* Geneva, Switzerland, International Organization for Standardization.

ZZ. ISO. 2011. ISO Standard 16000-3, *Indoor air—Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air—Active sampling method.* Geneva, Switzerland, International Organization for Standardization.

AA. ISO. 2000. ISO Standard 16017-1, *Indoor, ambient and workplace air—Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography—Part 1: Pumped sampling.* Geneva, Switzerland, International Organization for Standardization.

BB. ISO. 2003. ISO Standard 16017-2, *Indoor, ambient and workplace air—Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography—Part 2: Diffusive sampling.* Geneva, Switzerland, International Organization for Standardization.

DD. ISO. 2000. ISO Standard 4224, *Ambient air—Determination of carbon monoxide—Non-dispersive infrared spectrometric method.* Geneva, Switzerland, International Organization for Standardization.

EE. USEPA. 1999. EPA TO-17, *Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes in Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, Second Edition. Cincinnati, OH: U.S. Environmental Protection Agency.

FF. USEPA. 1999. EPA TO-11, *Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC) [Active Sampling Methodology] in Compendium of Methods for the Determination of Toxic Organic*

Compounds in Ambient Air, Second Edition. Cincinnati, OH: U.S. Environmental Protection Agency.

GG. USEPA. 1990. EPA IP-1, *Determination of Volatile Organic Compounds (VOCs) in Indoor Air in Compendium of Methods for the Determination of Air Pollutants in Indoor Air.* Research Triangle Park, NC: U.S. Environmental Protection Agency.

HH. USEPA. 1990. EPA IP-3, *Determination of Carbon Monoxide (CO) or Carbon Dioxide (CO2) in Indoor Air in Compendium of Methods for the Determination of Air Pollutants in Indoor Air*. Research Triangle Park, NC: U.S. Environmental Protection Agency.

II. USEPA. 1990. EPA IP-6, *Determination of Formaldehyde or other Aldehydes in Indoor Air in Compendium of Methods for the Determination of Air Pollutants in Indoor Air.* Research Triangle Park, NC: U.S. Environmental Protection Agency.

KK. ASTM. 2010. ASTM D6345, *Standard Guide for Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air.* West Conshohocken, PA: ASTM International.

LL. ASTM. 2016. ASTM D5197, *Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology).* West Conshohocken, PA: ASTM International.

Add the following reference to Informative Appendix M as shown. The remainder of Appendix M is unchanged.

J7. ACGIH. 2017. *TLVs and BEIs—Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* Section 6. Washington, DC: American Conference of Governmental Industrial Hygienists.

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ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

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