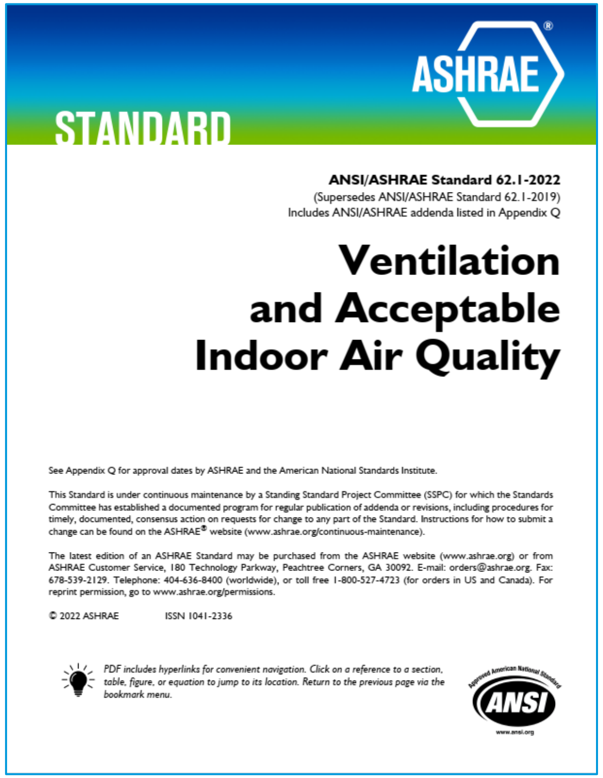
Indoor Air Quality Procedure (IAQP)

Made Simple

ASHRAE Standard 62.1 -2019 and -2022

2025

Audwin Cash
GPS Air
acash@gpsair.com


STANDARD

ASHRAE

ANSI/ASHRAE Standard 62.1-2022
(Supersedes ANSI/ASHRAE Standard 62.1-2019)
Includes ANSI/ASHRAE addenda listed in Appendix Q

Ventilation and Acceptable Indoor Air Quality

See Appendix Q for approval dates by ASHRAE and the American National Standards Institute.

This Standard is under continuous maintenance 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. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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PDF includes hyperlinks for convenient navigation. Click on a reference to a section, table, figure, or equation to jump to its location. Return to the previous page via the bookmark menu.

Approved American National Standard
ANSI
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Purpose

The indoor air quality procedure defined by AHSRAE Standard 62.1 and permitted under the Michigan Mechanical Code, provides a large energy savings potential that is often overlooked. Progress and publications from ASHRAE makes applying the indoor air quality procedure far more prescriptive and less risky for owners and operators.

Completing this presentation will increase a participant's knowledge and understanding of **ASHRAE 62.1 Ventilation and Acceptable Indoor Air Quality for Commercial Buildings,** specifically the **Indoor Air Quality Procedure** as an effective approach to deliver indoor air quality with lower cost and lower energy demands.

Building mechanical and energy codes are being updated, understanding the current sa demanding greater knowledge and mastery of 62.1-2019 and 62.1-2022. This course impacts several professional skills: confidence in the IAQP, LEED v5 evolving to support the Indoor Air Quality Procedure, economic trade offs of ventilation procedures, and the emerging industry trend that indoor air quality and ventilation management are jointly achievable.

Agenda

- Building Code Support
- Procedures & Evolution
- Mechanical Ventilation Procedures & O.A. Requirements
- IAQP
  - Design Compounds
  - Verification/Validation
- Calculators and tools
- Filtration & Air Cleaner Requirements
- CO2
- LEED
- Q&A

Codes and Standards

Before applying a ventilation standard from ASHRAE, understand what the relevant state or local mechanical code requires. Vast majority of locations support a unified IMC; which supports the VRP and the IAQP to maintain air quality.

Note the language in IMC 2015 and IMC 2021

§403.2 Outdoor air required.

The minimum outdoor air flow rate shall be determined in accordance with §403.3 (the VRP)

Exception: Where the registered design professional demonstrates that an engineered ventilation system design will prevent the maximum concentration of contaminants from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, **the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design**

ASHRAE Standard 62.1-2013 supports IMC 2015. Standard 62.1-2019 supports IMC2021

Outdoor Airflow Procedures

The Ventilation Rate Procedure (VRP), the Indoor Air Quality Procedure (IAQP), the Natural Ventilation Procedure, or a combination thereof shall be used to meet the requirements of this section.

Ventilation Rate Procedure. Prescriptive design procedure presented

Indoor Air Quality Procedure. Engineered approach procedure

Natural Ventilation Procedure. Outdoor air is provided through openings to the outdoors.

IAQP is the Preferred Approach

The VRP is an indirect solution to achieving acceptable IAQ. The IAQP is a more direct approach to the goal

62.1-2019 User's Manual D- 90163

- ✓ More cost-effective solution
- ✓ Better air quality
- ✓ Without increasing first cost

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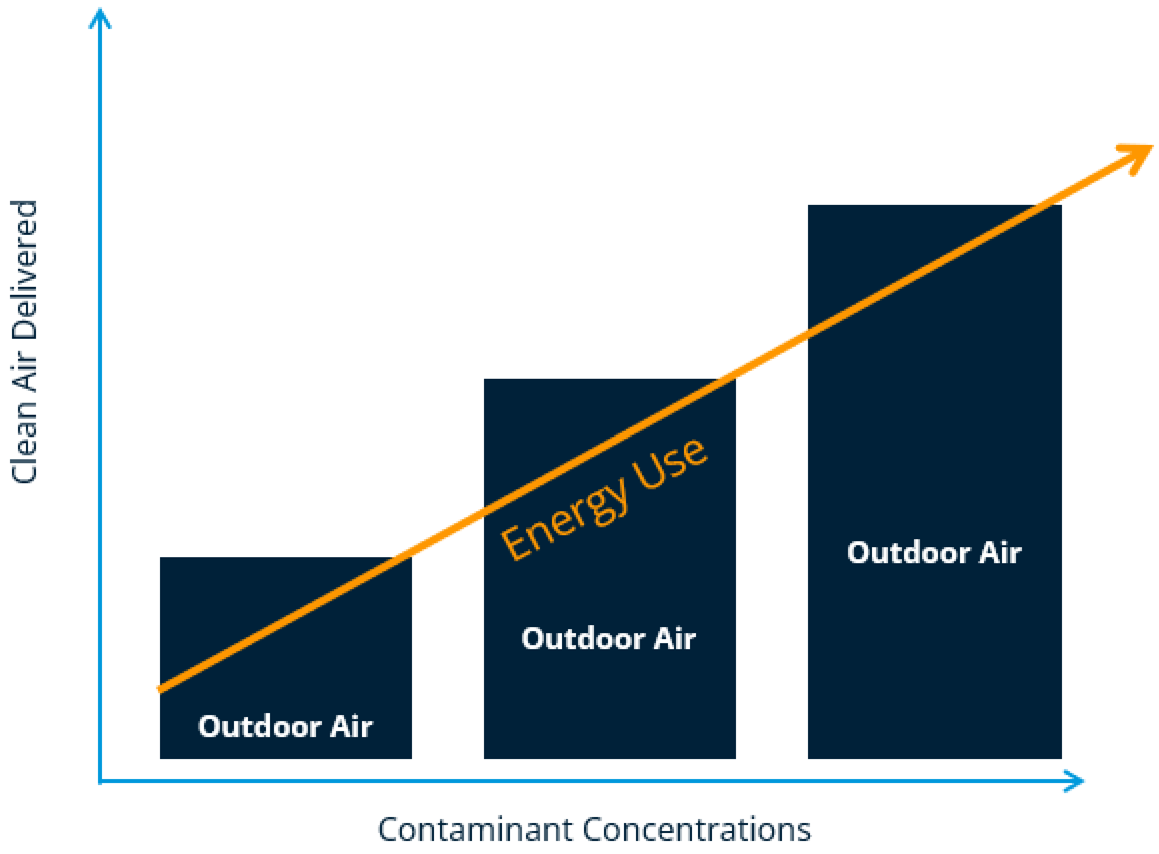
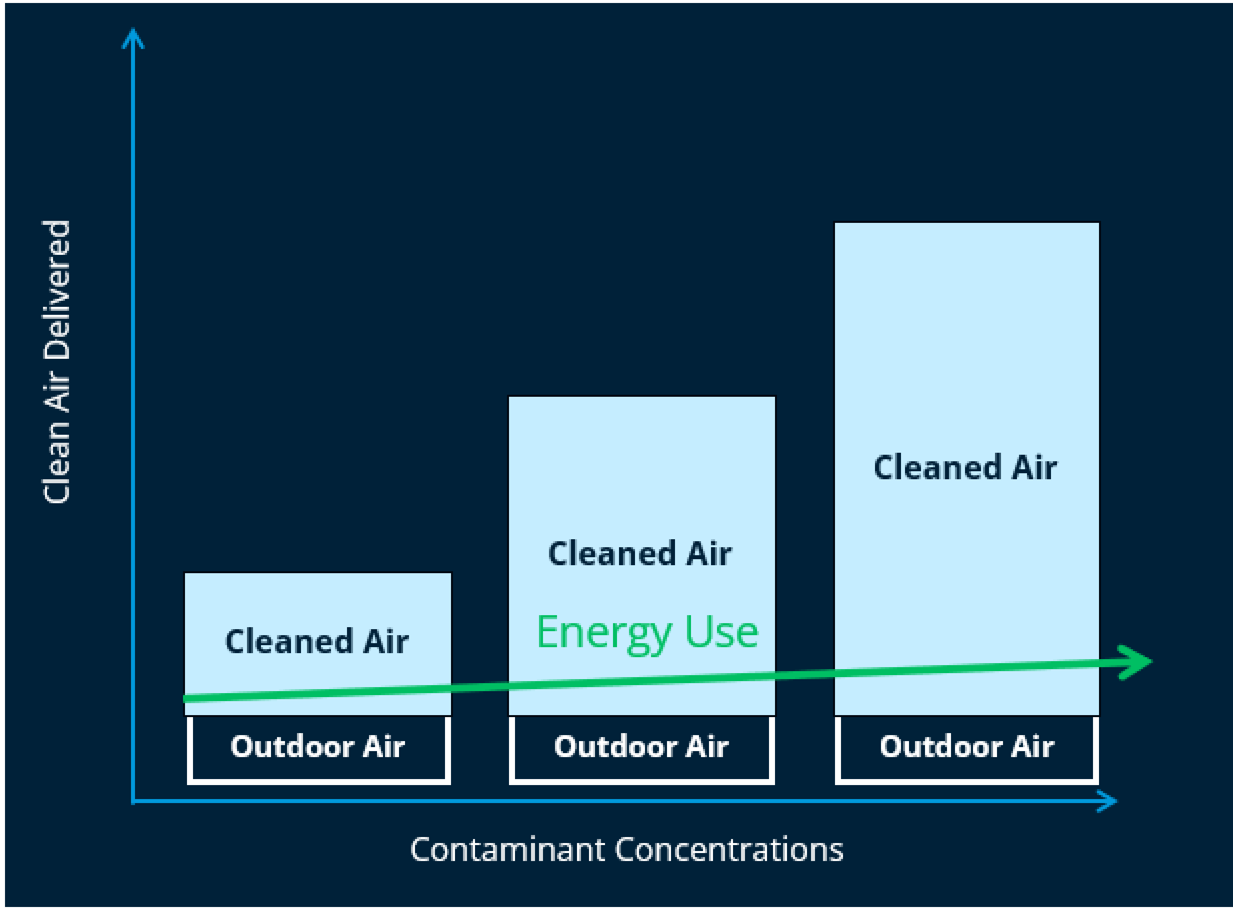
The Energy Component

Ventilation Rate Procedure



Indoor Air Quality Procedure



ASHRAE Tightly Defines IAQP

(reducing the variance and risk on the engineers)

ASHRAE 62.1 §6.3 Indoor Air Quality Procedure Steps	THEN -2016 and earlier	NOW -2019 and later
Outdoor Air Quality Evaluation	**STANDARD** resource list	**STANDARD** via EPA website* + **CALCULATOR**
Design Compounds	Undefined	**STANDARD** Table 6-5 + **CALCULATOR**
Design Compound Limits	Undefined	**STANDARD** Table 6-5 + **CALCULATOR**
Define Generation Rates by Sources	Undefined	**STANDARD** + **CALCULATOR**
Mixtures of Compounds	Undefined	**STANDARD** Table 6-6 + **CALCULATOR**
Determine & Air Cleaner Efficiency	Manufacturer Claims	**STANDARD** Tests ASHRAE 145.2 and 52.2
Perform Mass Balance Calculation for Outdoor Airflow	**STANDARD** Formula	**STANDARD** + **CALCULATOR**
Document Design	**STANDARD** §6.3.6	**STANDARD** §6.6
Evaluate Air Quality	Subjective Evaluation	**STANDARD** approach §7.3

* unique site conditions must be evaluated

ASHRAE 62.1-2019

Relevant Areas to Review

- Section 4 Outdoor Air Quality – outdoor air/local contaminants understand and document outdoor air quality – no action recommended/taken under the standard.
- Section 5 Systems & Equipment – any air cleaning devices must be listed to UL2998 (§5.9.1)
- Section 6 Procedures – VRP, IAQP, and Natural Ventilation
- Appendix C – Zone Air Distribution Effectiveness
- **Addendum AA - Ventilation and Acceptable Indoor Air Quality Approved 10/19/2021**

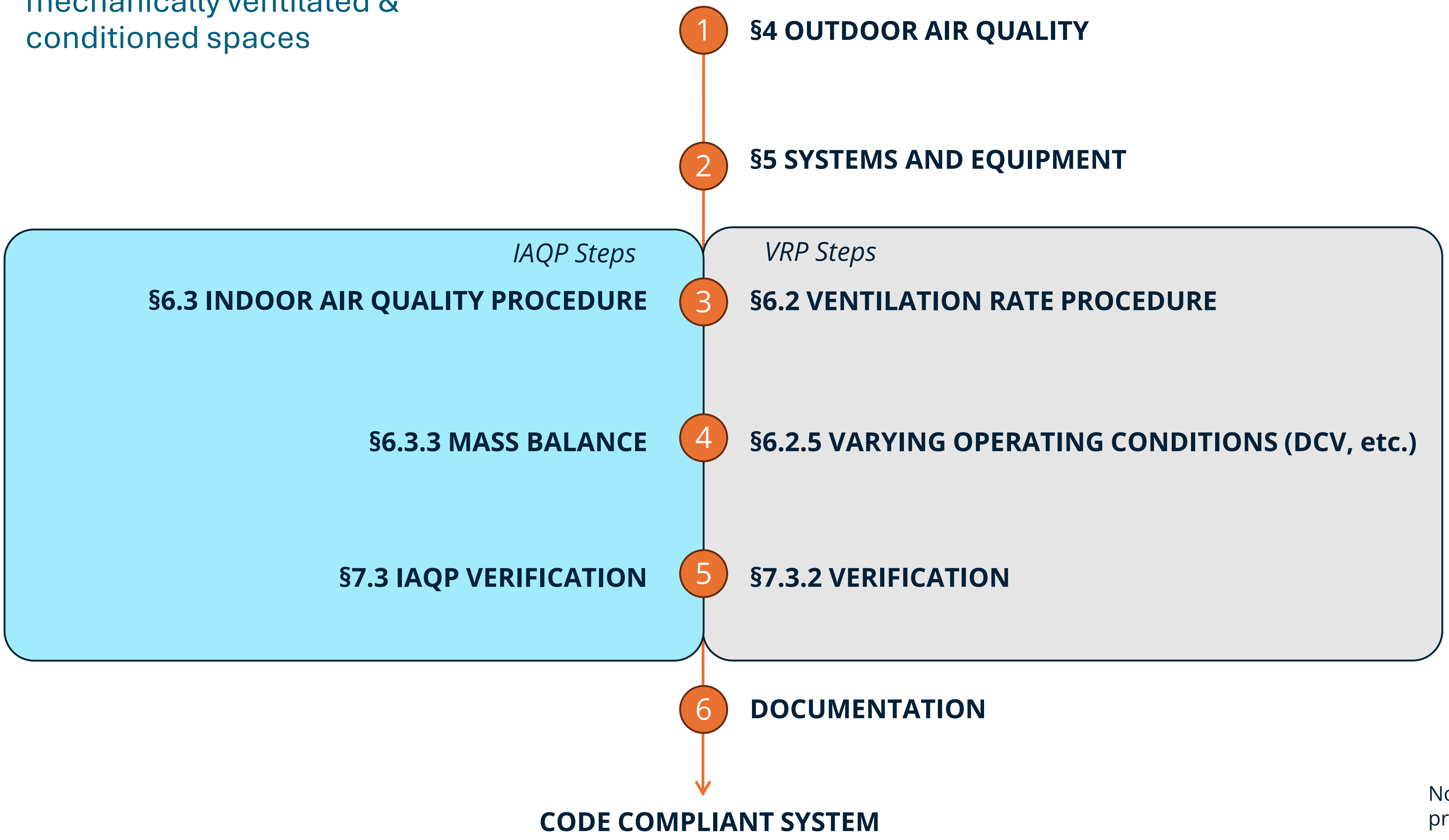
ASHRAE 62.1-2022

Relevant Areas to Review

- Section 4 Outdoor Air Quality – unchanged from -2019
- Section 5 Systems & Equipment – several changes; few impacting IAQP
- Section 6 Procedures – several changes, aligns to -2019 Addendum AA
- Section 7 – Construction & System Startup
- Appendix F, N, L
- **Addenda C, N - Ventilation and Acceptable Indoor Air Quality Approved 9/30/2022**

Designer Workflow

mechanically ventilated & conditioned spaces



Note: The natural ventilation procedure is not depicted here

Outdoor Air

1

§4 OUTDOOR AIR QUALITY
Investigate outdoor air quality and document in accordance with §4.1 and §4.2 and document in accordance with §4.3

§4.1 Regional Air Quality. use NAAQS data and/or U.S. EPA data: NAAQS Table | US EPA or Canada: Air Quality (ccme.ca). Interactive Map for the US: EPA Interactive

§4.2 Local Air Quality. An observational survey of the building site and immediate surroundings shall be conducted during the hours the building is expected to be normally occupied to identify local contaminants from surrounding facilities that will be of concern if allowed to enter the building.

§4.3 Documentation. Documentation of the outdoor air quality investigation shall be reviewed with building owners or their representatives and shall include regional air quality compliance, local survey information (details in standard) and a conclusion regarding the acceptability of outdoor air quality and the supporting information.

Equipment

2

§5 SYSTEMS AND EQUIPMENT
Follow the section as required by the building type and HVAC equipment used. Some particularly important decisions reside in:

§5.5 Particulate Matter Removal. MERV rating of 8 or higher as rated by Standard 52.2 or ISO ePM10 upstream of all cooling coils or other devices with wetted surfaces though which air is supplied to an occupiable space

§5.9.1 Air Cleaning Devices. Air-cleaning devices shall be listed and labeled in accordance with UL2998.

§5.9.2 Ultraviolet Devices. UV generating devices in supply air or spaces shall not transmit 185nm wavelengths, which may generate ozone.

§5.18.1 All systems shall be provided with manual or automatic controls to maintain not less than the outdoor air intake flow (V_{ot}) required by section 6 under all load conditions
§5.18.2 Systems with fans supply variable primary air (V_{ps}) shall be provided with control equipment, method or devices to maintain no less than the outdoor air intake flow (V_{ot}) required for §5.18.1

Procedures

3

§6 PROCEDURES

The Ventilation Rate Procedure (VRP), the Indoor Air Quality Procedure (IAQP), the Natural Ventilation Procedure, or a combination thereof shall be used to meet the requirements of this section.

§6.1.1 Ventilation Rate Procedure. Prescriptive design procedure presented in §6.2

§6.1.2 Indoor Air Quality Procedure. Engineered approach procedure presented in §6.3

§6.1.3 Natural Ventilation Procedure. The prescriptive or engineered system design procedure presented in section 6.4 in which outdoor air is provided through openings to the outdoors.

§6.1.4 Outdoor Air Treatment. In buildings located in an area where the national standard or guideline for PM10 is exceeded, particle filters shall be provided, or where PM2.5 exceeds, MERV11 or higher is required. Where the 8-hour ozone limit of 0.100 ppm or 195 µg/m^3 is exceeded, ozone air cleaning is required.

VRP

§6.2 Ventilation Rate Procedure.

The outdoor air intake flow (V_{ot}) shall be (Single Zone Systems Shown):

$V_{ot} = V_{oz}$ (6-3) *for single zone systems outdoor air total = outdoor air per zone*

$V_{oz} = V_{bz} / E_z$ (6-2)

Where Vbz is determined by calculating using values in Table 6-1:

$V_{bz} = R_p \times P_z + R_a \times A_z$ (6-1)

E_z is determined by looking up a value in Table 6-4. Two examples:

- Ceiling supply of warm air 15°F or more above the space temperature and ceiling return (E_z =0.8)
- Floor Supply of warm air and ceiling return (E_z =0.7)

Example *classrooms (ages 5 to 8)*

People rate: R_p =10 cfm/person

Area rate: R_a = 0.12 cfm/ft^2

Segment from Table 6-1

Occupancy Category	People Outdoor Air Rate R_p cfm/person	People Outdoor Air Rate R_p L/s·person	Area Outdoor Air Rate R_a cfm/ft^2	Area Outdoor Air Rate R_a L/s·m^2	Default Values Occupant Density #/1000 ft^2 or #/100 m^2	Air Class	OS (6.2.6.1.4)
Educational Facilities							
Art classroom	10	5	0.18	0.9	20	2	
Classrooms (ages 5 to 8)	10	5	0.12	0.6	25	1	
Classrooms (age 9 plus)	10	5	0.12	0.6	35	1	

VRP Example

§6.2 Ventilation Rate Procedure.

The outdoor air intake flow (V_{ot}) shall be:

Where Vbz is determined by calculating using values in Table 6-1 :

$V_{bz} = R_p \times P_z + R_a \times A_z$ (6-1)

V_{bz} = 10 cfm/person x 25 persons + 0.12 cfm/ft^2 * 1,000 ft^2

V_{bz} = 250+120 = 370 cfm

$V_{oz} = V_{bz} / E_z$ (6-2)

V_{oz} = 370 cfm / 0.8 (high supply high return)

V_{oz} = 462.5 cfm

$V_{ot} = V_{oz}$ (6-3)

V_{oz} = 462.5 cfm

Delivers approximately 18.5 cfm/person

IAQP

3 Determine breathing zone outdoor airflow (Vbz) following Sections 6.3.1 and 6.3.5 (or use a calculator)

Identify Design Compounds and PM2.5 Sources. People, Building, Outdoor Air, Other

§6.3.1 Design Compounds (DC) and PM2.5 Sources. The system design shall be based on the DCs and PM2.5 specified 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. For each DC and PM2.5, the emission rates form the indoor sources from occupants, building materials, furnishings, equipment and other sources and the outdoor concentration shall be determined.

Informative Notes:

1. Indoor emission rate information for some compounds is provided in Informative Appendix N
2. Outdoor concentrations were determined in §4

IAQP Design Compounds

Table 6-5 Design Compounds, PM 2.5, and Their Design Limits

Design Compounds (D.C.)	Design Limit	Cognizant Authority
Acetaldehyde	140.0 µg/m3	Cal EPA CREL
Acetone	1200.0 µg/m3	AgBB LCI
Benzene	3.0 µg/m3	Cal EPA CREL
Dicholoromethane	400.0 µg/m3	Cal EPA CREL
Formaldehyde	33.0 µg/m3	Cal EPA 8-hour CREL
Napthalene	9.0 µg/m3	Cal EPA CREL
Phenol	10.0 µg/m3	AgBB LCI
Tetrachloroethylene	35.0 µg/m3	Cal EPA CREL
Toluene	300.0 µg/m3	Cal EPA CREL
1,1,1 - trichloroethane	1000.0 µg/m3	Cal EPA CREL
Xylene, total	50.0 µg/m3	AgBB LCI
PM2.5	12.0 µg/m3	US EPA NAAQS (annual mean)
Carbon monoxide	10310.0 µg/m3	US EPA NAAQS
Ozone	137.0 µg/m3	US EPA NAAQS
Ammonia	200.0 µg/m3	Cal EPA CREL

ASHRAE: Published peer-reviewed papers provide a reference for design teams to use to compile reasonable emissions rates of the design compounds. ASHRAE IAQP calculator D-86925 simplifies that selection.

IAQP Design Compounds (continued)

Table 6-6 Mixtures of Compounds

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

§6.3.2 Design Compounds (DC) and PM2.5 Concentration. Compounds having one or more of the mixture effects in Table 6-6 shall be added in the mixed exposure sum (E_m), as determined by Equation 6-12 shall be less than 1.0.

$$E_m = C_1 / DL_1 + C_2 / DL_2 + C_i / DL_i \qquad (6\text{-}12)$$

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

Mass Balance

4 **§6.3.3.1 Mass-Balance Analysis**. Using a steady-state or dynamic mass-balance analysis, the minimum outdoor airflow rates required to achieve the concentration limits specified in §6.3.2 shall be determined for each DC, mixture of DCs and PM2.5 within each zone served by the system.

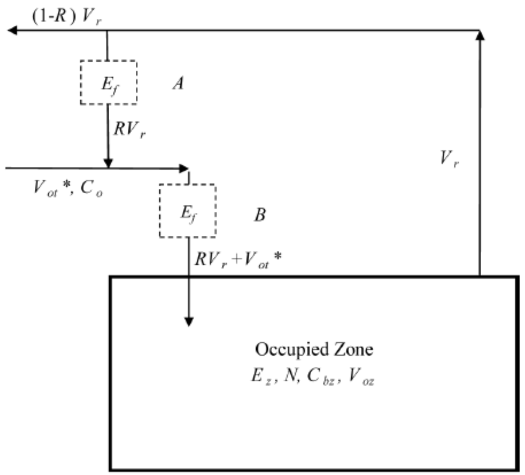


Figure F-1 Ventilation system schematic—constant-volume system with no infiltration/exfiltration. (*V_{ot} = V_{oz} for single-zone systems.)

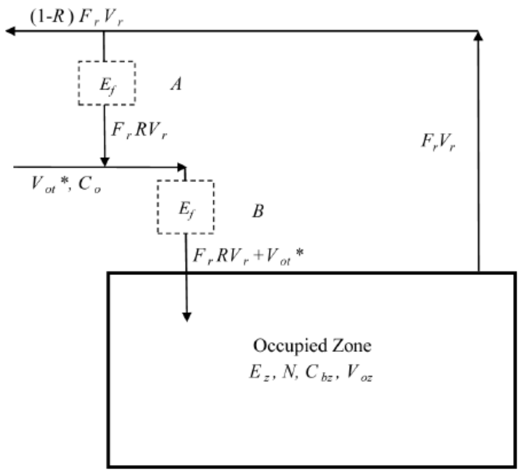


Figure F-2 Ventilation system schematic—variable-air-volume system with no infiltration/exfiltration. (*V_{ot} = V_{oz} for single-zone systems).

Symbol or Subscript	Definition
A, *B*	filter location
V	volumetric flow
C	contaminant concentration
E_z	zone air distribution effectiveness
E_f	filter efficiency
F_r	design flow reduction fraction factor
N	contaminant generation rate
R	recirculation flow factor
Subscript: *o*	outdoor
Subscript: *r*	return
Subscript: *b*	breathing
Subscript: *z*	zone

Required Recirculation Rate				
Filter Location	**Flow**	**Outdoor Airflow**	**Required Zone Outdoor Airflow (V_{oz} in Section 6)**	**Space Breathing Zone Contaminant Concentration**
None	VAV	100%	$V_{oz} = \frac{N}{E_z F_r (C_{bz} - C_o)}$	$C_{bz} = C_o + \frac{N}{E_z F_r V_{oz}}$
A	Constant	Constant	$V_{oz} = \frac{N - E_z R V_r E_f C_{bz}}{E_z (C_{bz} - C_o)}$	$C_{bz} = \frac{N + E_z V_{oz} C_o}{E_z (V_{oz} + R V_r E_f)}$
A	VAV	Constant	$V_{oz} = \frac{N - E_z F_r R V_r E_f C_{bz}}{E_z (C_{bz} - C_o)}$	$C_{bz} = \frac{N + E_z V_{oz} C_o}{E_z (V_{oz} + F_r R V_r E_f)}$
B	Constant	Constant	$V_{oz} = \frac{N - E_z R V_r E_f C_{bz}}{E_z [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z V_{oz} (1 - E_f) C_o}{E_z (V_{oz} + R V_r E_f)}$
B	VAV	100%	$V_{oz} = \frac{N}{E_z F_r [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z F_r V_{oz} (1 - E_f) C_o}{E_z F_r V_{oz}}$
B	VAV	Constant	$V_{oz} = \frac{N - E_z F_r R V_r E_f C_{bz}}{E_z [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z V_{oz} (1 - E_f) C_o}{E_z (V_{oz} + F_r R V_r E_f)}$

Air Cleaner Testing Procedures

ASHRAE 62.1-2022

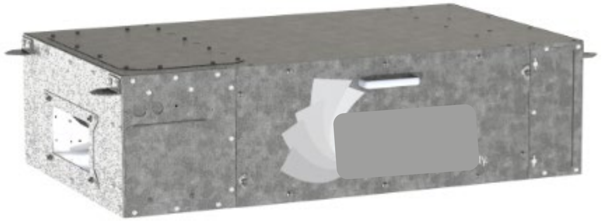
Where particulate matter or gas-phase air cleaning is included in the design, the removal efficiencies shall be specified as follows. Particle matter filters show report an efficiency reporting value (MERV) in accordance with ASHRAE Standard 52.2 or reporting in accordance with ISO 16890. Gas-phase air cleaners shall report an efficiency test for all compounds included in the design in accordance with any of the following:

a. ASHRAE Standard 145.2
b. ISO 10121-2
c. Testing Methods in Section 6.1.2.10.4 and 10.5 and reported as required in ASHRAE Standard 145.2 Section 11
d. Testing to a national consensus standard approved by AHJ
e. For technologies not covered by any of the above, tests developed to demonstrate the removal efficiency shall be performed by a third party. The custom efficiency tests shall be conducted for all compounds included in the design and shall comply with: … not conform to above, Or custom third-party tests approved by the AHJ and performed in situ

Standard 145.2:
Laboratory Test Method for Assessing the Performance of Gas-Phase Air-Cleaning Systems: Air Cleaning Devices

Standard 52.2:
Method for Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

Filter & Air Cleaner Effectiveness



ASHRAE Shaping Tomorrow's Built Environment Today

ASHRAE Position Document on

Filtration and Air Cleaning

Approved by the ASHRAE Board of Directors June 26, 2024

Expires June 26, 2027

ASHRAE

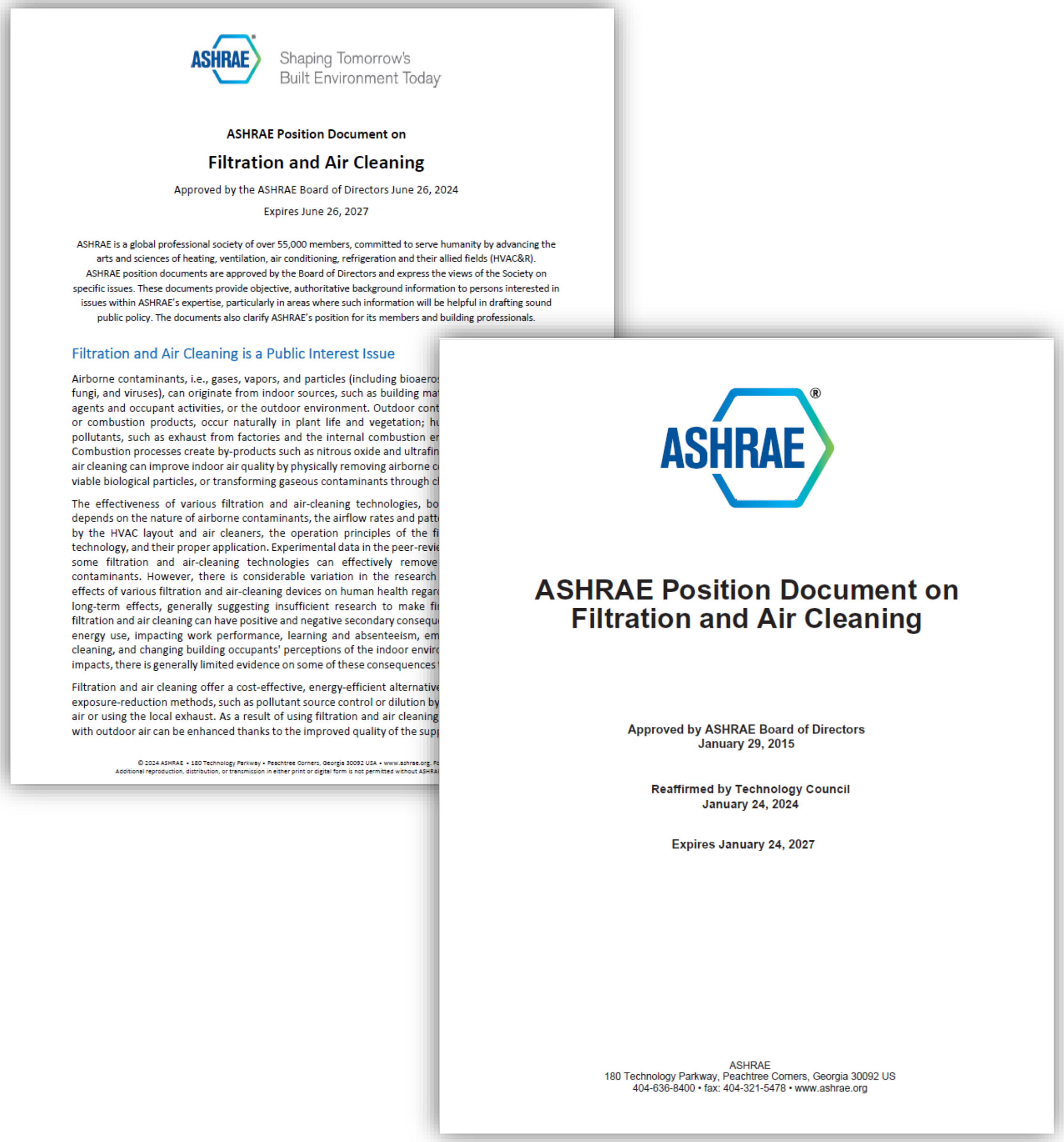
ASHRAE Position Document on Filtration and Air Cleaning

Filter Efficiency (E_f)

Removal Efficiency (Ef) ASHRAE 145.2/52.2	
Acetaldehyde	44%
Acetone	45%
Benzene	54%
Dicholoromethane	52%
Formaldehyde	40%
Napthalene	95%
Phenol	73%
Tetrachloroethylene	78%
Toluene	86%
1,1,1 - trichloroethane	41%
Xylene, total	92%
PM2.5	77%
Carbon Monoxide	0%
Ozone	36%
Ammonia	10%

Validating Air Cleaners

- 62.1-2022 requires Standards 145.2 and 52.2 with some alternatives
- ASHRAE has at least 2 position papers on filtration and air cleaning
  - Devices that produce compounds to remove or inactivate pollutant(s) should only be used if proven safe
  - Performance should be based on published standardized tests from ASHRAE or other orgs. or agencies
  - Devices should only be used when tested and labeled for ozone emissions in accordance with UL 2998


ASHRAE Shaping Tomorrow's Built Environment Today

ASHRAE Position Document on

Filtration and Air Cleaning

Approved by the ASHRAE Board of Directors June 26, 2024

Expires June 26, 2027

ASHRAE is a global professional society of over 55,000 members, committed to serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration and their allied fields (HVAC&R). ASHRAE position documents are approved by the Board of Directors and express the views of the Society on specific issues. These documents provide objective, authoritative background information to persons interested in issues within ASHRAE's expertise, particularly in areas where such information will be helpful in drafting sound public policy. The documents also clarify ASHRAE's position for its members and building professionals.

Filtration and Air Cleaning is a Public Interest Issue

Airborne contaminants, i.e., gases, vapors, and particles (including bioaeros fungi, and viruses), can originate from indoor sources, such as building ma agents and occupant activities, or the outdoor environment. Outdoor cont or combustion products, occur naturally in plant life and vegetation; h pollutants, such as exhaust from factories and the internal combustion e Combustion processes create by-products such as nitrous oxide and ultrafin air cleaning can improve indoor air quality by physically removing airborne c viable biological particles, or transforming gaseous contaminants through c

The effectiveness of various filtration and air-cleaning technologies, bo depends on the nature of airborne contaminants, the airflow rates and patt by the HVAC layout and air cleaners, the operation principles of the f technology, and their proper application. Experimental data in the peer-revi some filtration and air-cleaning technologies can effectively remove contaminants. However, there is considerable variation in the research effects of various filtration and air-cleaning devices on human health regar long-term effects, generally suggesting insufficient research to make fi filtration and air cleaning can have positive and negative secondary consequ energy use, impacting work performance, learning and absenteeism, em cleaning, and changing building occupants' perceptions of the indoor envir impacts, there is generally limited evidence on some of these consequences

Filtration and air cleaning offer a cost-effective, energy-efficient alternativ exposure-reduction methods, such as pollutant source control or dilution by air or using the local exhaust. As a result of using filtration and air cleaning with outdoor air can be enhanced thanks to the improved quality of the sup

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ASHRAE Position Document on Filtration and Air Cleaning

Approved by ASHRAE Board of Directors January 29, 2015

Reaffirmed by Technology Council January 24, 2024

Expires January 24, 2027

ASHRAE
180 Technology Parkway, Peachtree Corners, Georgia 30092 US
404-636-8400 • fax: 404-321-5478 • www.ashrae.org

Standard 62.1 Air Quality Journey

Verification

5

§7.3 Indoor Air Quality Procedure Verification

§7.3.1 Objective Evaluation. Perform design compound (DC) and PM2.5 measurement in the completed building to verify that design limits (DLs) are met. The peak concentrations over an 8-hour occupied period shall not exceed the DL for carbon monoxide. For Ozone, PM2.5, the average concentration measured over an 8-hour occupied period shall not exceed the DL. Measurement methods and procedures are defined in Tables 7-1, 7-2, and 7-3

Table 7-1 Allowed Laboratory Test Methods

Compound	Allowed Test Methods
VOCs except formaldehyde, acetaldehyde and acetone	ISO 16000-6; EPA IP-1, EPA TO-17; ISO 16017-1; ISO 16017-2; ASTM D6345-10
Formaldehyde, acetaldehyde and acetone	ISO 16000-3; EPA TO-11; EPA IP-6; ASTM D5197
Carbon monoxide	ISO 4224; EPA IP-3

Table 7-2 Direct Reading Instruments Minimum Specifications

	Ozone	PM2.5	Carbon Monoxide
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

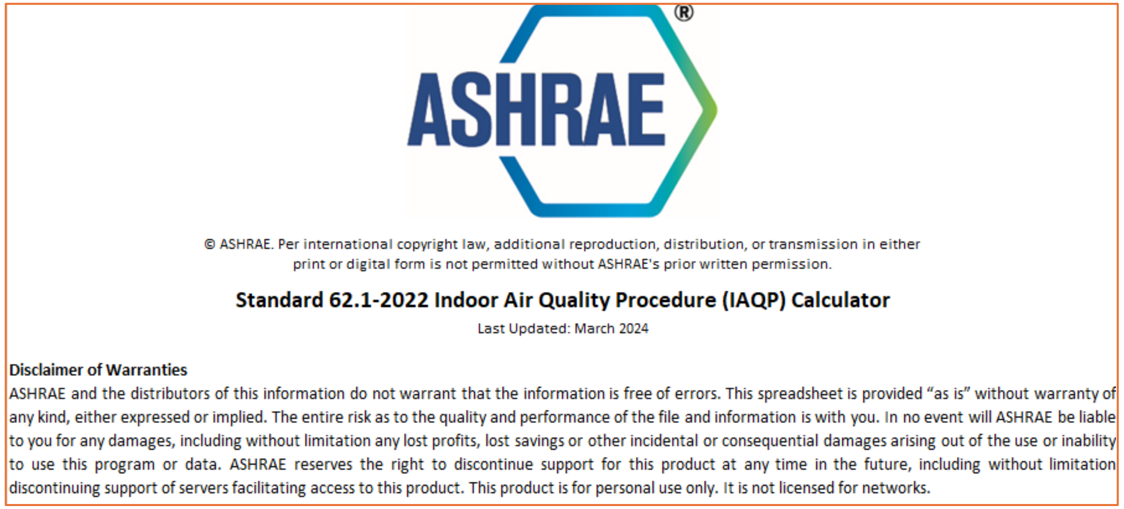
Table 7-3 Number of Measurements Points

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

Typically, air quality canister systems will meet these requirements

IAQP In Practice

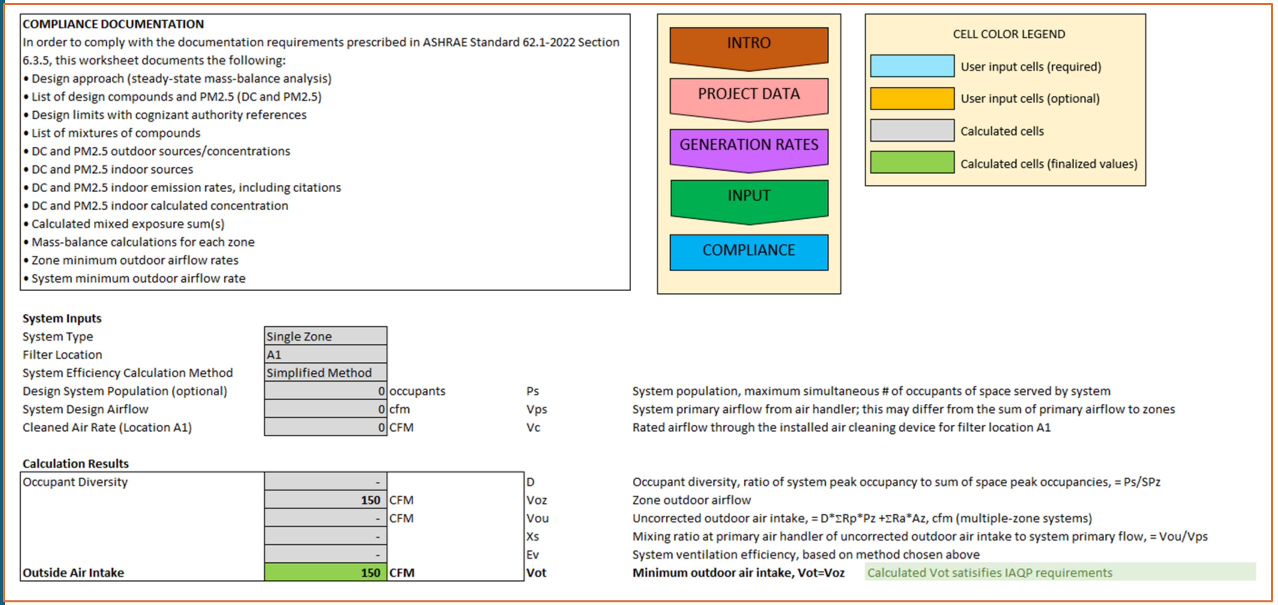
- ASHRAE and manufactures have published calculators
- Mass-balance for DC's and combinations is automated
- Designer needs to provide location (OA data) and air cleaner selection
- Link to the calculator: ASHRAE IAQP Calculator



Standard 62.1-2022 Indoor Air Quality Procedure (IAQP) Calculator

Last Updated: March 2024

Disclaimer of Warranties



COMPLIANCE DOCUMENTATION

In order to comply with the documentation requirements prescribed in ASHRAE Standard 62.1-2022 Section 6.3.5, this worksheet documents the following:

- Design approach (steady-state mass-balance analysis)
- List of design compounds and PM2.5 (DC and PM2.5)
- Design limits with cognizant authority references
- List of mixtures of compounds
- DC and PM2.5 outdoor sources/concentrations
- DC and PM2.5 indoor sources
- DC and PM2.5 indoor emission rates, including citations
- DC and PM2.5 indoor calculated concentration
- Calculated mixed exposure sum(s)
- Mass-balance calculations for each zone
- Zone minimum outdoor airflow rates
- System minimum outdoor airflow rate

INTRO
PROJECT DATA
GENERATION RATES
INPUT
COMPLIANCE

CELL COLOR LEGEND
- User input cells (required)
- User input cells (optional)
- Calculated cells
- Calculated cells (finalized values)

System Inputs

System Type	Single Zone			
Filter Location	A1			
System Efficiency Calculation Method	Simplified Method			
Design System Population (optional)	0	occupants	Ps	System population, maximum simultaneous # of occupants of space served by system
System Design Airflow	0	cfm	Vps	System primary airflow from air handler; this may differ from the sum of primary airflow to zones
Cleaned Air Rate (Location A1)	0	CFM	Vc	Rated airflow through the installed air cleaning device for filter location A1

Calculation Results

Occupant Diversity	-		D	Occupant diversity, ratio of system peak occupancy to sum of space peak occupancies, = Ps/SPz
	150	CFM	Voz	Zone outdoor airflow
	-	CFM	Vou	Uncorrected outdoor air intake, = D*ΣRp*Pz +ΣRa*Az, cfm (multiple-zone systems)
	-		Xs	Mixing ratio at primary air handler of uncorrected outdoor air intake to system primary flow, = Vou/Vps
	-		Ev	System ventilation efficiency, based on method chosen above
Outside Air Intake	**150**	**CFM**	**Vot**	**Minimum outdoor air intake, Vot=Voz** Calculated Vot satisifies IAQP requirements

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62.1 IAQP Standards Driven Tool

Classroom IAQP

System Selection

System Type	Single Zone			Choose selection from dropdown.
Filter Location	A1			Choose selection from dropdown. (Refer to **INTRO** tab for more information on filter location.)
System Efficiency Calculation Method	Simplified Method			Choose method from dropdown. (**Simplified Method** should only be selected for **Multiple Zone**)

DATA ENTRY INSTRUCTIONS:
1. Enter data in row 42 for a single zone only.
2. Enter data for the Clean Air Rate in cell D16.
3. Data for Primary Zone Airflow (column J) is optional.

System Inputs

Design System Population (optional)		occupants	Ps	System population, maximum simultaneous # of occupants of space served by system
System Design Airflow (optional)		cfm	Vps	System primary airflow from air handler. This may differ from the sum of primary airflow to zones. **REQUIRED ENTRY for Filter Locations A2 and B if no values are entered for zone primary airflows.**
Cleaned Air Rate (Location A1)	250	CFM	Vc	Rated airflow through the installed air cleaning device for filter location A1

Calculation Results

Occupant Diversity	-		D	Occupant diversity, ratio of system peak occupancy to sum of space peak occupancies, = Ps/∑Pz
	125	CFM	Voz	Zone outdoor airflow (Single Zone Systems)
	-	CFM	Vou	Uncorrected outdoor air intake (Multiple Zone Systems)
	-		Xs	Mixing ratio at primary air handler of uncorrected outdoor air intake to system primary flow, = Vou/Vps
	-		Ev	System ventilation efficiency, based on method chosen above
Outside Air Intake	**125**	**CFM**	**Vot**	**Minimum outside air intake, Vot=Voz** Calculated Vot satisifies IAQP requirements
Critical Zone	-			This zone has the highest calculated ventilation efficiency

Mixtures Check

Outside Air Intake Override	125	**CFM**	**Voz**	Increase Voz if doesn't pass mixtures check
Mixed Exposure Sum	0.18		**Em**	Upper Respiratory Tract Irritation
Mixed Exposure Sum	0.68		**Em**	Eye Irritation
Mixed Exposure Sum	0.04		**Em**	Central Nervous System
Pass Mixtures Check?	Yes		**Em < 1**	Yes|No

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Using 5 cfm of O.A. per student and 250 cfm of air cleaning at 50% removal value creates a passing scenario

Comparing IAQP and VRP

First Cost

Project Location: Atlanta, GA

FIRST TIME EQUIPMENT SAVINGS

				Outdoor Airflow (cfm)			Capacity & Initial Equipment Savings				
								IAQP Savings @ Various Cost/Ton of HVAC			
Space Type	Area (ft^2)	Pop.	Ez	VRP	IAQP	VRP-	s	$2k/ton	$3k/ton	$4k/ton	$5k/ton
Classroom (ages 5-8)	950	25	0.8	462	125	337	3	$ 6,000	$ 9,000	$ 12,000	$ 15,000
Lecture Hall (fixed seats)	2,000	300	0.8	2,370	1,200	1,170	14	$ 2,000	$ 42,000	$ 56,000	$ 70,000
Office Space	5,000	50	0.8	688	200	488	4	$ 8,000	$ 12,000	$ 16,000	$ 20,000

Enthalpy for Atlanta, GA: 40

Considers HVAC capacity savings (tonnage) not including installation, duct sizing, DCV, ERV, or other simplifications.

Comparing IAQP and VRP

Operating Cost

Results vary based on system design, geography, etc. Examples for Atlanta with annual energy estimate of 10 kWh/cfm

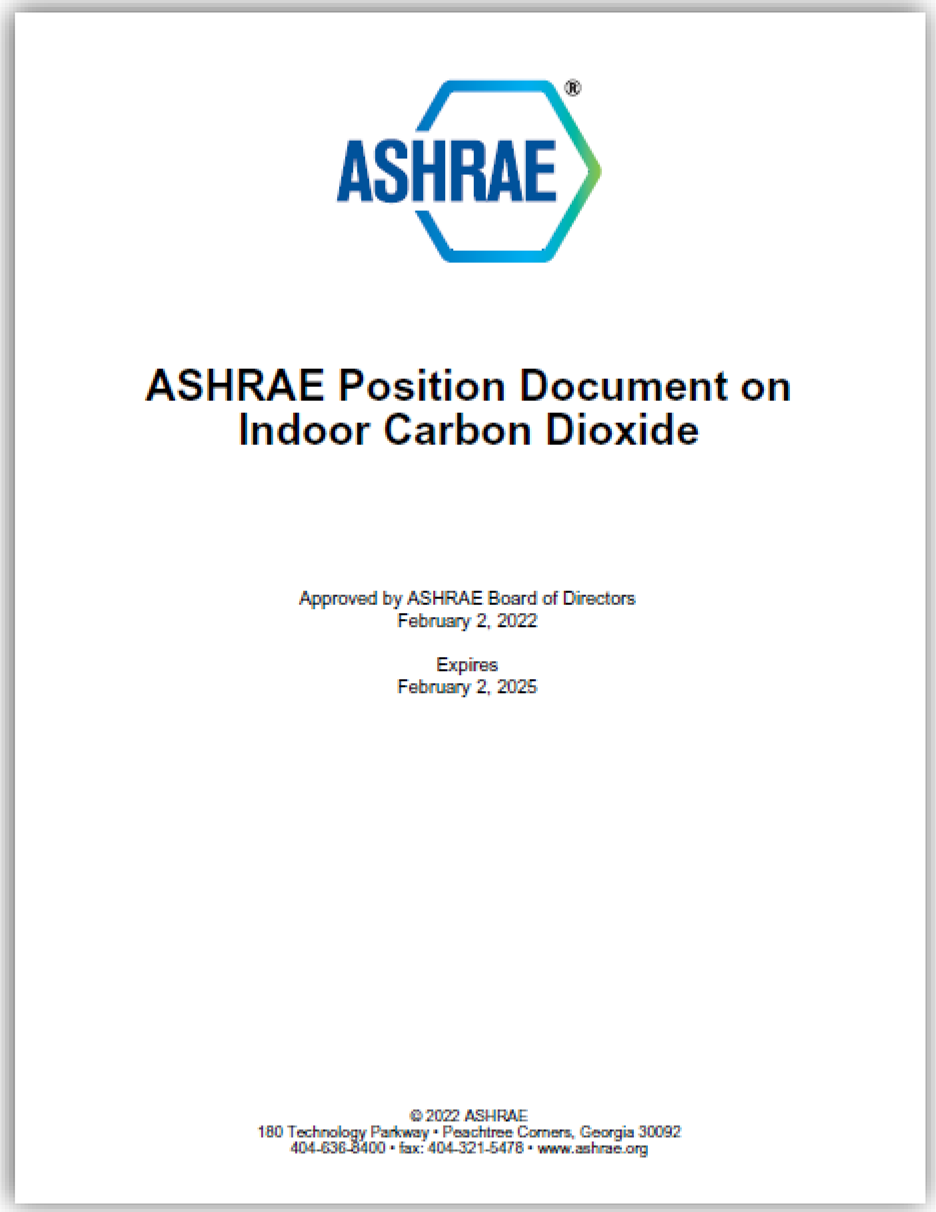
Project Location: Atlanta, GA

ANNUAL OPERATING BENEFIT OF THE IAQP				OUTDOOR AIRFLOW (cfm)			ANNUAL ENERGY SAVINGS AT VARIOUS kWh RATES			
Space Type	Area (ft^2)	Pop.	Ez	VRP	IAQP	VRP-IAQP	Energy (kWh/cfm)	$0.10/kWh	$0.12/kWh	$0.15/kWh
Classroom (ages 5-8)	950	25	0.8	462	125	337	10	$ 337	$ 404	$ 506
Lecture Hall (fixed seats)	2,000	300	0.8	2,370	1,200	1,170	10	$ 1,170	$ 1,404	$ 1,755
Office Space	5,000	25	0.8	688	200	488	10	$ 488	$ 586	$ 732

* estimate: assumes one air cleaner per 1,000 sq. ft. with 50% first pass removal efficiency

Concerning CO_2

- CO_2 is not a design compound under 62.1
- There research and results on healthy levels of CO_2 is inconclusive
- ASHRAE is continuing to research and advise on this subject
- Reference Demand Control Ventilation levels in 62.1-2019 Table 6-1



ASHRAE®

ASHRAE Position Document on Indoor Carbon Dioxide

Approved by ASHRAE Board of Directors
February 2, 2022

Expires
February 2, 2025

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180 Technology Parkway • Peachtree Corners, Georgia 30092
404-636-8400 • fax: 404-321-5478 • www.ashrae.org

Excerpts from the ASHRAE Position Document

- Indoor CO_2 as an indicator of IAQ and ventilation is **commonly misinterpreted** within the HVAC industry and the research community and among the public.
- Indoor CO_2 concentrations greater than 1,000 ppm have been associated with increases in self-reported, nonspecific symptoms commonly referred to as sick building syndrome. However, those observations were not controlled for other contaminants or environmental parameters
- Indoor CO_2 concentrations vary by space type. Standard 62.1 range from about 1,000 ppm in office spaces to between 1,500 and 2,000 ppm in restaurants, lecture classrooms and above 2,500 ppm in conference rooms and auditoriums

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- 62.1-2022 Addendum recommends demand control ventilation schemes (DCV) to be triggerable, depending upon space with CO_2 concentrations 600 to 2,100 ppm over 400 ppm ambient (1,000 to 2,500 ppm)
- Studies of U.S. Navy submariners show no significant difference in decision making performance in CO_2 concentrations of 600, 2,500, or 15,000 ppm
  (Acute exposure to low-to-moderate Carbon Dioxide Levels and Submarine Decision Making, Rodeheffer, Christoper et all, Aerospace Medical Association, June 2018)

Growing Support

Source reduction and air cleaning … can greatly reduce contaminant harm without increasing ventilation rate—**thus saving energy**.

In typical buildings minimum ventilation will be necessary to provide oxygen and remove human bioeffluents … closer to the level of 4cfm/person…

Combination of source control, ventilation and air cleaning is most practical to handle the contaminants of concern.

IAQ Paradigms—The Next Generation

BY MAX SHERMAN, PH.D., FELLOW/LIFE MEMBER ASHRAE

ASHRAE's Vision is "a healthy and sustainable built environment for all." The "healthy" part of that vision primarily has to do with providing appropriate indoor air quality (IAQ). For the first century of ASHRAE's existence, that meant determining and providing minimum ventilation rates. Over the last few decades, however, research both within ASHRAE and in the health community has shown us that the ventilation-only approach cannot always achieve the vision because of the diversity of sources and the potential contributions of other removal mechanisms. On the other hand, consideration of sources and their impacts can lead to improvements in both health and sustainability. This article covers the evolution from the first paradigm—ventilation rate—to the emerging harm paradigm, which has recently been enabled by some important research.

Even more than decarbonization, indoor air quality is fundamental to who ASHRAE is. The Society has long recognized that the provision of acceptable IAQ is an essential building service and central to ASHRAE's purpose.[1] Such a position is not exactly surprising given that since there was anything that could be called "indoors," early humans recognized the need to exhaust contaminants from fires. How we address IAQ, however, has changed over time as both technology and our understanding of the science of IAQ has evolved. Accordingly, the paradigms we use have evolved. We are likely in the midst of another paradigm shift.

These paradigms owe much to the English, particularly considering their proclivity to continually burn down the City of London. The first ventilation standard, which was of course before the advent of mechanical ventilation, might be said to be due to King Charles II and the Great Fire of 1666. All the new buildings were required to have sufficient operable windows for ventilation. Whenever the Palace of Westminster (aka the English Parliament) burned down, they attempted to build back better.

The first quantitative attempt at achieving acceptable IAQ is due largely to the fact that the English Parliament has often been considered by many[2] to be foul, rancid and pestiferous. While such a categorization may have been due to the location on a polluted Thames or the affairs of its occupants, Parliament chose to believe it was due to the building itself. When on Oct. 16, 1834, another Great Fire burned the building down, it

Max Sherman, Ph.D., is a professor at the University of Nottingham and a retired staff senior scientist at the Lawrence Berkeley National Laboratory.

ASHRAE Journal July 2024

By Max Sherman, ASHRAE Fellow & Vice-Chairman ASHRAE 241 Committee

IAQP in LEED

Under LEED v5 the USGBC references ASHRAE 62.1-2022 and opens the door to using the Indoor Air Quality procedure, adding credits for measurement & better indoor air.

Relevant section (points)

- Fundamental air quality (1)
- Air quality testing & monitoring (2)
- Enhanced air quality (1)
- Resilient spaces (2)

Initial Savings Opportunities

Smaller HVAC equipment:

- Air handlers and compressors (lower tonnage)
- Chillers
- Boilers

Simplified Designs:

- Eliminate DCV and sensors
- Smaller duct sizes
- Eliminate ERV

Other considerations:

- Eliminate or shrink onsite PV or geothermal systems
- Shift from "exotic" HVAC system designs to RTU or unitary equipment on some projects

Indoor Air Quality Procedure

The IAQP is potentially more cost effective but certainly delivers equivalent or better indoor air quality. With lower outdoor air, ongoing conditioning costs will be smaller.

Using the procedure will ensure a focus reducing and managing contaminants so that the HVAC equipment is appropriately sized to manage temperature and humidity while air cleaners mitigate design compounds for healthy air.

Q&A