WHITEPAPER

Compliance with the Indoor Air Quality Procedure of ASHRAE® Standard 62.1

IAQP Updates and Examples

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Introduction

ASHRAE® Standard 62.1 *Ventilation and Acceptable Indoor Air Quality,* prescribes requirements meant to ensure acceptable indoor air quality for the human occupants and minimize adverse health effects. The standard is written in code-enforceable language to streamline its adoption into building codes. Three procedures available to determine zone and system ventilation rates:

- **Ventilation Rate Procedure (VRP)** prescribes minimum zone-level outdoor air rates and procedures to determine the system-level outdoor air intake rate.
- **Indoor Air Quality Procedure (IAQP)** allows compliance based on an analysis of design compounds and design mixtures using performance criteria. Indoor air quality is monitored through survey and measurement, and air-cleaning devices may be used to clean supply air.
- **Natural Ventilation Procedure (NVP)** prescribes minimum outdoor air openings—rather than outdoor air rates—for natural (passive) ventilation.

Project teams can choose one, or a combination, of these procedures to comply with the ventilation requirements of the standard. Often, the Natural Ventilation Procedure is used in conjunction with either the Ventilation Rate Procedure or Indoor Air Quality Procedure because mechanical ventilation must be available whenever passive ventilation is undesirable or ineffective.

The VRP is the most commonly used procedure for determining minimum outdoor airflow requirements. Use of the IAQP has been less common in the marketplace, largely because of the assumptions and documentation required; however, recent addenda have improved its usability.

Overview of the Indoor Air Quality Procedure (IAQP)

IAQP is a performance-based procedure used to determine minimum outdoor airflow rates by evaluating design compounds, particulate matter, and mixtures of compounds while maintaining both objective and subjective occupant satisfaction. In contrast, the VRP is a prescriptive procedure designed to determine outdoor air rates by referencing people- and area-based ventilation rates from a table in the standard and then applying system-specific calculations.

Unlike the VRP, the IAQP allows designers to account for the addition of an air-cleaning device to remove contaminants from the circulated air. This can reduce the ventilation rate lower than the value determined in accordance with the VRP, while maintaining indoor air quality and meeting occupant satisfaction requirements. As a result, ventilation rates for systems designed using the IAQP may be lower than the same system designed with the VRP; which can allow for downsized equipment and reduced energy use.

Addendum n to Standard 62.1-2022 requires that air-cleaning devices be tested in accordance with current standards, such as ASHRAE® Standard 145.2, ISO 10121-2, or others. If an air-cleaning technology is not covered by the standards, a third-party test may be performed to demonstrate removal efficiency.

Designers must consider pollutants as either particulate matter or gaseous contaminants when identifying design compounds and mixtures of compounds. **Design compounds** include a prescribed list of compounds with design concentration limits established by cognizant authorities. **Particulate matter** includes inert particles, biological particles, and liquid droplets. There are many sources of particles. Most inert particles and liquid particles originate outdoors, while biological particles may originate both indoors and outdoors. Gaseous contaminants—either organic or inorganic—also originate both indoors and outdoors. Table 1 provides a list of design compounds and particulate matter along with their respective design limits and cognizant authorities. Designers are also required to consider any unusual sources of additional design compounds and add them to the analysis.

Standard 62.1 is under continuous maintenance, meaning it is constantly being updated by a committee of volunteers. In 2021, ASHRAE® approved *Addendum aa* to Standard 62.1-2019. This addendum included significant changes designed to simplify and improve the IAQP. Previously, designers were required to identify "contaminants of concern," indoor and outdoor sources, concentration limits, exposure periods, determine a percentage of satisfied building occupants, and perform a mass balance analysis for selected compounds. The updated standard now specifies limits for design compounds, mixtures of compounds, and particulate matter, with an additional requirement to include "unusual" sources as needed. Additionally, the committee added a minimum occupant satisfaction requirement and objective and subjective testing requirements.

In 2022, ASHRAE® approved *Addendum n* to Standard 62.1-2022, adding air-cleaning device efficiency requirements. In 2024, *Addendum c* was released with a set of spreadsheet-based calculation tools. Several other addenda to the 2022 publication of Standard 62.1 were used to remove a design compound (1,1,1-trichloroethane, *addendum q*) and update both design limits and cognizant authorities (*addendum q, r, v*). *Addendum aa* to Standard 62.1-2022 added a new requirement to use the end-of-useful life efficiency for formaldehyde to account for degradation of air cleaner formaldehyde efficiency over time.

Table 1. Compounds, particulate matter, cognizant authorities, and design limits IAQP Revision

Design Compound or $PM_{2.5}$	Cognizant Authority	Design Limit
acetaldehyde	OEHHA CREL	140 µg/m^3
acetone	AgBB LCI	120,000 µg/m^3
benzene	OEHHA 8REL	3 µg/m^3
dichloromethane	OEHHA CREL	400 µg/m^3
formaldehyde	CARB	33 µg/m^3
naphthalene	OEHHA CREL	9 µg/m^3
phenol	AgBB LCI	70 µg/m^3
tetrachloroethylene	OEHHA CREL	35 µg/m^3
toluene	OEHHA CREL	420 µg/m^3
xylene, total	AgBB LCI	500 µg/m^3
carbon monoxide	40 CFR 50	9 ppm
$PM_{2.5}$	40 CFR 50 (annual mean)	9 µg/m^3
ozone	40 CFR 50	70 ppb
ammonia	OEHHA CREL	200 µg/m^3

Mixtures of compounds are either source- or impact-related. Source mixtures (such as diesel exhaust or tobacco smoke) comprise a wide range of contaminants—often both particles and gases—that originate from known sources or processes. Mixtures of compounds comprise a set of particles or gases known to impact the same human organ or system, such as the eyes, the respiratory system, or the nervous system.

Many contaminants must be considered both as individual design compounds and as constituents of one or more mixtures. Ozone, for example, is considered an individual design compound and also a constituent of several mixtures of compounds because it affects the upper respiratory tract and eyes.

Both indoor and outdoor pollutants must be considered. Section 4 of Standard 62.1 provides more information on determining outdoor pollutants. Appendix F of Standard 62.1 includes a select list of standards and guidelines for outdoor particulate matter and ozone concentrations. For indoor pollutants, Appendix O of Standard 62.1 provides some publications that identify indoor pollutant emission rates for select space types.

How to Apply the IAQP

Section 6.3 in Standard 62.1-2025 outlines the requirements used to determine the breathing zone outdoor airflow (V_{bz}). The following steps are derived from those requirements.

Step 1: Identify the design compounds and particulate matter. Determine the design compounds and particulate matter ($PM_{2.5}$) starting with Table 1 (Standard 62.1-2025 Table 6-6). Additional compounds may be identified from one or more sources, such as an outdoor air quality survey performed in accordance with Standard 62.1 Section 4, or other unusual identified sources. These additional compounds should be assessed to determine whether a cognizant authority and concentration design limit are to be included in the analysis.

Step 2: Determine design compound emission rates and outdoor concentrations. The design team must determine emission rates for each design compound. One method to may include evaluating each floor, wall, and ceiling finish, along with furnishings and other items in the space that may emit design compounds. Alternatively, Appendix O of Standard 62.1 provides a list of publications and resources that can be used to determine design compound emission rates.

The outdoor air concentration of each design compound must also be established. Local air quality may be assessed through the outdoor air quality survey discussed in Standard 62.1 Section 4. Alternatively, data from air quality monitoring stations may be available from agencies, such as the United States of America's Environmental Protection Agency (U.S. EPA) through the National Ambient Air Quality Standards (NAAQS) program.

Step 3: Establish design limits. Standard 62.1 Table 6-6, reproduced as Table 1, includes concentration design limits for the listed design compounds. A combination of outdoor air and air cleaning system(s) can be designed to ensure design compound concentrations, mixtures of compounds, particulate matter, and any additional compounds (previously identified in step 2) are less than the corresponding concentration design limits.

The designer must establish whether the added compound has one or more mixture effects listed in Table 2 (Standard 62.1-2025 Table 6-7): upper respiratory tract irritation, eye irritation, and central nervous system depression.

For each mixture, compute the mixed exposure sum (E_m) and ensure the sum is less than 1.0.

$$E_m = \frac{C_1}{DL_1} + \frac{C_2}{DL_2} + \frac{C_i}{DL_i}$$

Where:

E_m = mixed exposure sun

C_i = mass-balanced model calculated airborne peak concentration for the i-th design compound

DL_i = design limit for the i-th design compound

The designer will need to revise the system if the mixed exposure sum is greater than 1.0. Example options include, but are not limited to, increasing the ventilation rate or increasing air-cleaning device efficiency for one or more design compounds. It may also be possible to reduce design compound source strengths by changing building materials, finishes, or indoor furnishings.

There are several exceptions to this requirement. First, benzene, phenol, and tetrachloroethylene are not included in the mixture calculation for upper respiratory tract irritation, eye irritation, and central nervous system depression.

Outside of the United States of America, the design limit for carbon monoxide, $PM_{2.5}$, or ozone may be dictated by local applicable ambient air standards or by the authority having jurisdiction (AHJ).

Finally, ammonia is only included for spaces with non-human animals.

Table 2. Mixtures of compounds and effects

Upper Repository Tract Irritation	Eye Irritation	Central Nervous System Depression
• acetaldehyde • acetone • ozone • xylene, total	• acetaldehyde • acetone • formaldehyde • ozone • xylene, total	• acetone • dichloromethane • toulene • xylene, total

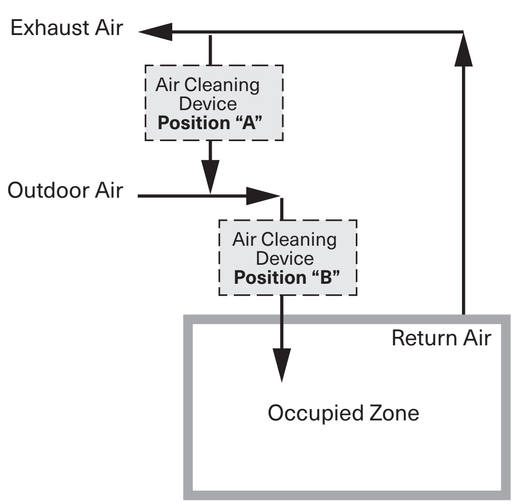
Step 4: Perform a Mass-Balance Analysis. A mass-balance analysis is performed to determine whether the initial minimum breathing zone outdoor air rate is sufficient to ensure each design compound concentration does not exceed its design limit and that each mixed exposure sum (E_m) does not exceed 1.0. Air-cleaning devices designed to reduce one or more design compounds are included in the analysis.

Addendum aa to Standard 62.1-2022 was released in 2025 and incorporated into the 2025 publication. This addendum adds a new requirement to evaluate air-cleaning devices for end-of-useful-life efficiency (EEOL) for formaldehyde and at least one nonpolar volatile organic compound, based on the expected total mass of contaminant captured. This allows the designer to understand how removal efficiency changes over time. System designs and ventilation rates may be selected based upon initial removal efficiency but may not comply with the design compound design limits as air-cleaning device efficiency degrades. Understanding and evaluating end-of-life useful efficiency allows the designer to decide whether the ventilation rate should be adjusted or if the air-cleaning device replacement interval should be adjusted while ensuring design limits and mixtures of compounds are not exceeded.

Informative Appendix G to Standard 62.1 includes mass balance equations for single-zone systems with an air-cleaning device located in the recirculated air stream (position "A") or mixed air stream (position "B") as shown in Figure 1 (adapted from Standard 62.1-2025 Figure G-1).

ASHRAE® has released a set of IAQP and VRP calculators for purchase in the ASHRAE Bookstore (available from www.ashrae.org/bookstore). The IAQP calculator can be used to evaluate both single- and multiple-zone systems.

Figure 1. Air-cleaning device locations



Step 5: Evaluate Objective and Perceived Indoor Air Quality then provide Design Documentation. Design documentation must be provided in accordance with Standard 62.1 Section 7.3. This includes performing an objective evaluation to measure design compounds and $PM_{2.5}$ in the completed building to ensure the design limits are not exceeded. For carbon monoxide, the peak concentration over an eight-hour period must not exceed the design limit. The standard provides requirements to support the evaluation, including a list of allowed compound test methods, measurement instrumentation accuracy and resolution requirements, and measurement points.

Next, a subjective evaluation must be conducted to demonstrate that zone outdoor airflow rates are "sufficient to ensure that 80 percent or more of the occupants exposed do not express dissatisfaction with the quality of the air" when evaluated. Standard 62.1 Informative Appendix O includes an example subjective evaluation that may be used.

The standard clarifies, in an exception, that both the objective and subjective evaluations are "not required for every substantially similar zone" provided the outdoor airflow rates ensure objective and subjective satisfaction. The standard further clarifies, in an informative note, that a ventilation zone is similar if it has the same occupancy category (from Standard 62.1-2025 Table 6-1), occupant density, zone air distribution effectiveness, and design zone primary airflow per unit area. In a collection of similar zones, the designer should evaluate the single zone that receives the least amount of ventilation air.

Finally, design documentation should be provided that includes test methodology, test results, and adjustments made to the design outdoor air rates.

Indoor Air Quality Procedure Example

Consider an example single-zone air handler that serves a classroom, designated as the "Classrooms (ages 5 to 8)" category. The single-zone, constant-volume air handler is designed to provide ventilation air while cleaning the return/outdoor air mixture. The design team is evaluating whether supplying 5 cfm of outdoor air per person [8.5 m^3/hr per person] will be adequate to maintain the design limits.

- Occupancy category: Classrooms (ages 5 to 8)
- Area: 1,000 ft^2 [92.9 m^2]
- Design zone population: 25 people
- Design supply airflow: 1,000 cfm [1,699 m^3/hr]
- Proposed ventilation rate: 5 cfm/person [8.5 m^3/hr·person]
- Zone air distribution effectiveness, cooling (E_z): 1.0
- Zone air distribution effectiveness, heating (E_z): 0.8

For comparison, the design outdoor air intake flow is calculated using the procedure outlined in the Standard 62.1 Ventilation Rate Procedure, applying the smaller zone air distribution effectiveness value:

$$V_{ot} = V_{oz} = \frac{V_{bz}}{E_z} = \frac{R_p \times P_z + R_a \times A_z}{E_z}$$

$$= \frac{10 \text{ cfm/person} \times 25 \text{ people} + 0.12 \text{ cfm/ft}^2 \times 1{,}000 \text{ ft}^2}{0.8}$$

= 463 cfm [786 m3/hr]

The design team has proposed to use 5 cfm/person [8.5 m^3/hr per person], which results in an outdoor air intake flow of 125 cfm [212 m^3/hr]:

$$V_{ot\_proposed} = 5 \text{ cfm/person} \times 25 \text{ people}$$

$$= 125 \text{ cfm } [212 \text{ m}^3\text{/hr}]$$

Step 1: Identify the design compounds and particulate matter. After evaluation, no additional design compounds were identified by the design team. The list of design compounds and particulate matter provided by Standard 62.1 will be evaluated (see Table 1).

Step 2: Determine design compound emission rates and outdoor concentrations. Design compound emission rates were sourced from the ASHRAE® IAQP spreadsheet calculator, available from the ASHRAE Bookstore, for classrooms (ages 5-8). Design compound outdoor concentrations were sourced from the ASHRAE Standard 62.1-2019 User's Manual. Outdoor concentrations may be provided in different unit systems and must be converted to micrograms per cubic meter for each compound (see Table 3).

Step 3: Establish design limits. The design limits and mixed exposure sums published in Standard 62.1 will be used. No additional design compounds were added to the analysis.

Step 4: Perform a mass-balance analysis. A mass-balance analysis is used to determine breathing-zone concentration of each design compound. The following equation was selected from Standard 62.1-2025 Table G-1 based on the use of a single-zone, constant-volume system with an optional air-cleaning device in position "B," which cleans the return/outdoor air mixture. The entire return/outdoor air mixture will be cleaned, so the recirculation flow factor is set to 1.0. Initially, the system is evaluated without air cleaning to determine acceptability, so the air-cleaning device efficiency term (E_f) is set to 0. This process is repeated for each design compound to determine the contaminant concentration in the zone.

$$C_{bz} = \frac{N + E_z V_{oz}(1-E_f)\, C_o}{E_z\,(V_{oz} + R V_r E_f)}$$

Where:

C_{bz} = breathing zone contaminant concentration (µg/m^3)

N = contaminant emission rate (µg/hr)

E_z = zone air distribution effectiveness (dimensionless)

V_{oz} = outdoor air flow rate (m^3/hr)

E_f = air cleaning device efficiency (percent)

C_o = outdoor contaminant concentration (µg/m^3)

R = recirculation flow factor through the air cleaning device (dimensionless)

V_r = recirculation air flow rate (m^3/hr)

First, the indoor contaminant emission rate (N) must be determined for each design compound. For this example, formaldehyde will be evaluated in detail. The emission rates are based on floor area.

$N_{formaldehyde}$ = floor area × emission rate = 92.9 m² × 59.2 µg/hr·m² = 5,499.9 µg/hr

Next, the single-zone, constant-volume breathing-zone contaminant concentration equation is independently evaluated for each design compound.

$$C_{bz,\ formaldehyde} = \frac{N + E_z V_{oz}(1-E_f)\ C_o}{E_z\ (V_{oz} + RV_r E_f)}$$

$$= \frac{5{,}499.9\ \mu g/hr + (0.8)(212.4\ m^3/hr) \times (1 - 0)(3.71\ m^3/hr)}{(0.8)(212.4\ m^3/hr + 1.0 \times 1{,}699\ m^3/hr \times 0)}$$

$$= 36.08\ \mu g/m^3$$

Table 3. Design compound details

Design Compound or $PM_{2.5}$	Design Limit	Molecular Weight	Indoor Emmision Rate [1]	Outdoor Air Concentration [2]	
				Parts per Billion	C_o, Micrograms per Cubic Meter
acetaldehyde	140 µg/m³	44.05 g/mol	16.5 µg/hr·m²	0.98 ppb	1.77 µg/m³
acetone	120,000 µg/m³	58.08 g/mol	37.7 µg/hr·m²	2.4 ppb	5.70 µg/m³
benzene	3 µg/m³	78.11 g/mol	0.21 µg/hr·m²	1.2 ppb	3.83 µg/m³
dichloromethane	400 µg/m³	84.93 g/mol	1.18 µg/hr·m²	0 ppb	0 µg/m³
formaldehyde	33 µg/m³	30.03 g/mol	59.2 µg/hr·m²	3.02 ppb	3.71 µg/m³
naphthalene	9 µg/m³	128.17 g/mol	0.38 µg/hr·m²	0.4 ppb	2.10 µg/m³
phenol	70 µg/m³	94.11 g/mol	6.25 µg/hr·m²	0.6 ppb	2.31 µg/m³
tetrachloroethylene	35 µg/m³	165.82 g/mol	0.14 µg/hr·m²	0.6 ppb	4.07 µg/m³
toluene	420 µg/m³	92.14 g/mol	3.84 µg/hr·m²	1.1 ppb	4.15 µg/m³
xylene, total	500 µg/m³	106.17 g/mol	3.13 µg/hr·m²	0.6 ppb	2.61 µg/m³
carbon monoxide	10,310 µg/m³ (9 ppm) [3]	28.01 g/mol	0 µg/hr·m²	0.98 ppb	1.12 µg/m³
$PM_{2.5}$ [4]	9 µg/m³	N/A	0 µg/hr·m²	N/A	5.7 µg/m³
ozone	137.7 µg/m³ (70 ppm) [5]	48.0 g/mol	0 µg/hr·m²	1.2 ppb	2.36 µg/m³
ammonia [6]	200 µg/m³	17.03 g/mol	0 µg/hr·m²	0 ppb	0 µg/m³

[1] The indoor emission rates are based on units of floor area.

[2] The following formula can be used to convert concentration from parts per billion to micrograms per cubic meter: concentration (µg/m³) = concentration (ppb) × molecular weight (g/mol) ÷ 24.45. For example, 0.98 ppb of acetaldehyde (molecular weight of 44.05 g/mol) is equal to 1.77 µg/m³ (concentration = 0.98 x 44.05 ÷ 24.45 = 1.77 µg/m³).

[3] Using the procedure described in Footnote 2, the design limit for carbon monoxide was calculated to be 10,310 µg/m³.

[4] A common conversion for particulate matter does not exist because the composition of liquids and solids varies. As a result, there is no uniform molecular weight. Particulate matter is typically reported in micrograms per cubic meter.

[5] Using the procedure described in Footnote 2, the design limit for ozone was calculated to be 137.7 µg/m³.

[6] For this analysis, there are no non-human animals in the space; therefore, ammonia was not evaluated, but the molecular weight is provided for reference.

[7] This whitepaper is written in the Imperial (I-P) unit system. The Standard 62.1 IAQP equations are evaluated in the International System of Units (SI).

This process is repeated for each design compound. Table 4 shows the calculated concentration for each design compound. The computed concentration values for benzene and formaldehyde exceed their respective design limits.

Table 4. Design compound summary

Design Compound or $PM_{2.5}$	Design Limit	Breathing Zone Contaminant Concentration, C_{bz}	Percent of Design Limit
acetaldehyde	140 µg/m³	10.79 µg/m³	7.7%
acetone	1,200 µg/m³	26.32 µg/m³	0.0%
benzene	3 µg/m³	3.95 µg/m³	**131.6%**
dichloromethane	400 µg/m³	0.65 µg/m³	0.2%
formaldehyde	33 µg/m³	36.08 µg/m³	**109.3%**
naphthalene	9 µg/m³	2.30 µg/m³	25.6%
phenol	10 µg/m³	5.73 µg/m³	8.2%
tetrachloroethylene	35 µg/m³	4.15 µg/m³	11.8%
toluene	300 µg/m³	6.25 µg/m³	1.5%
xylene, total	500 µg/m³	4.32 µg/m³	0.9%
carbon monoxide	10,310 µg/m³	1.12 µg/m³	0.0%
$PM_{2.5}$ [4]	12 µg/m³	5.70 µg/m³	63.3%
ozone	137.7 µg/m³	2.36 µg/m³	1.7%
ammonia	200 µg/m³	0 µg/m³	0.0%

Finally, the Mixed Exposure Sums (E_m) must be evaluated to determine whether any exceed 1.0.

$$E_m = \frac{C_1}{DL_1} + \frac{C_2}{DL_2} + \frac{C_i}{DL_i}$$

Where:

E_m = mixed exposure sun

C_i = mass-balanced model calculated airborne peak concentration for the i-th design compound

DL_i = design limit for the i-th design compound

For upper respiratory tract irritation, acetaldehyde, acetone, xylene, total, and ozone are input into the equation:

$$E_m = \frac{10.79\ \mu g/m^3}{140\ \mu g/m^3} + \frac{26.32\ \mu g/m^3}{120{,}000\ \mu g/m^3} + \frac{4.32\ \mu g/m^3}{500\ \mu g/m^3} + \frac{2.36\ \mu g/m^3}{137.7\ \mu g/m^3} = 0.103\ (10.3\%)$$

Table 5 provides a summary of the mixtures of compounds and the results of each calculation. The eye irritation category has resulted in a value greater than 1.0 due to the high concentration of formaldehyde.

Table 5. Mixtures of compounds summary

Upper Repository Tract Irritation	Eye Irritation	Central Nervous System Depression
• acetaldehyde • acetone • ozone • xylene, total	• acetaldehyde • acetone • formaldehyde • ozone • xylene, total	• acetone • dichloromethane • toulene • xylene, total
0.103 (10.3%)	1.196 (119.6%)	0.025 (2.5%)

The system must be revised to demonstrate compliance. Several options are available to the design team:

- **Install an air-cleaning device.** A gaseous air-cleaning device could be installed to remove design compounds from some or all the recirculated air (position "A") or the return/outdoor air mixture (position "B").
- **Increase the delivery of outdoor air for ventilation.** If the problematic design compound(s) concentration values are due to indoor emission, increased ventilation may be used to increase dilution and reduce the indoor concentrations.
- **Reduce the indoor design compound emission rate(s).** Different construction materials, finishes, and/or furnishings could be selected to decrease design compound emission rates.

Combining these design decisions and conducting a life-cycle cost analysis can help determine the best solution for IAQP-intended projects.

For this example, the design team will employ a gaseous air-cleaning device and particulate filter to reduce the concentration of design compounds and the resulting mixtures as a new alternative. This device will be installed into position "B" to clean the return/outdoor air mixture. The device has an initial efficiency rate of 60% when used with formaldehyde, and all return/outdoor air will pass through it, resulting in a recirculation flow factor of 1.0.

$$C_{bz,\ formaldehyde} = \frac{N + E_z V_{oz}(1 - E_f)\ C_o}{E_z\,(V_{oz} + RV_r E_f)}$$

$$= \frac{5{,}499.9\ \mu g/hr + (0.8)(212.4\ m^3/hr) \times (1 - 0.60)(3.71\ m^3/hr)}{(0.8)(212.4\ m^3/hr + 1.0 \times 1{,}699\ m^3/hr \times 0.60)}$$

$$= 5.84\ \mu g/m^3$$

Table 6 and Table 7 summarize the results of the new alternative using the air-cleaning devices. With the air-cleaning devices, all design compound concentrations are below their respective design limits, and the mixture sums are below 1.0.

To comply with the standard's end-of-useful-life efficiency (E_{EOL}) requirement, the designer may repeat the analysis using the air-cleaning device efficiency rates at the recommended device replacement interval. For example, if the air-cleaning device's E_{EOL} efficiency rate for formaldehyde is 20% compared to 60% at startup, re-evaluating at 20% results in a predicated indoor concentration of 13.59 ug/m^3 and an eye irritation mixed exposure sum of 43.4%. Because both values are below their respective limits, no change is necessary. However, if one or both limits were exceeded, the system ventilation rate may need to be increased and/or the replacement interval adjusted to ensure design limits are not exceeded.

Table 6. Design compound summary – air-cleaning device alternative

Compound or $PM_{2.5}$	Design Limit	Air-Cleaning Device Efficiency	Breathing Zone Contaminant Concentration, C_{bz}	Percent of Design Limit
acetaldehyde	140 µg/m^3	45%	2.17 µg/m^3	1.6%
acetone	1,200 µg/m^3	45%	5.16 µg/m^3	0.0%
benzene	3 µg/m^3	80%	0.12 µg/m^3	**4.0%**
dichloromethane	400 µg/m^3	55%	0.12 µg/m^3	0.0%
formaldehyde	33 µg/m^3	60%	5.84 µg/m^3	**17.7%**
naphthalene	9 µg/m^3	55%	0.21 µg/m^3	2.4%
phenol	10 µg/m^3	55%	0.83 µg/m^3	1.2%
tetrachloroethylene	35 µg/m^3	55%	0.35 µg/m^3	1.0%
toluene	300 µg/m^3	80%	0.40 µg/m^3	0.1%
xylene, total	500 µg/m^3	25%	1.22 µg/m^3	0.2%
carbon monoxide	10,310 µg/m^3	25%	0.28 µg/m^3	0.0%
$PM_{2.5}$ [4]	12 µg/m^3	10% [8]	2.85 µg/m^3	31.7%
ozone	137.7 µg/m^3	25%	0.59 µg/m^3	0.4%
ammonia	200 µg/m^3	0%	0.00 µg/m^3	0.0%

[8] Gaseous air-cleaning systems must include a particulate filter to reduce $PM_{2.5}$. This analysis assumes a MERV 8 filter. The efficiency value of 10% was selected to correspond with the filter's worst performance near its most penetrating particle size.

Table 7. Mixtures of compounds summary – air-cleaning device alternative

Upper Repository Tract Irritation	Eye Irritation	Central Nervous System Depression
• acetaldehyde • acetone • ozone • xylene, total	• acetaldehyde • acetone • formaldehyde • ozone • xylene, total	• acetone • dichloromethane • toulene • xylene, total
0.022 (2.2%)	0.199 (19.9%)	0.004 (0.4%)

Step 5: Evaluate Objective and Perceived Indoor Air Quality, then Provide Design Documentation. After system start-up and commissioning, the design team provides design documentation to the building owner or owner's agent. Both an objective and subjective evaluation are performed to ensure occupant satisfaction and design compounds do not exceed their respective design limits.

Conclusion

The IAQP can be used to demonstrate compliance with ASHRAE® Standard 62.1's ventilation requirements. This can be done with an analysis that evaluates design compounds and mixtures of compounds. Air-cleaning devices can be used to remove design compounds from the air and may potentially reduce the system ventilation rate.

Bibliography

ANSI/ASHRAE Standard 62.1-2025: Ventilation for Acceptable Indoor Air Quality. Available from www.ashrae.org/bookstore

ANSI/ASHRAE Standard 62.1-2019 User's Manual. Available from www.ashrae.org/bookstore

ASHRAE IAQP calculator. Available from www.ashrae.org/bookstore

Additional Resources

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