ASHRAE Guideline 42P

Public Review Draft

Enhanced Indoor Air Quality in Commercial and Institutional Buildings

Third Public Review (January 2023)
(Draft shows Proposed Independent Substantive Changes to Previous Public Review Draft)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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FOREWORD

Since 1999, ASHRAE Standard 62 and its subsequent publications and derivation to 62.1 has maintained a minimum standard for ventilation. As a minimum ANSI/ASHRAE standard intended for international Code adaptation, 62.1 could not mandate the abundance of evidence based improved indoor air quality practices that enhance indoor air quality.

Guideline 42 is intended for a global audience and will provide guidance to engineers, designers, hygienists, air quality practitioners, and building owners on measures which may be taken to enhance IAQ in commercial and institutional buildings. The sections in this document will provide a roadmap of varied best practices regarding buildings and systems that augment air quality within the built environment. This guidance is not intended to be all inclusive, nor does it guarantee enhanced ventilation, it will however, guide the audience through concepts, research, and processes that have been developed and implemented successfully when designed, installed, and operated effectively. It is also intended to be supplemental documentation to coincide with various other peer-based organization publications from ASHRAE, IAQA, EPA, AIHA, CDC, etc. It is intended that future versions of Guideline 42 will adapt to relevant research and technologies as they are tested and validated to improve indoor air quality.

The organization of Guideline 42 sections is purposeful. This guideline is structured to reflect the path of air, starting outside the building and moving through the building envelope, systems, and equipment and to the indoor space. Enhanced indoor air quality is a function of interacting building systems and occupant activity; therefore understanding the air path and rearranging subsections accordingly allows logical placement of any future revisions. Figure 1 and 2 below show how the Standard and Guideline sections are related.

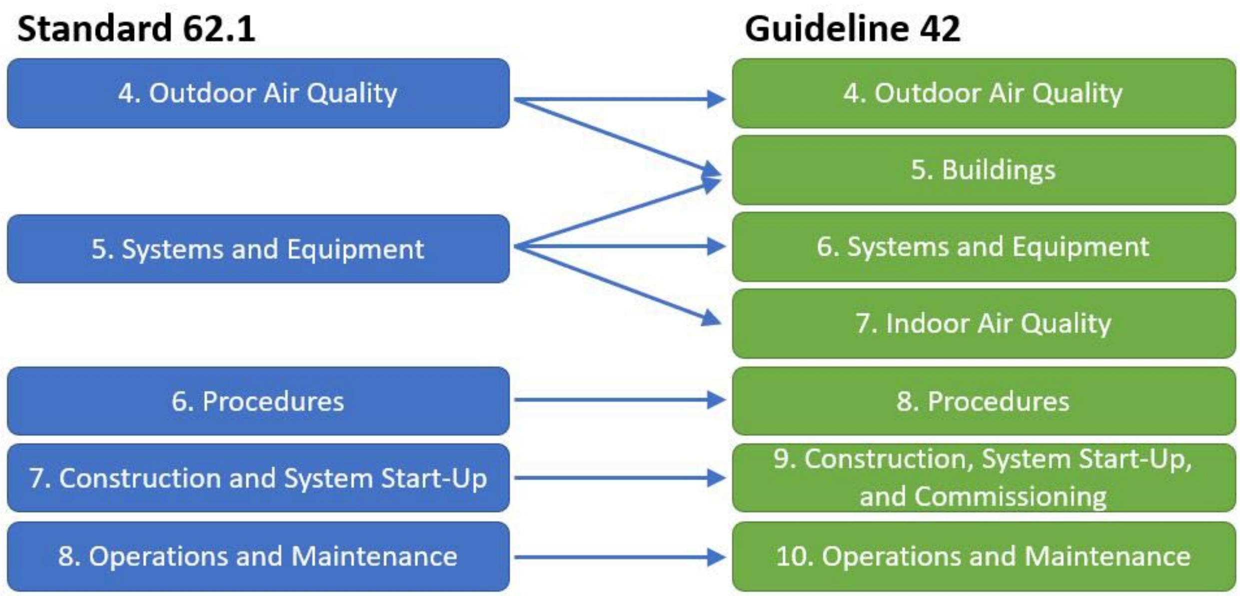


Figure 1: Diagram of sectional comparison with Standard 62.1

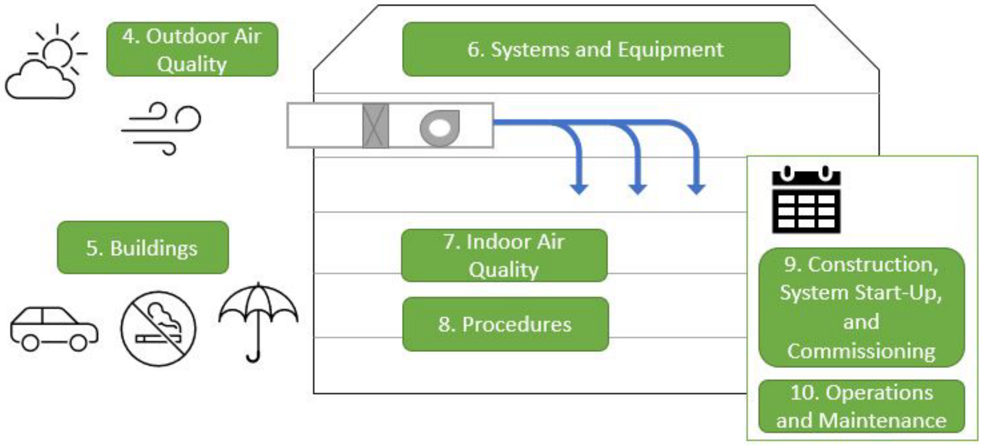


Figure 2 Sections of this document as related to a building

[Note to Reviewers: This public review draft makes proposed independent substantive changes to the previous public review draft. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

[…]

3. DEFINITIONS

(* Same definition as Standard 62.1 and ASHRAE Terminology)

air change rate: volume of air supplied to and removed from a space, via mechanical systems or through the building enclosure, per unit of time divided by the volume of the space, using the same units for volume such that the unit is inverse time.(*)

occupiable space: (1) any enclosed space inside the pressure boundary (including, but not limited to, all habitable spaces, toilets, closets, halls, storage and utility areas, and laundry areas) and intended for human activities. (2) that portion of the premises accessible to or occupied by people, excluding machinery rooms.(*)~~an enclosed space intended for human activities, excluding those spaces that are intended primarily for other purposes, such as storage rooms and equipment rooms, and that are only occupied occasionally and for short periods of time.~~

~~***residential occupancies:*** occupancies that are not classified as institutional by the authority having jurisdiction and that contain permanent provisions for sleeping. (*)~~

ventilation zone: any indoor area that requires ventilation and comprises one or more spaces with the same occupancy category, occupant density, zone air distribution effectiveness, and design zone primary airflow per unit area. (*)

[…]

6.2.1.2 Additional Guideline Information for Preventing Accumulation of Dirt and Debris. The accumulation of dust and debris in HVAC systems can result in microbial growth on these materials. Prevention of dirt and debris accumulation in the HVAC systems is discussed in Section 6.4.2 - *Options for Improved ~~Superior~~ Cleanliness and Access*; Section 7.3.1 – *Particles*; Section 9.1.3 - *Protective Aspects*; Section 9.2 - *System Start-up and Commission*; and Section 10.6.2.1.1 - *Air Cleaning Devices*.

[…]

6.3.2 Options for ~~Superior~~ Improved Cleanliness and Access. Access that encourages service is extremely important and hinged access doors are offered on most air handlers that are large enough to serve more than one space. True walk-in access is offered on most large air handlers.

Designing for MERV 13 or higher enhances IAQ by reducing indoor particle concentrations and helping with cleanliness, as discussed in Sections 7.3.1, 9.1.2 and 10.6.2.2 of this document.

ASHRAE Research Project RP-1738[24] showed Ultraviolet C (UVC) irradiation can be effective at reducing air pressure drop and restoring the heat transfer coefficient of cooling coils that had been previously fouled by biofilm. New equipment coils and drain pans can potentially be kept clean with similar application of UVC. If condensate drain pans contain standing water and cannot be modified to drain completely, UV lights can be installed to control biological water borne-pathogens as an option. Where the drain pans are also the floor of the AHU and are required for service access, they are designed to be walked on and not create depressions, dents, or low spots where condensate can pool and will not drain completely.

[…]

6.5.1 Indoor Humidity. Indoor humidity impacts occupant comfort and ASHRAE 55 is the best guide for comfort. The Berkeley Comfort Guide provides a useful tool for following ASHRAE 55 at comfort.cbe.Berkeley.edu. Indoor humidity also impacts health, indoor air quality, and building durability as shown in ASHRAE Research Project 1630 and Chapter 22 of the 2021 ASHRAE Handbook. Both discuss the benefits of humidity control. Many references such as this suggest keeping indoor humidity in a range between 30 and 60% RH, when the air temperature is held at or below 75°F (25°C) during the cooling season and at or above 68°F (20°C) during the heating season. However, although humidity is usually defined in terms of relative humidity, to avoid air quality problems and health risks associated with building dampness, caution is important with respect to the indoor dew point. During humid weather, when the outdoor dew point is above 60ºF (15ºC), ASHRAE Standard 62.1-2019 requires that the dew-point temperature of the indoor air (the absolute amount of humidity) must be limited to 60°F (15°C) or below, including unoccupied hours. Relative humidity is an imperfect control variable for dampness, as the RH measured in the air is rarely the same as relative humidity at the surface of materials. Surfaces are nearly always either warmer or cooler than the air. When surfaces are cooler, the RH at the surface is higher than the RH as measured in the air, which results in moisture absorption even though the air RH appears to be low enough to prevent such problems. Measuring the surface relative humidity of all indoor materials, contents and HVAC components is not practical. Instead, a 60°F (15°C) dew point limit helps reduce the absolute amount of indoor moisture that could lead to dampness and microbial growth. Note that ASHRAE 62.1 specifies minimum requirements, and a lesser dew point may be desirable. It is widely recognized that in humid climates, turning off air conditioning (dehumidification) for extended periods of time to save energy, such as in K-12 schools, can lead to moisture accumulation and mold growth.

During the heating season, the indoor dew-point temperature must be much lower than 60°F (15°C) to avoid condensation on cold window frames and to limit moisture absorption into the cool surfaces of materials in interstitial spaces. These problems occur most often overnight, when indoor air temperature is sometimes reduced to save heating energy in unoccupied spaces. Risks of condensation increase with higher indoor humidity, colder outdoor air temperature, more cold hours, and higher wind speed during those cold hours. The appropriate winter humidity limit depends on the design and installation of the building's exterior air barrier and insulation.

For winter design, meeting the minimum building enclosure requirements of ASHRAE Standard 90.1 allows greater latitude in setting the humidity limit. Standard 90.1 requires that the building be designed and tested to be air-tight. Air tightness minimizes cold air infiltration, helping to keep interstitial and indoor surfaces warmer and less likely to condense or absorb moisture. The standard further requires that exterior insulation be continuous, without thermal bridges that create the cold spots that lead to condensation and moisture absorption. In most climates, building envelopes that are compliant with the minimum requirements of ASHRAE Standard 90.1-2019 have little risk of moisture accumulation. Chapter 22, Humidifiers, of the Systems and Equipment ASHRAE handbook provides guidance on confirming this for a given application (see Sterling chart in Section 6).

[…]

6.9.2.1 Performance. Energy recovery devices can be independently certified for performance metrics from programs like AHRI 1060 or Eurovent. Independent certification validates energy recovery efficiency, air pressure drop, Outdoor Air Correction Factor (OACF), and Exhaust Air Transfer Ratio (EATR). Exhaust Air Transfer is the technical term used to define and quantify bulk air transfer from the exhaust to the supply airstream (discussed in Appendix C). The ASHRAE Epidemic Task Force (ETF) adopted a document developed by ASHRAE TC 5.5[28], which provides an in-depth exploration of recirculation concerns in Energy Recovery Systems. ~~Compared to other sources of recirculation, such as collocated ducts, zones with recirculation, and re-entrainment, ERVs are generally the smallest contributor.~~

[…]

7.3.1 Particles. Mechanical filtration is the most effective strategy for removing particles (of both inert and living materials) from the air stream. Filters with higher MERV ratings, as defined in ASHRAE Standard 52.2 and illustrated in Table 2, capture more particles, including those particles that have adverse health effects. For example, MERV 8 filters, the minimum filtration level required in Standard 62.1, remove at least 70% of particles 3.0-10 µm and 20% of particles 1.0-3.0 µm, but have no efficiency requirement for ~~are not rated for~~ particles 0.3-1.0µm in size. MERV 13 filters remove at least 90% of particles 3.0-10 µm in size, 85% of particles 1.0-3.0µm in size, and 50% of particles from 0.3-1.0µm in size. The designer can evaluate the impacts of more effective filtration in the HVAC system and compensate for any impacts on system performance. An alternate or temporary option is the use of in-room~~standalone~~ air cleaners or filtration devices, often using HEPA (high efficiency particulate air) filters, which exceed the performance of MERV-16. For information on selecting and using these alternate or temporary filtration options in existing buildings, see Section 10.6.2.2. When additional devices are used to remove pollutants, the reliability of the overall system cannot be adversely impacted by the failure of the filtration devices. Temporary systems are not a substitute for minimum design requirements. Proper cleaning and replacing any filters that are part of the electronic devices can provide a more reliable system.

[…]

7.3.3 Gases and Gaseous Mixtures. Gas-phase air cleaners are those used to remove ozone, volatile organic compounds and odors from the air.[52] ASHRAE 145.2 is a test method for measuring the performance of in-duct sorptive media gas-phase air-cleaning devices. Currently, this Standard is being updated to address other type of gas-phase air cleaners, including electronic air cleaners. ~~The technologies for removing gases and gaseous mixtures from supply air is rapidly evolving and there are no standardized methodologies for testing the efficacy and benefits of some of these technologies. Therefore,~~ ASHRAE's current position on air cleaning technologies is "All filtration and air-cleaning technologies should be accompanied by data documenting their performance regarding removal of contaminants; these data should be based on established industry test standards. If not available, scientifically controlled third-party evaluation and documentation should be provided." "Commissioning, active maintenance, and monitoring of filtration and air-cleaning devices are needed to ensure design performance. Additionally, filtration and air cleaners should be tested for extended durations to examine the possible change of performance in time of operation and the minimum period at which regular performance checks should be made. Information on these aspects is nearly nonexistent, and there are nearly no documents regulating and necessitating examination of long-term performance of filtration and air cleaning devices."[30] Additional information is available in the ASHRAE Position Document on Filtration and Air Cleaning, which is available on the ASHRAE website.

Ozone. Ground level ozone is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight. Ozone is chemically unstable and will decompose rapidly in air. A study of standard HVAC filters concluded that they may contribute between 22% and 95% of ozone removal with higher efficiency associated with dirty filters [P. Zhao et al, 2007] [34]. Another study showed that activated carbon filters provided a more durable removal effectiveness between 60% and 70% [W.J. Fisk et al, 2009] [35]. For design purposes, the use of activated carbon filters is the most reliable means to control ozone concentrations from outdoor sources.

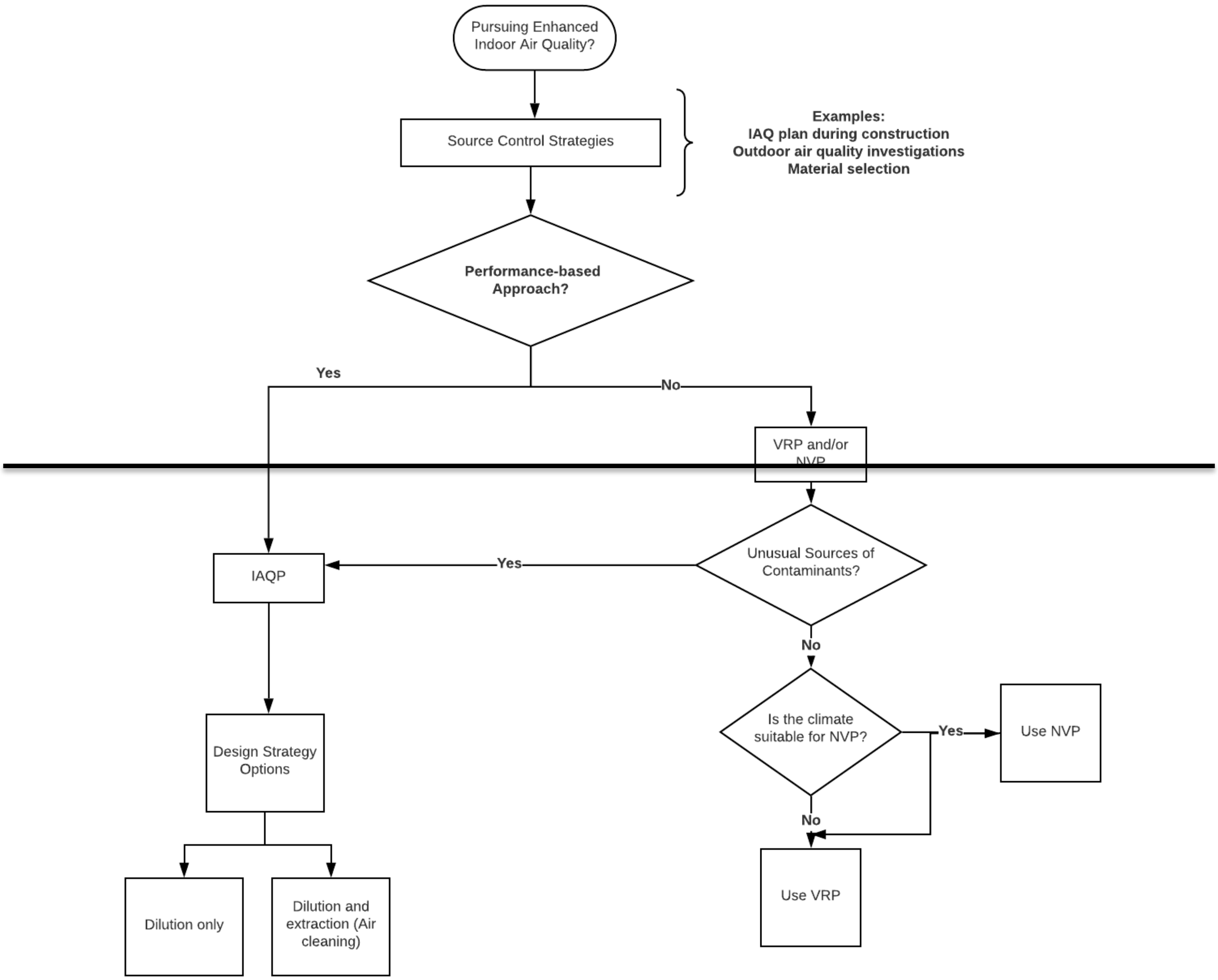
[…]

8.1.1 Determining the Optimal Procedure for Enhanced IAQ. Improved indoor air quality entails assessing sources of pollutants in the outdoor and indoor air, defining design targets for contaminants, and selecting strategies to achieve those targets. A single building can use any and all of the procedures. This section identifies potential strategies to improve indoor air quality:

- Ventilation Strategy
    - Efficiency of heating and cooling components serving the ventilation system.
    - Physical size of ventilation system.
    - Non-mandatory energy recovery requirements – In some cases, energy recovery can be eliminated with the installation of an air cleaning system and respective reduction in % of outdoor airflow on the supply air.
- Air Cleaning Strategy (if needed)
    - Capture ~~E~~efficiency of air cleaning system, as determined by third party tests based on ASHRAE Standard 145.2, ASHRAE Standard 52.2, ISO, or others
    - Airflow of the air cleaning system
    - Physical size of air cleaning system
- Source Control Strategy
    - Assessing outdoor concentrations of design compounds as determined by investigation of regional and local outdoor air quality in accordance with Section 4 – Outdoor Air Quality of this document and Section 4 – Outdoor Air Quality of ANSI/ASHRAE Standard 62.1 –

2019. Using dilution to maintain indoor air quality can increase contaminant concentrations within the indoor space if there are high concentrations of contaminants in the outdoor air, such as particulate matter (PM), ozone, carbon monoxide, and nitrogen dioxide, and addressing these contaminants before they can be introduced to the occupied space reduces occupant exposure.
  - IAQ Plan for design through construction, as described in Section 9 of this document, to address construction practices and material selection.
  - Limiting the introduction of contaminants during occupancy. Section 10 of this document addresses operations and maintenance considerations, such as cleaning and pest management procedures.
- Established IAQ Design Targets
  - Local standards and green certifications such as LEED, WELL, and others may employ their own design targets for enhanced indoor air quality.
  - Refer to ASHRAE Standard 62.1, including the testing requirements

Figure 9 provides a holistic design process flow for how procedures can be applied to arrive at an enhanced indoor air quality solution.


Pursuing Enhanced Indoor Air Quality?
Source Control Strategies
Examples:
IAQ plan during construction
Outdoor air quality investigations
Material selection
Performance-based Approach?
Yes
No
VRP and/or NVP
Unusual Sources of Contaminants?
Yes
IAQP
No
Design Strategy Options
Is the climate suitable for NVP?
Yes
Use NVP
No
Dilution only
Dilution and extraction (Air cleaning)
Use VRP

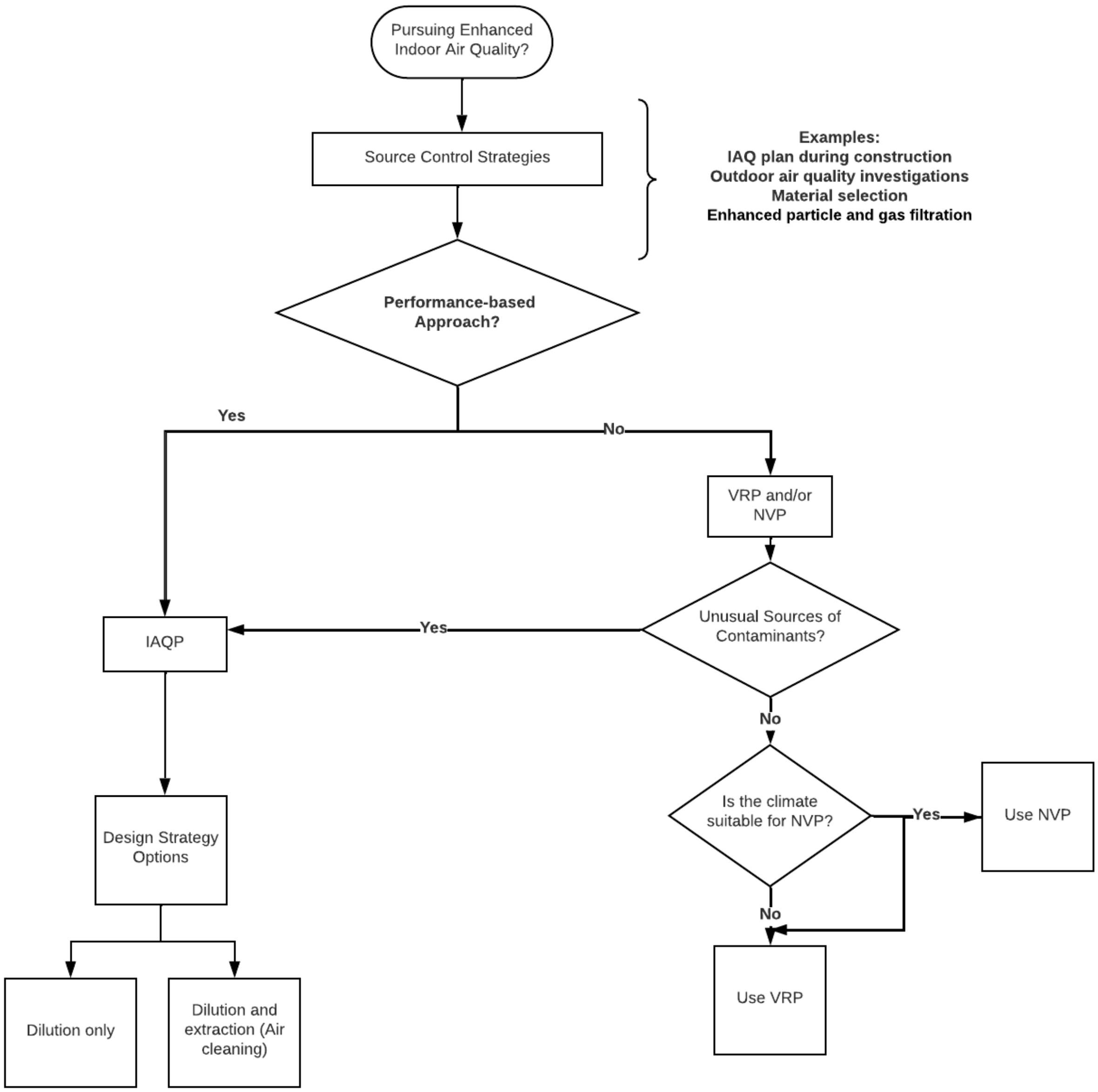


Figure 3 - Process Flow for Applying ASHRAE Standard 62.1 Procedures to Meet Indoor Air Quality Design Targets

Note: VRP: consider enhanced parameters such as higher zone airflow rates (Section 8.2) and/or additional source control. NVP: consider enhanced parameters such as larger openings, stack effect chimneys, OA entry tunnels (Section 8.4) and/or additional source control.

For each ventilation procedure (VRP, IAQP, and NVP), the following paragraphs outline strategies that can be used to enhance indoor air quality.

[…]

8.3 IAQ Procedure. The IAQP is a performance-based procedure. Rather than prescribing rates based on occupancy categories, rates are calculated based on contaminant source emission rates for a list of design compounds and indoor concentration limits provided in ASHRAE 62.1 using mass balance calculations. The IAQP allows designers to take credit for contaminant source control and removal measures, such as selection of low-emitting materials and operation of air cleaning devices. It is often used with air cleaning technology in an effort to adjust the total amount of ventilation to a space relative to the amount required by the VRP. Cautious designers understand that some air cleaner manufacturers have not published removal efficiencies for air pollutants. Additional information is available in the ASHRAE Position Document on Filtration and Air Cleaning, which is available on the ASHRAE website. Furthermore, any reduction in the outdoor air intake flow will cause elevated concentrations for any pollutants that cannot be controlled by source control and removal measures. Consideration of all potential contaminants in the space often results in enhanced indoor air quality.

8.3.1 Establishing Enhanced Indoor Air Quality Design Targets. Cognizant authorities such as USEPA, CA EPA, California Dept. of Public Health (CDPH), NIOSH, and the Committee for Health-Related Evaluation of Building Products (AgBB) publish concentration limits for compounds, many of which may be present in the indoor environment. Table 3 includes ~~sample~~ design compounds and respective design targets (or concentration limits) and cognizant authority, which have been incorporated into 62.1-2019. This table does not include every possible compound that may be present in indoor air, but rather includes a sufficient number and diversity of compounds such that control of the compounds is anticipated to result in air quality that meets ANSI/ASHRAE 62.1 Standard's definition of "acceptable."

Table 3 – Design Targets – Acceptable Indoor Air Quality

Compound or PM2.5	CAS Number	Cognizant Authority	Design Target
Acetaldehyde	75-70-0	Cal EPA CREL (June 2016)	140 μg/m³
Acetone	67-64-1	AgBB LCI	1,200 μg/m³
Benzene	71-43-2	Cal EPA CREL (June 2016)	3 μg/m³
Dichloromethane	75-09-2	Cal EPA CREL (June 2016)	400 μg/m³
Formaldehyde	50-00-0	Cal EPA 8-hour REL (2004)	33 μg/m³
Naphthalene	91-20-3	Cal EPA CREL (June 2016)	9 μg/m³
Phenol	108-95-2	AgBB LCI	10 μg/m³
Tetrachloroethylene	127-18-4	Cal EPA CREL (June 2016)	35 μg/m³
Toluene	108-88-3	Cal EPA CREL (June 2016)	300 μg/m³
1,1,1-trichloroethane	71-55-6	Cal EPA CREL (June 2016)	1,000 μg/m³
Xylene, total	108-83-3, 95-47-6, and 106-42-3	AgBB LCI	500 μg/m³
Carbon monoxide	630-08-0	USEPA NAAQS	9 ppm
PM2.5	-	USEPA NAAQS (annual mean)	12 μg/m³
Ozone	10028-15-6	USEPA NAAQS	70 ppb

Table 3 ~~can be used to develop an indoor air quality baseline~~ lists the required design compounds and PM2.5. When designing for enhanced indoor air quality, the designer may choose additional design compounds, such as CO_2, and more stringent design targets (concentration limits), such as a more stringent formaldehyde limit. Considerations for the selection of design compounds include:

1. Is a compound expected to be present in indoor air with reasonable frequency at concentrations relevant to (but not necessarily above) the design target?
2. Is there a design target that has been proposed by a cognizant authority for the proposed contaminants?
3. Does it seem reasonable to expect that product emissions rates may be available for the proposed contaminants?

In addition to the individual compounds, contaminant mixtures (two or more contaminants that target the same organ system) must also be considered such that the ratio of the concentration of each contaminant to its concentration limit shall be determined, and the sum of these ratios shall not be greater than one.

[…]

10.5.5.2 Ambient (Outdoor Air Quality) Hazard Events. Wildfires, chemical attack, and high pollutant levels all contain hazardous particulates that can be irritating and hazardous to occupant health. ASHRAE Guideline 44P, *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events,* will include a framework for building operations under these hazardous conditions. When sources are beyond safe levels (NAAQS), shutting off outdoor air intakes may offer an acceptable means of protecting occupants. If a building is designed and operating with reduced ventilation air, then systems and appropriate filtration <u>for particles and gases should</u> ~~could~~ be in place. Evaluation of these systems should be part of the emergency operations plan. In other cases, where ventilation is provided and calculated based on prescriptive path or exhaust requirement, the overall mechanical systems and building balance should be considered. For example, just shutting the OA intakes at the units could cause the building to go into negative pressure if all the exhaust fans are left running. Therefore, causing the outdoor air to infiltrate through building openings. Whether a Building Lockdown or “Emergency Ventilation OFF” procedure is fully automated through the building automation system or a series of detailed steps for operations staff to follow, it should be documented, periodically tested, and shared with appropriate personnel. If a regional area is more prone (nonattainment) or the building is in a sensitive area prone to fires or other particulates, selection of filtration means is critical. In these cases, ventilation calculation and operation procedures should be evaluated frequently or as needed to ascertain the safest operation while maintaining enhanced air quality[8].

10.5.5.3 Infectious Disease Events. Infection control is not a goal of ASHRAE Standard 62.1, and typical commercial buildings do not have the design and operation features of a healthcare building designed to meet ASHRAE Standard 170. Some infectious diseases spread particularly well in indoor environments. ASHRAE’s Environmental Health Committee published Emerging Issue Briefs from 2010, *Biological Agents in Context of Globalization and Pandemic Influenza and Airborne Transmission*[47]*,* and from 2020, *Pandemic COVID-19 and Airborne Transmission.*[48]A Position Document on Infectious Aerosols in 2020[49] summarize the challenges and a general building systems response to an airborne infectious disease. For COVID-19 specifically, the Epidemic Task Force developed Core Recommendations for Reducing Airborne Infectious Aerosol Exposure[50] <u>that are based on the concept that ventilation, filtration, and air cleaners can be combined flexibly using an equivalent air change approach to achieve exposure reduction goals. The Core Recommendations are</u> summarized as: 1. Follow all public health guidance; 2. Use <u>a combination of</u> ventilation, filtration, and air cleaning; 3. Promote air mixing to increase dilution; 4. Maintain basic HVAC system operating requirements; 5. Verify that all HVAC systems are functioning as designed.

[…]

10.6.2.1 Inspection of Systems. It is best practice to incorporate inspection of systems as a PM. If the

CMMS or available PM documents do not include specific inspection requirements and steps, refer to O&Ms for inspection and observation details. The PM may also include any necessary adjustments. Whether performing the inspection with in-house labor or outside contractor, personnel should be trained and familiar with the equipment they are looking at, wear the appropriate PPE and understand the safety precautions necessary, such as de-energizing the unit. Typical inspections on an air handling unit will include confirming filters are properly installed on the rack, sealing gaskets intact and no by-pass airflow, filters are clean, the condensate pan is draining, no bio-growth, fan is operational, doors close tight, and gaskets are in place. Gauges should be checked to be reading within specified range. The inspection can go into more detail, but it is important to document any changes from previous inspections which could include noises, housekeeping, and unit performance. These changes should be evaluated and discussed with appropriate personnel. Templates of common inspections can be found in Facility Maintenance Standards such as ASHRAE Standard 180 and NFPA 25 or found online. These standards and other guidance can be built into the CMMS. Knowledge of the individual components as well as the interactions of systems will be useful in identifying the probable cause of a potential system failure or other problematic system issues such as incorrect pressurization.

10.6.2.2 Air Cleaning Devices. The ASHRAE Position Document on Filtration and Air Cleaning (2021)[30] discusses the health consequences of filtration and air cleaning and provides a detailed literature review of research and current technologies. This section will discuss air cleaning considerations in existing buildings.

Mechanical filters are the most common and effective air cleaning device for commercial and institutional buildings. For enhanced IAQ, a filter rated at MERV 13 or higher should be used. However, existing HVAC units may only have a 1" (or smaller) filter rack. If this is the case, a headered filter that fits in the rack can offer lower pressure drop with sufficient room behind the filter rack. Many operators are concerned about insufficient static pressure to accommodate a higher level MERV filter, but there is wide variation in pressure drop among filters with the same rating. Some MERV-13 filters have the same, or lower, initial pressure drops than some MERV-8 filters. By monitoring filter pressure drop during use and changing filters when the final pressure drop of the original filter is reached, higher filtration can be achieved, with the tradeoff of increased filter changes. This also mitigates any potential energy penalty of a filter upgrade, by operating within the same pressure parameters. Central HVAC units may also be retrofit with a prefilter at a unit intake or upstream in ductwork where more space is available. Prefilters can capture return air, ventilation air, or both.

If a higher level of filtration cannot be used in the central HVAC system, or if some areas require additional particle source control or removal, in-room HEPA filter devices, in the occupied space or a return plenum, can provide very effective air cleaning. The Association of Home Appliance Manufacturers (AHAM) tests and verifies the clean air delivery rate (CADR) of air cleaners of all types at three different particle size ranges: tobacco smoke (0.09 um to 1.0 um), dust (0.5 um to 3.0 um), and pollen (0.5 um to 11.0 um).[51] Typical air cleaning devices available on the market today have CADRs on the order of 50-500 cfm per device. The rule-of-thumb for sizing is to select a device with a CADR at least two-thirds of the room's area; higher CADR devices will remove particles at a faster rate. CADR impacts are additive, and multiple smaller devices can be used together, a useful strategy for large areas or where noise levels are a concern. The Epidemic Task Force created a 2-page guide[52] for adding an in-room air cleaner to reduce the concentration of infectious aerosols, including a sample calculation for sizing CADR. One study found that aerosol concentration reduced by over 90% within 30 minutes in a classroom with four in-room HEPA filter devices, for 5.5 clean air changes per hour; drastic particle reductions occurred at all particle sizes and evenly throughout the room (Curtius et al, 2021)[53].

Gas-phase filters may be used to remove gaseous contaminants such as ozone, formaldehyde, and other VOCs. Gas-phase filters may be used to achieve enhanced IAQ with the IAQ Procedure to replace a portion of the outside air requirement under the VRP with cleaned indoor air to achieve a more cost effective and energy efficient ventilation system design without compromising IAQ. When using gas-phase filters with the IAQ Procedure, it is important to use only filters with published removal efficiencies.

Supplemental air cleaning technologies not based on mechanical filtration alone require close examination. Air cleaning processes based on chemical reactions in the breathing zone require careful evaluation of potential byproducts and their levels, including those from incomplete reactions, as those byproducts may be contaminants. ANSI/ASHRAE Standard 62.1 requires air cleaning devices to be listed and labeled in accordance with UL2998 in ANSI/ASHRAE Standard 62.1. Owners of these devices should set up an operations and maintenance program to verify performance and proper operation, based on the manufacturer's requirements and additional industry recommendations.

The Position Document on Filtration and Air Cleaning and the Epidemic Task Force's summary of Filtration and Disinfection[54] technologies ~~provide~~discuss the available information on devices that use ~~bipolar ionization, corona discharge, needlepoint ionization, and other ion or reactive oxygen air cleaners.~~ reactive air cleaner technology.

Supplemental air cleaning devices do not eliminate the need for outdoor air unless they can be applied in full compliance with the IAQ Procedure. The Indoor Air Quality (IAQ) Procedure of ASHRAE Standard 62.1 allows that filtration and air cleaning, together with recirculation, can be used as a substitute for a portion of outdoor air ventilation.[55,56] Decreasing ventilation air at the expense of occupant health is not a viable tradeoff. At the same time, outdoor air quality should be considered when increasing ventilation to avoid bringing outdoor-generated pollutants inside. The ASHRAE Position Document on Filtration and Air Cleaning (2021) states "One consideration that warrants discussion is that the overlap between contaminants with indoor sources versus those with external (outdoor) sources is relatively small and the use of increased ventilation air without filtration and air cleaning can result in substituting one set of contaminants (internally generated) with a different set (externally generated) with any associated health effects. This is especially important in regions that do not meet national or regional air quality standards for one or more criteria pollutants (i.e., ozone, PM10, PM2.5) or where there may be local sources of air pollution." ~~Limited data exist on the impact of gas-phase air cleaning as an alternative to ventilation [ASHRAE Position Document on Filtration and Air Cleaning] [30]. Air cleaning devices that generate ozone are not allowed under ANSI/ASHRAE Standard 62.1, as ozone causes adverse health effects even at low levels.~~

Air Handlers, Fans. Using direct driven equipment eliminates fan belts, which can deteriorate and introduce belt pieces to the air stream when they fail. Retrofit evaluations can be completed by the OEM or experienced design professional.

[…]

References cited in the text of the guideline will be renumbered accordingly to reflect the changes in Section 11.

11. REFERENCES

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[…]

(This appendix is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

INFORMATIVE APPENDIX A
HEALTH IMPACTS OF AIR POLLUTANTS

Control Measures

Managing the levels of indoor air pollutants relies on three factors: source control, dilution ventilation, and air cleaning. Source control is preferred where possible since the pollutant that is avoided will be the easiest to control. The design phase is the most effective time to select and specify low-emitting materials to implement source control. Reduce the source before it is brought into the building.

VOC levels can be managed using ventilation by applying the IAQ procedure in ANSI/ASHRAE Standard 62.1 if emission rates are known. Multiple certification schemes for low emitting materials, furnishings, and equipment have been developed in recent decades. These include programs provided by industry trade groups, state regulatory agencies, multinational regulatory agencies, and independent third-party programs. These programs set maximum emission rate limits for numerous compounds. These emission rate limits are publicly available and can be used in the IAQ procedure as a 'worst-case' scenario for products that meet the criteria of the respective programs. Examples of these programs are included in Informative Appendix D of ANSI/ASHRAE Standard 62.1.

Air cleaning is the third option for managing pollutant levels, including VOCs, for acceptable IAQ. Where source control of VOCs is not practical, dilution ventilation may be reduced if VOC emission rates are known or can be applied based on studies for similar space types and if the removal efficiency of gas phase air cleaners is known. As mentioned above, emission rates for many VOCs can be inferred from maximum allowable emission rates in certification programs. ~~The removal efficiencies of some gas phase air cleaning devices are known and the IAQ procedure is already applicable to those devices.~~ Removal efficiency of some gas-phase cleaning devices is known. As removal efficiency of others~~the removal efficiency of additional gas phase cleaning technologies~~ become available, these can then be used with the IAQ procedure as well.

[…]

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INFORMATIVE APPENDIX C
CARRYOVER IN ENERGY RECOVERY UNITS

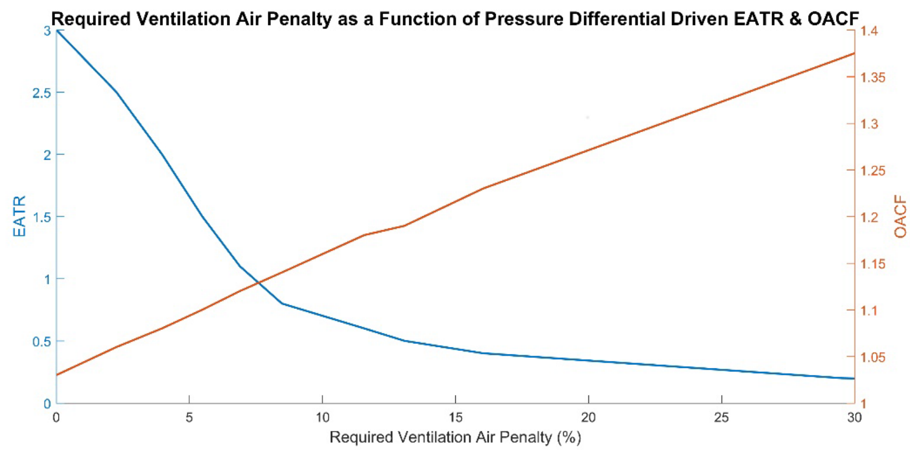

Figure C-3 – How Pressure Differential Increases Gross Ventilation Airflow

(ASHRAE Journal Article, November 2017, IAQ & Energy Impact of Exhaust Air Transfer Ratio – Figure 3)

Figure C-3 demonstrates the increase in fan operation costs as EATR is decreased, and how these costs are due to the increase in OACF because of the difference in pressure across the supply/exhaust interface. To avoid unnecessary expenses, designers and manufacturers can influence system design to optimize EATR / OACF to a point that optimizes fan energy.

EATR can be minimized by:

1. Using plate frame or other “almost 0” EATR device.
2. Optimizing the OA / EA pressure difference [EAF preferred to RAF, minimize OA path APD]
3. Specifying independently certified low EATR components at the application pressure.
4. Run around loops can be designed to eliminate cross contamination

[…]

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INFORMATIVE APPENDIX E
INFORMATIVE REFERENCES AND BIBLIOGRAPHY

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