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Overview of ASHRAE Standard 62.1-2010

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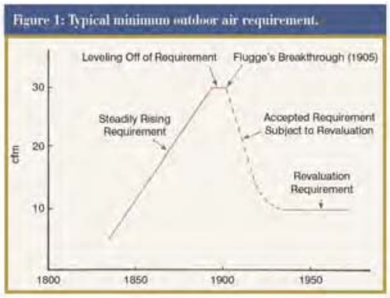
Hall of Fame

Published in June 1970 ASHRAE Journal

History of the Changing Concepts In Ventilation Requirements

1970

Figure 1: Typical minimum outdoor air requirement.

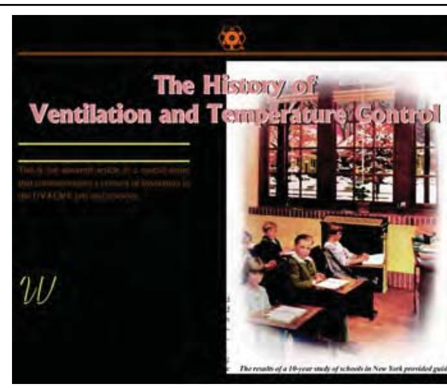


1970

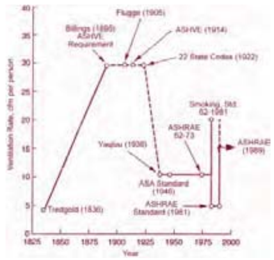
The importance of air space per person is illustrated by the fact that ASHRAE requires a mere 7 cfm when the air space is 500 cu ft per person, but requires an increase to 25 cfm when the air space is 100 cu ft per person.[12] These design parameters are based on work carried out by Yaglou, Riley and Coggins in 1936.

1973

- ASHRAE Standard 62-73
- Offices
  - Minimum 15, Recommended 15-25
- Schools/Classrooms
  - Minimum 10 Recommended 10-15



1999 Janssen Article



1980's Research

- W. Cain, et. al (1983) and P.O. Fanger, et. al, (1983) published results of new studies that generally confirmed Yaglou's early results. Cain working at Yale University and Fanger at the Technical University of Denmark both agreed that 15 cfm (7.5 L/s) of outdoor air was needed to dilute occupant odors to a concentration acceptable to 80% (20% dissatisfied) of the "visitors" entering an occupied space. These new data did not, however confirm Yaglou's dependence on air space. Thus, Standard 62-1989 adopted 15 cfm (7.5 L/s) per occupant of outdoor air as the minimum.

2002 Research Report

- Ventilation Rates and Health – Seppanen, Fist, Mendell
- Literature Review
- "The available data indicate that occupant health and perceived IAQ will usually be improved by avoiding ventilation rates below 20 cfm per occupant and indicate that further improvements in health and perceived IAQ will sometimes result from higher ventilation rates up to 40 cfm per person."
- "The limitations in the existing data point to several research needs."

2006 Research Report

Research Report on

Effects of HVAC On Student Performance

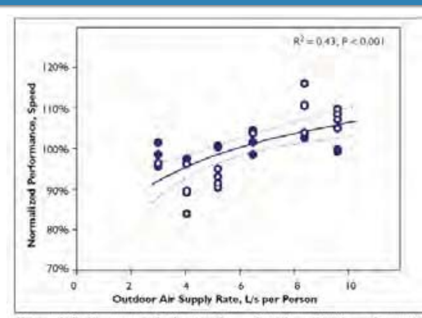


Figure 3: Performance of schoolwork as a function of outdoor air supply

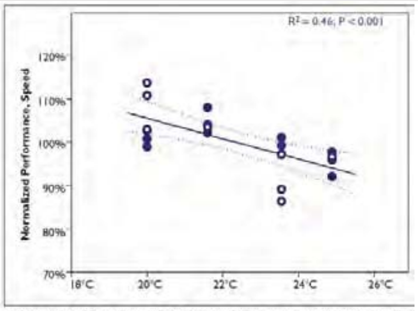


Figure 4: Performance of schoolwork as a function of classroom temp.

ASHRAE 62.1-2010 Overview Outline

- Title, purpose and scope (Sections 1,2)
- Applicability and definitions (Sections 3,G)
- Air quality requirements (Sections 4,5,6)
- Building, systems and equipment requirements (Sections 5,7,8)
- Air quantity requirements (Section 6)

Ventilation for Acceptable Indoor Air Quality – Purpose

- **1.1** The purpose of this standard is to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects.
- **1.2** This standard is intended for regulatory application to new buildings, additions to existing buildings, and those changes to existing buildings that are identified in the body of the standard.
- **1.3** This standard is intended to be used to guide the improvement of indoor air quality in existing buildings.

Ventilation for Acceptable Indoor Air Quality – Scope

- **2.1** This standard applies to all spaces intended for human occupancy except those within single-family houses, multifamily structures of three stories or fewer above grade, vehicles, and aircraft.
- **2.2** This standard defines requirements for ventilation and air-cleaning system design, installation, commissioning and operation and maintenance.
- **2.3** Additional requirements for laboratory, industrial, health care and other spaces may be dictated by workplace and other standards, as well as by the processes occurring within the space.

Ventilation for Acceptable Indoor Air Quality – Scope

- **2.9** Acceptable indoor air quality may not be achieved in all buildings meeting the requirements of this standard for one or more of the following reasons:
  - a. because of the diversity of sources and contaminants in indoor air;
  - b. because of the many other factors that may affect occupant perception and acceptance of indoor air quality, such as air temperature, humidity, noise, lighting and psychological stress;
  - c. because of the range of susceptibility in the population; and
  - d. because outdoor air brought into the building may be unacceptable or may not be adequately cleaned.

Definitions

- ***Acceptable indoor air quality:*** air in which there are no known **contaminants** at harmful **concentrations** as determined by **cognizant authorities** and with which a substantial majority (80% or more) of the people exposed **do not express dissatisfaction.**

Definitions

- ***Zone:*** one occupied space or several occupied spaces with similar occupancy category (see Table 6.1), *occupant density*, *zone air distribution effectiveness* (see Section 6.2.1.2), and *zone primary airflow* (see Section 6.2.4.1) per unit area.
- **Note:** A ventilation zone is not necessarily an independent thermal control zone; however, spaces that can be combined for load calculations can often be combined into a single zone for ventilation calculations.

Ventilation terms

- Vbz – Breathing zone outdoor airflow
  - ***breathing zone:*** the region within an occupied space between planes 3 and 72 in. (75 and 1800 mm) above the floor and more than 2 ft (600 mm) from the walls or fixed air-conditioning equipment.
- Voz – Zone outdoor airflow
  - Air that must be supplied to a ventilation zone
- Vot – Outdoor air intake flow
  - Air that must be supplied to the system

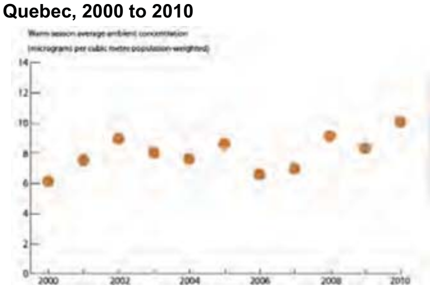
Air Quality Requirements

- Outdoor air quality (Section 4)
- Outdoor air intakes (5.6)
- Air classification and recirculation (5.17)
- Buildings containing ETS areas (5.18)
- Outdoor air treatment (6.2.1)

Outdoor Air Quality

- Regional air quality
- Local air quality
- Documentation

Fine particulate matter concentrations, southern Quebec, 2000 to 2010



Outdoor Air Treatment

- **6.2.1 Outdoor Air Treatment.** If outdoor air is judged to be unacceptable in accordance with Section 4.1, each ventilation system that provides outdoor air through a supply fan shall comply with the following sections:
  - Particulate matter
  - Ozone
  - Other outdoor contaminants

Particulate Matter $PM_{2.5}$

- **6.2.1.2 Particulate Matter smaller than 2.5 micrometers ($PM_{2.5}$).** When the building is located in an area where the national standard or guideline for $PM_{2.5}$ is exceeded, particle filters or air cleaning devices shall be provided to clean the outdoor air at any location prior to its introduction to occupied spaces. Particulate matter filters or air cleaners shall have a Minimum Efficiency Reporting Value (MERV) of 11 or higher when rated in accordance with ASHRAE Standard 52.2.

Ozone

- 6.2.1.3 Ozone. Air-cleaning devices for ozone shall be provided when the most recent 3-year average annual fourth-highest daily maximum 8-hour average ozone concentration exceeds 0.107 ppm (209 μg/m3) .
- Such air-cleaning devices shall have a minimum volumetric ozone removal efficiency of 40%.

Outdoor Air Intakes

- Location – Table 5.1
- Appendix F (informative)
- Rain entrainment
- Rain intrusion
- Snow entrainment

Air Classification and Recirculation (5.17)

- **Class 1:** Air with low contaminant concentration, low sensory-irritation intensity, and inoffensive odor.
- **Class 2:** Air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors. Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes.

Air Classification and Recirculation (5.17)

- **Class 3:** Air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor.
- **Class 4:** Air with highly objectionable fumes or gases or with potentially dangerous particles, bio-aerosols or gases, at concentrations high enough to be considered harmful.

Recirculation Limitations

- Class 1 air may be recirculated or transferred to any space.
- Class 3 air may be recirculated within the space of origin. Class 3 air shall not be recirculated or transferred to any other space.
- Class 4 air shall not be recirculated or transferred to any space nor recirculated within the space of origin.

Recirculation Limitations Class 2

- **5.17.3.2.1** Recirculation of Class 2 air within the space of origin shall be permitted.
- **5.17.3.2.2** Recirculation or transfer of Class 2 air to other Class 2 or Class 3 spaces shall be permitted, provided the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space.

Recirculation Limitations Class 2

- **5.17.3.2.3** Transfer of Class 2 air to toilet rooms shall be permitted.
- **5.17.3.2.4** Recirculation or transfer of Class 2 air to Class 4 spaces shall be permitted.
- **5.17.3.2.5** Class 2 air shall not be recirculated or transferred to Class 1 spaces.
- **5.17.2.3** Ancillary Spaces. Re-designation of Class 1 air to Class 2 air shall be permitted for Class 1 "spaces that are ancillary to Class 2 spaces".

Building Systems and Equipment Requirements

- Design requirements
- Construction and start-up requirements
- Operations and maintenance requirements
- Documentation

Design – Air Requirements

- Ventilation air distribution (5.2)
- **5.4 Ventilation System Controls.** Mechanical ventilation systems shall include controls, manual or automatic, that enable the fan system to operate whenever the spaces served are occupied. The system shall be designed to maintain the minimum outdoor airflow as required by Section 6 under any load condition.

Design – Moisture Control

- Dehumidification systems (5.10)
  - Applies to air conditioning systems
  - Design for ≤65% RH @ dehumidification design condition
  - Net exfiltration required for building
- Drain pans (5.11)
- Humidifier and water spray systems (5.13)
- Building envelope and interior surfaces (5.15)
  - Water intrusion
  - Vapor control and condensation

Construction and Startup (7) Operations and Maintenance (8)

- Air requirements
- Water control
- Dirt/mold control

Documentation Requirements

- Outdoor air quality investigation (4.3)
- Air balancing and assumptions re: air distribution and ventilation rates (5.2)
- Classification of air other than table values (5.17)
- Other outdoor air contaminants (6.2)
- IAQ procedure (if selected) (6.3)
- Design criteria and assumptions (6.4)
- Provided to owner – drawings, T&B, controls info., O&M manual, design criteria (7.2)
- O&M manual requirements (8.2)

Design Procedures

- **6.1 General.** The Ventilation Rate Procedure, the IAQ Procedure, and/or the Natural Ventilation Procedure shall be used to meet the requirements of this section.
- **Note:** Although the intake airflow determined using each of these approaches may differ significantly because of assumptions about the design, any of these approaches is a valid basis for design.

Air Quantity Requirements

- Ventilation rate procedure (6.2)
  - Single-zone systems
  - 100% outdoor air systems
  - Multiple-zone recirculating systems
- Indoor air quality procedure (6.3)
- Natural ventilation procedure (6.4)
- Exhaust ventilation (6.5)

Ventilation Rate Procedure – Breathing Zone Outdoor Airflow

Vbz = RpPz + RaAz (6-1)

where*:*

- *Rp* = outdoor airflow rate required per person as determined from Table 6-1
- *Pz* = *zone population:* the number of people in the ventilation zone during typical usage
- *Ra* = outdoor airflow rate required per unit area as determined from Table 6-1
- *Az* = *zone floor area:* the net occupiable area of the ventilation zone , ft^2, (m^2)

Table 6-1

- ***Rp*, *Ra***
- Default Occupant Density
- Air Class
- This table is not valid in isolation; it must be used in conjunction with the accompanying notes.
- One Related Requirement: The rates in this table are based on all other applicable requirements of this standard being met.

Ventilation Rate Procedure – Zone Outdoor Airflow

Voz = Vbz/Ez (6-2)

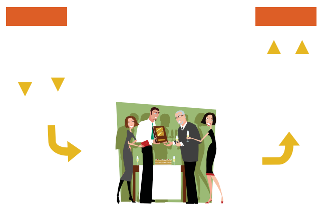
- (*Ez*) The zone air distribution effectiveness shall be no greater than the default value determined using Table 6-2 [part of table shown below]

TABLE 6-2
Zone Air Distribution Effectiveness

Air Distribution Configuration	E_z
Ceiling supply of cool air	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air at least 8°C (15°F) above space temperature and ceiling return.	0.8

Zone Air Distribution Effectiveness

$Ez = 1.0$

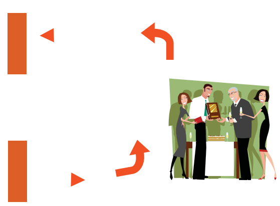


Zone Air Distribution Effectiveness

$Ez = 0.8$

Zone Air Distribution Effectiveness

$Ez = 0.5$



Ventilation Rate Procedure – Outdoor Airflow Single Zone

$Vot = Voz$ (6-3)

- **Single-Zone Systems.** For ventilation systems wherein one or more air handlers supply a mixture of outdoor air and recirculated air to only one ventilation zone, the *outdoor air intake flow (Vot)* shall be determined in accordance with Equation 6-3.

Ventilation Rate Procedure – Outdoor Airflow – 100% OA

$Vot = \Sigma_{all\ zones}\ Voz$ (6-4)

- **100% Outdoor Air Systems.** For ventilation systems wherein one or more air handlers supply only outdoor air to one or more ventilation zones, the *outdoor air intake flow (Vot)* shall be determined in accordance with Equation 6-4.

Multiple Zone Recirculating Systems

- For ventilation systems wherein one or more air handlers supply a mixture of outdoor air and recirculated air to more than one ventilation zone, the *outdoor air intake flow (Vot)* shall be determined in accordance with Sections 6.2.5.1 through 6.2.5.4.
- **6.2.5.4 Outdoor Air Intake.** The design outdoor air intake flow *(Vot)* shall be determined in accordance with Equation 6-8:

  $Vot = Vou / Ev$ (6-8)

Multiple Zone Recirculating Systems – Uncorrected OA Intake

6.2.5.3 Uncorrected Outdoor Air Intake. The *uncorrected outdoor air intake (Vou)* shall be determined in accordance with Equation 6-6:

$$Vou = D^* \sum_{all\ zones} RpPz + \sum_{all\ zones} RaAz \quad (6\text{-}6)$$

Multiple Zone Recirculating Systems

- The *occupant diversity* ratio *(D)* shall be determined in accordance with Equation 6-7 to account for variations in population within the ventilation zones served by the system.

$$D = Ps / \sum_{all\ zones} Pz \quad (6\text{-}7)$$

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

Multiple Zone Recirculating Systems – System Ventilation Efficiency

- **6.2.5.2 System Ventilation Efficiency.** The *system ventilation efficiency (Ev)* shall be determined in accordance with Table 6-3 or Normative Appendix A.

TABLE 6-3
System Ventilation Efficiency

Max (Z_p)	E_V
≤ 0.25	0.9
≤ 0.35	0.8
≤ 0.45	0.7
≤ 0.55	0.6
> 0.55	Use Appendix A

Multiple Zone Systems – Primary Outdoor Air Fraction

- **6.2.5.1 Primary Outdoor Air Fraction.** *Primary outdoor air fraction (Zpz)* shall be determined for ventilation zones in accordance with Equation 6-5:

$$Zpz = Voz / Vpz \quad (6\text{-}5)$$

where *Vpz* is the zone primary airflow; i.e., the primary airflow rate to the ventilation zone from the air handler including outdoor air and recirculated air. **Note**: For VAV system design purposes, *Vpz* is the lowest primary airflow value expected at the design condition analyzed.

What is Design Condition Analyzed?

- Often in heating season and cooling season the HVAC system is designed to operated in different air distribution modes.
- Usually in VAV systems, the cooling airflow is higher than the heating airflow as heat is supplied locally by reheat coils or other heat sources.
- For example, often the heat does not come on in the box until the airflow is below some box setting such as 30%. This would be the lowest expected airflow in heating season.

Different Multiple-Zone Systems

- Multiple configurations including *ASHRAE Journal* articles about:
  - Single Zone and Dedicated OA (Oct 2004)
  - Changeover Bypass VAV (Nov 2004)
  - Single-Path Multiple Zone (Jan 2005)
  - Dual-Path Multiple Zone (May 2005)

Ventilation Rate Procedure Spreadsheet

- Spreadsheet provided with the *User's Manual*
- 62MZCalc

How Many Calculations?

- In many systems, heating and cooling have different conditions so we must calculate both seasons
- Zone air distribution effectiveness *(Ez)* is different
- Also, minimum primary airflow *(Vpz)* may be different in heating and cooling season
- And total system airflows (*Vps*) may be different

VAV Systems

- For VAV system design purposes, zone ventilation efficiency (*Evz*) for each ventilation zone shall be found using the minimum expected zone primary airflow (*Vpz*) and using the highest expected system primary airflow (*Vps*) at the design condition analyzed.
- Default assumptions may include *Ds* = 100% and expected minimum primary zone airflow to equal 35%

Cautions

- Look for too high *Ev* or too low *Vp* when reviewing *Vot* design calculations in VAV systems.
- Design conditions must be properly selected for system sizing and to make sure that ventilation is provided to the breathing zone under design loads.
- For operations, often the ventilation can be reduced under conditions where *Ev* and populations vary and can be quantified.

Design for Varying Operating Conditions

- If it is known that peak occupancy will be of short duration and/or ventilation will be varied or interrupted for a short period of time, the design may be based on the average conditions over a time period *T* determined by Equation 6-9:

  T* = 3 *v* / *Vbz (6-9a) IP

  where:

  T = averaging time period, (min)

  v = the volume of the zone for which averaging is being applied, (ft^3)

  Vbz = the *breathing zone outdoor airflow* calculated using Equation 6-1 and the design value of the zone population *Pz*, (cfm)

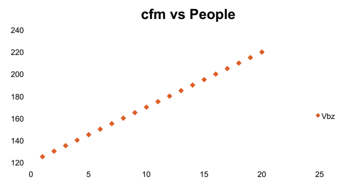
Demand Control Ventilation

- **6.2.7.1.2** The breathing zone outdoor airflow (*Vbz*) shall be reset in response to current occupancy and shall be no less than the building component (*Ra*Az*) of the DCV zone.
- **Note:** Examples of reset methods or devices include population counters, carbon dioxide (CO_2) sensors, timers, occupancy schedules or occupancy sensors.

People Counter Method

No one in room = 120 cfm

Each person adds 5 cfm



CO_2 DCV Method

- Assumes sensor is located in a manner representative of average (well mixed) concentration in breathing zone
- Assumes CO_2 generation rate is accurate in terms of mets and body mass
- Assumes feedback into an air volume controller (not damper position)
- Assumes single zone

CO_2 DCV for Multiple Spaces

- Simple approaches do not work for multiple spaces
- No current published method for using CO_2 for DCV in multiple spaces
- Subject of current ASHRAE research project

Indoor Air Quality Procedure

- Performance-based design approach
- Designs shall comply with the following:

6.3.1 Contaminant Sources. Contaminants or mixtures of concern for purposes of the design shall be identified. For each contaminant or mixture of concern, indoor sources (occupants and materials) and outdoor sources shall be identified, and the emission rate for each contaminant of concern from each source shall be determined.

Indoor Air Quality Procedure

- **6.3.2 Contaminant Concentration.** For each contaminant of concern, a target concentration limit and its corresponding exposure period and an appropriate reference to a cognizant authority shall be specified.
- **6.3.3 Perceived Indoor Air Quality.** The design level of indoor air acceptability shall be specified in terms of the percentage of building occupants and/or visitors expressing satisfaction with perceived IAQ.

Natural Ventilation (6.4)

- **6.4 Natural Ventilation Procedure.** Natural ventilation systems shall be designed in accordance with this section and shall include mechanical ventilation systems designed in accordance with Section 6.2 and/or Section 6.3

Exhaust Ventilation 6.5

- Exhaust airflow shall be provided in accordance with the requirements in Table 6-4.
- Exhaust makeup air may be any combination of outdoor air, recirculated air and transfer air.

ASHRAE 62.1

Standard is under continuous maintenance process
You can propose a change to the standard
Notice of proposed changes appears in ASHRAE Standards Action
You can comment on proposed changes
You can request an interpretation

ASHRAE 62.1

User's manual for 62.1-2010
IMC & UMC Code adoption
ALI Short Course and Professional Development Course
eLearning course
IAQ Design Guideline is in the works
Next publication of ASHRAE 62.1-2013

Questions?

ASHRAE 62.1-2010
Overview