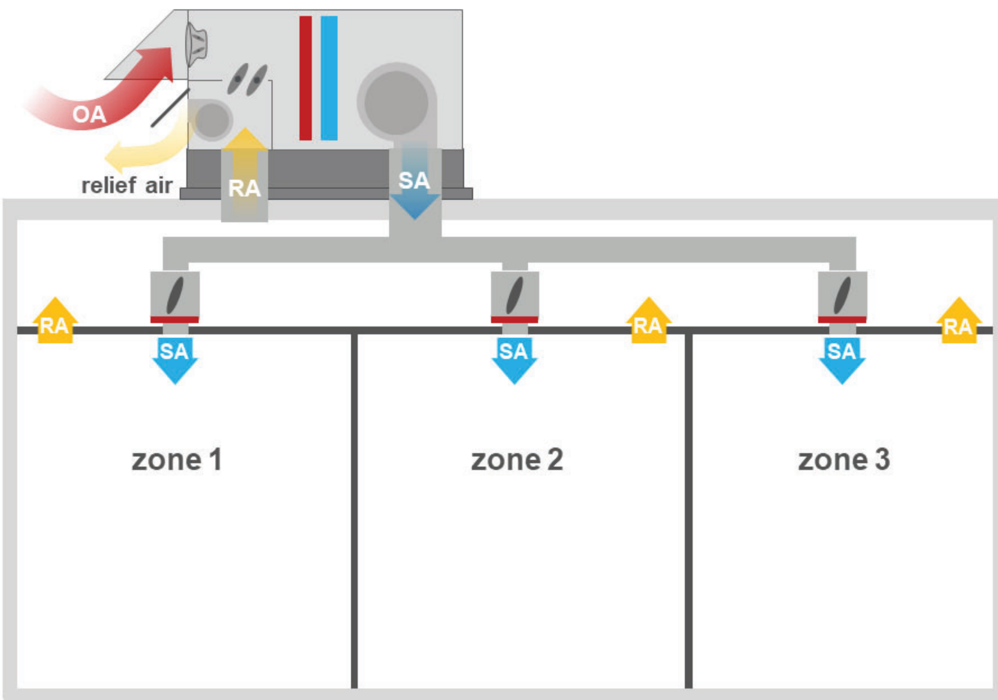
Trane *Engineers Newsletter Live*

ASHRAE Standard 62.1-2019

with Trane Engineers Chris Hsieh, John Murphy, and Eric Sturm



Trane program number: APP-CMC077-EN
May 2021

Agenda

Trane *Engineers Newsletter Live* Series

ASHRAE Standard 62.1-2019

Abstract

The 2019 version of ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality, was published in late 2019. This ENL will overview the standard, discuss several key changes implemented in the 2019 version, explain the three allowed procedures for determining ventilation airflows (Ventilation Rate Procedure, IAQ Procedure, and Natural Ventilation Procedure), and walk through calculation steps using an example office building.

Presenters: Chris Hsieh, John Murphy, and Eric Sturm

After viewing attendees will be able to:

1. Identify the different sections of Standard 62.1
2. Explain key changes implemented in the 2019 version, including a maximum indoor dew point limit and a new Simplified Procedure for designing a multiple-zone recirculating system
3. Perform zone- and system-level ventilation calculations required for compliance with the standard's Ventilation Rate Procedure
4. Understand the steps required for compliance with the standard's IAQ Procedure

Agenda

- Section 4 (Outdoor Air Quality)
- Section 5 (Systems and Equipment)
- Section 6 (Procedures)
    - 6.1 Ventilation Rate Procedure
    - 6.2 IAQ Procedure
    - 6.3 Natural Ventilation Procedure
    - 6.4 Exhaust
- Section 7 (Construction and System Start-Up)
- Section 8 (Operations and Maintenance)

Presenter biographies

ASHRAE Standard 62.1-2019

CHRIS HSIEH | APPLICATIONS ENGINEER | TRANE

Chris has been with Trane since 1996. His ongoing charter includes system applications support, industry-related green/environmental programs such as ENERGY STAR®, LEED, and ASHRAE 189.1 as well as IAQ initiatives. Chris volunteers to serve on ASHRAE's SSPC 189.1, SSPC 145, various TCs, and the ASHRAE La Crosse Chapter. Chris also assisted LEED EB (Silver) certification for Trane St. Paul building and LEED NC (Gold and Certified) certifications for Trane Taicang office and facility buildings. He is a LEED-AP BD+C, Certified Energy Manager, UL Environment DfS (Design for Sustainability) Gold certified, and ASHRAE member.

Chris is passionate about youngsters' education. To increase Trane's local community involvement and focus on STEM education, Chris has volunteered to serve as a math club team coach for a local middle school since 2018—which advanced to the Wisconsin State competition in 2019, 2020, and 2021.

JOHN MURPHY | APPLICATIONS ENGINEER | TRANE

John has been with Trane since 1993. His primary responsibility as an applications engineer is to aid design engineers and Trane sales personnel in the proper design and application of HVAC systems. His main areas of expertise include energy efficiency, dehumidification, dedicated outdoor-air systems, air-to-air energy recovery, psychrometry, airside system control and ventilation. He is also a LEED Accredited Professional.

John is the author of numerous Trane application manuals and Engineers Newsletters, and is a frequent presenter on Trane's Engineers Newsletter Live series. He has authored several articles for the ASHRAE Journal, and was twice awarded "Article of the Year" award. He is an ASHRAE Fellow and has served on the "Moisture Management in Buildings" and "Mechanical Dehumidifiers" technical committees. He was a contributing author of the Advanced Energy Design Guide for K-12 Schools and the Advanced Energy Design Guide for Small Hospitals and Health Care Facilities, a technical reviewer for the ASHRAE Guide for Buildings in Hot and Humid Climates, and a presenter on the 2012 ASHRAE "Dedicated Outdoor Air Systems" webcast.

ERIC STURM | LEAD APPLICATIONS ENGINEER | TRANE

Eric joined Trane in 2006 after graduating from the University of Wisconsin – Platteville with a Bachelor of Science degree in mechanical engineering. Prior to joining the applications engineering team, he worked in the Customer Direct Services (C.D.S.) department as a marketing engineer and product manager for the TRACE™ 700 load design and energy simulation application. As a C.D.S. marketing engineer he supported and trained customers globally.

In his current role as an applications engineer, Eric's areas of expertise include acoustics, airside systems, and indoor agriculture, and indoor air quality. He is currently involved with ASHRAE as a representative on Members Council and member of the "indoor agriculture" and "Sound and Vibration" technical committees. Eric is the recipient of the ASHRAE Distinguished Service Award and Young Engineers in ASHRAE Award of Individual Excellence.

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Learning Objectives

1. Identify the different sections of Standard 62.1
2. Explain key changes implemented in the 2019 version, including a maximum indoor dew point limit and a new Simplified Procedure for designing a multiple-zone recirculating system
3. Perform zone- and system-level ventilation calculations required for compliance with the standard's Ventilation Rate Procedure
4. Understand the steps required for compliance with the standard's IAQ Procedure

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  - 6.1 Ventilation Rate Procedure
  - 6.2 IAQ Procedure
  - 6.3 Natural Ventilation Procedure
  - 6.4 Exhaust
- Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)

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Today's Presenters

Eric Sturm
Applications Engineer

John Murphy
Applications Engineer

Chris Hsieh
Applications Engineer

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ASHRAE Standard 62.1-2019
Title, Purpose, and Scope

Title: "Ventilation for Acceptable Indoor Air Quality"

Purpose: "…to specify minimum ventilation rates and other measures intended to provide indoor air quality (IAQ) that is acceptable to human occupants and that minimizes adverse health effects."

Scope: "…spaces intended for human occupancy within buildings except those within dwelling units in residential occupancies in which occupants are nontransient."

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ASHRAE Standard 62.1-2019
Ventilation for Acceptable Indoor Air Quality

Foreword

1. Purpose
2. Scope
3. Definitions
4. Outdoor Air Quality
5. Systems and Equipment
6. Procedures
7. Construction and System Start-Up
8. Operations and Maintenance
9. Normative References

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- **Section 4 (Outdoor Air Quality)**
- **Section 5 (Systems and Equipment)**
- Section 6 (Procedures)
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  - 6.3 IAQ Procedure
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  - 6.5 Exhaust
- Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)

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Section 4
Outdoor Air Quality

4. Outdoor Air Quality. Outdoor air quality shall be investigated in accordance with Sections 4.1 and 4.2 prior to completion of ventilation system design. The results of this investigation shall be documented in accordance with Section 4.3.

4.1 Regional Air Quality. The status of compliance with national ambient air quality standards shall be determined for the geographic area of the building site.

…

4.2 Local Air Quality. An observational survey of the building site and its immediate surroundings shall be conducted during 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 representative and shall include the following as a minimum…

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Section 4.1
Regional Air Quality

4.1 Regional Air Quality. The status of compliance with national ambient air quality standards shall be determined for the geographic area of the building site.

4.1.1 In the United States, compliance status shall be either in "attainment" or "nonattainment" with the National Ambient Air Quality Standards (NAAQS). In the United States, areas with no U.S. Environmental Protection Agency (USEPA) compliance status designation shall be considered "attainment" areas.

Informative Notes:

1. The NAAQS are shown in Table D-1 of Informative Appendix D.
2. The USEPA list of nonattainment areas can be found at www.epa.gov/green-book.
3. Air quality data collected at outdoor monitors across the U.S. can be found at www.epa.gov/outdoor-air-quality-data.
4. Internet links to detailed information on the NAAQS and contaminant levels for other select counties and regions can be found in Informative Appendix D.

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Section 4. Outdoor Air Quality
National Ambient Air Quality Standards (NAAQS)

Pollutant	
Carbon Monoxide (CO)	
Lead (Pb)	
Nitrogen Dioxide (NO_2)	
Ozone (O_3)	
Particle Pollution (PM)	$PM_{2.5}$
	PM_{10}
Sulfur Dioxide (SO_2)	

Source: https://www.epa.gov/criteria-air-pollutants/naaqs-table

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Section 4. Outdoor Air Quality
National Ambient Air Quality Standards (NAAQS)

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 μg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM) $PM_{2.5}$	primary	1 year	12.0 μg/m^3	annual mean, averaged over 3 years
	secondary	1 year	15.0 μg/m^3	annual mean, averaged over 3 years
	primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
PM_{10}	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

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Section 4. Outdoor Air Quality
U.S. EPA's Green Book

The EPA Green Book provides detailed information about area National Ambient Air Quality Standards (NAAQS) designations, classifications and nonattainment status. Information is current as of the Green Book posted date and is available in reports, maps and data downloads.

Select one of the NAAQS below to view information about designated nonattainment areas.

Ozone
- 8-Hour Ozone (2015 Standard)
- 8-Hour Ozone (2008 Standard)
- 8-Hour Ozone (1997 Standard)
- 1-Hour Ozone (1979 Standard)

Particulate Matter (PM)
- PM-2.5 (2012 Standard)
- PM-2.5 (2006 Standard)
- PM-2.5 (1997 Standard)
- PM-10 (1987 Standard)

Sulfur Dioxide
- Sulfur Dioxide (2010 Standard)
- Sulfur Dioxide (1971 Standard)

Lead
- Lead (2008 Standard)
- Lead (1978 Standard)

Carbon Monoxide
- Carbon Monoxide (1971 Standard)

Nitrogen Dioxide
- Nitrogen Dioxide (1971 Standard)

National Multi-Pollutant
- National Area and County-Level Multi-Pollutant Information

Other Resources
- Data, GIS, and Map Downloads
- Frequent Questions
- Related Air Quality and Designation Websites

What's New

New features in this Green Book:

- At the top of each NAAQS page is "All Designated Area Selections" with reports that combine nonattainment and maintenance information.
- Interactive maps are available from each NAAQS page with current status information.
- A "Downloads" link provides access to data exports, GIS shapefiles, and sets of Green Book maps.

Source: https://www.epa.gov/green-book

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Section 4.2
Local Air Quality Assessment

4. Outdoor Air Quality. Outdoor air quality shall be investigated in accordance with Sections 4.1 and 4.2 prior to completion of ventilation system design. The results of this investigation shall be documented in accordance with Section 4.3.

4.1 Regional Air Quality. The status of compliance with national ambient air quality standards shall be determined for the geographic area of the building site.

4.2 Local Air Quality. An observational survey of the building site and its immediate surroundings shall be conducted during 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 representative and shall include the following as a minimum…

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Section 4.3
Documentation

4.3 Documentation. Documentation of the outdoor air quality investigation shall be reviewed with building owners or their representative and shall include the following as a minimum:

a. Regional air uality compliance status
b. Local survey information
    a. Date of observations
    b. Time of observations
    c. Site description
    d. Description of facilities on site and on adjoining properties
    e. Observation of odors or irritants
    f. Observation of visible plumes or visible air contaminants
    g. Description of sources of vehicle exhaust on site and on adjoining properties
    h. Identification of potential contaminant sources on the site and from adjoining properties, including any that operate only seasonally
c. Conclusion regarding the acceptability of outdoor air quality and the information supporting the conclusion

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Ventilation for Acceptable Indoor Air Quality

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Ventilation for Acceptable Indoor Air Quality

Section 5.1 – Ventilation Air Distribution
Section 5.2 – Exhaust Ducts
Section 5.3 – Ventilation System Controls
Section 5.4 – Airstream Surfaces
Section 5.5 – Outdoor Air Intakes
Section 5.6 – Local Contaminants
Section 5.7 – Ozone Generating Devices
Section 5.8 – Combustion Air
Section 5.9 – Particulate Filters
Section 5.10 – Maximum Indoor Air Dew Point
Section 5.11 – Building Exfiltration
Section 5.12 – Condensate Drain Pans
Section 5.15 – Access for Inspection, Cleaning, and Maintenance
Section 5.16 – Building Envelope and Interior Surfaces
Section 5.17 – Buildings with Attached Parking Garages
Section 5.18 – Air Classification and Recirculation
Section 5.19 – Environmental Tobacco Smoke

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Section 5.5
Outdoor Air Intakes

5.5 Outdoor Air Intakes. Ventilation system outdoor air intakes shall be designed in accordance with the following subsections.

5.5.1 Location. **Outdoor air intakes** (including openings that are required as part of a natural ventilation system) **shall be located such that the shortest distance from the intake to any specific potential outdoor contaminant source listed in Table 5-1 shall be equal to or greater than**

a. the separation distance in Table 5-1 or
b. the calculation methods in Normative Appendix B

and shall comply with all other requirements of this section.

Section 5.5
Outdoor Air Intakes, continued

5.5.1.1 Exhaust/Relief Outlets. Separation criteria for Class 2 and Class 3 exhaust/relief outlets apply to the distance from the outdoor air intakes for one ventilation system to the exhaust outlets and relief outlets for any other ventilation system.

5.5.1.2 Fuel-Burning Equipment. The minimum distances relative to fuel-fired appliances shall be as required by ANSI Z223.1/NFPA 54 for fuel-gas-burning appliances and equipment, NFPA 31 for oil-burning appliances and equipment, and NFPA 211 for other combustion appliances and equipment.

5.5.1.3 Roof, Landscaped Grade, or Another Surface Directly Below Intake. Where snow accumulation is expected, the surface of the snow at the expected average snow depth shall be considered to be a surface directly below an intake.

> ***Exception to 5.5.1.3:*** The minimum separation distance in Table 5-1 shall not apply where outdoor surfaces below the air intake are sloped more than 45 degrees from horizontal or where such surfaces are less than 1 in. (30 mm) in width.

5.5.1.4 Laboratory Exhaust. Separation criteria for fume hood exhaust shall be in compliance with ANSI/AIHA Z9.5.

Section 5.5 Outdoor Air Intakes
Table 5-1 Excerpt

Object	Minimum Distance (feet)
Class 2 air exhaust/relief outlet	10
Class 3 air exhaust/relief outlet	15
Class 4 air exhaust/relief outlet	30
Cooling tower exhaust	25
Driveway, street, or parking place	5
Garage entry, automobile loading area, or drive-in queue	15
Garbage storage/pick-up area, dumpsters	15
Plumbing vents terminating at least 3 feet above the level of the outdoor air intake	3
Plumbing vents terminating less than 3 feet above the level of the outdoor air intake	10
Vents, chimneys, and flues from combustion appliances and equipment	15

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Section 5.7
Ozone Generating Devices

5.7 Ozone Generating Devices. The use of ozone generating devices shall comply with the following sections.

Exception to 5.7: Electronic devices used exclusively for the operation of HVAC equipment and controls.

Informative Note: Ozone generation is expected from ozone generators, corona discharge technology, some ultraviolet lights, electronic devices that create chemical reactions within the system, and some devices using a high voltage (>480 V). Motors and relays are examples of electronic devices that would be exempt.

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Section 5.7
Ozone Generating Devices

5.7.1 Air-Cleaning Devices. Air-cleaning devices shall be listed and labeled in accordance with UL 2998.

Informative Note: The use of devices not intended for air cleaning with the potential to generate ozone should be avoided.

5.7.2 Ultraviolet Devices. Ultraviolet generating devices in supply air or spaces shall not transmit 185 nm wavelengths.

Informative Note: Ultraviolet devices used in treatment of closed water systems may produce 185 nm wavelengths, which may generate ozone.

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Section 5.9
Particulate Filters

5.9 Particulate Matter Removal. Particulate matter filters or air cleaners having either

a. a **MERV of not less than 8** where rated in accordance with ASHRAE Standard 52.2 or

b. the minimum efficiency within ISO ePM10 where rated in accordance with ISO 16890

shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an occupiable space.

Exception to 5.9:
Cooling coils that are designed, controlled, and operated to provide sensible cooling only.

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Section 5.10
Maximum Indoor Air Dew Point Temperature

5.10 Maximum Indoor Air Dew Point in Mechanically Cooled Buildings. Buildings or spaces equipped with or served by mechanical cooling equipment shall be provided with dehumidification components and controls that limit the indoor humidity to a maximum dew point of 60°F (15°C) during both occupied and unoccupied hours whenever the outdoor air dew point is above 60°F (15°C). The dew-point limit shall not be exceeded when system performance is analyzed with outdoor air at the dehumidification design condition (that is, design dew point and mean coincident dry-bulb temperatures) and with the space interior loads (both sensible and latent) at cooling design values and space solar loads at zero.

Exceptions to 5.10:

1. Buildings or spaces that are neither equipped with nor served by mechanical cooling equipment.
2. Buildings or spaces equipped with materials, assemblies, coatings, and furnishings that resist microbial growth and that are not damaged by continuously high indoor air dewpoints.
3. During overnight unoccupied periods not exceeding 12 hours, the 60°F (15°C) dewpoint limit shall not apply, provided that indoor relative humidity does not exceed 65% at any time during those hours.

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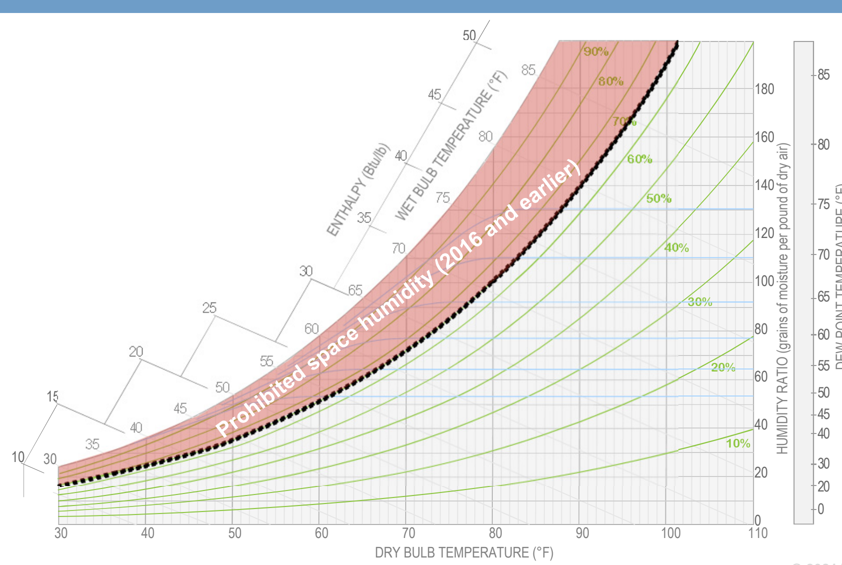
62.1-2016 and earlier
Maximum Indoor Humidity



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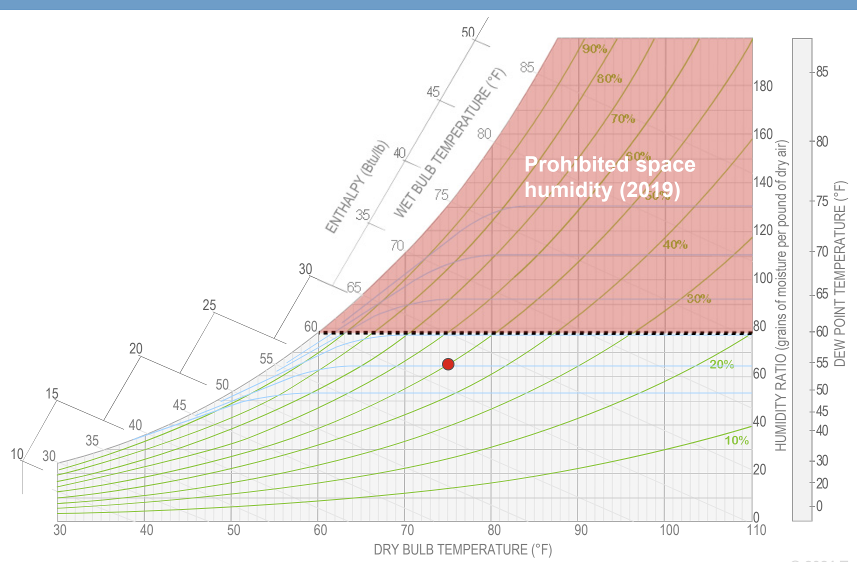
Section 5.10
Maximum Indoor Air Dew Point Temperature



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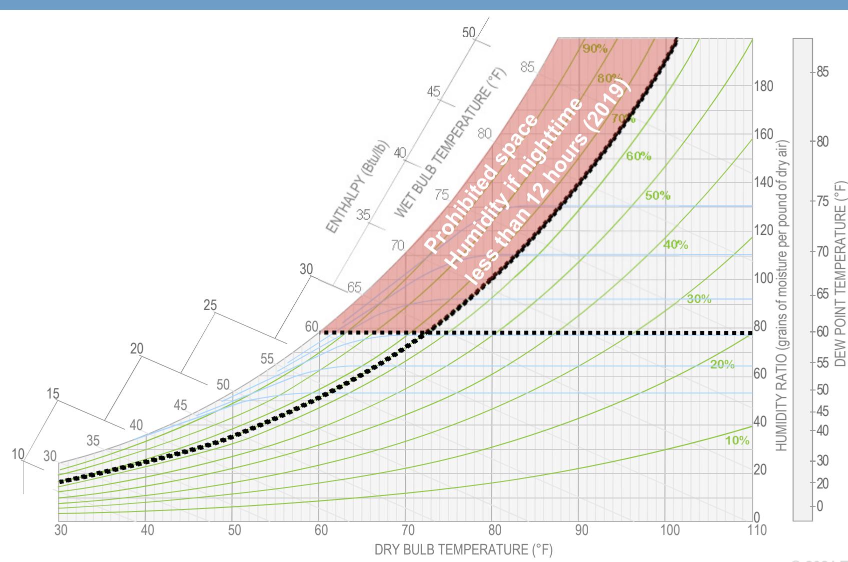
Section 5.10
Maximum Indoor Air Dew Point Temperature



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Section 5.10
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Section 6.2
Ventilation Rate Procedure (VRP)

Find:

1. Zone outdoor airflow, based upon prescribed rates
2. System outdoor air intake flow, based upon prescribed calculation procedures

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Section 6.2
Ventilation Rate Procedure (VRP)

- **Zone calculations**
  - Determine breathing-zone outdoor airflow for each zone, based on prescribed rates in Table 6-1
- **System calculations**
  - Calculate outdoor-air intake flow for the entire system, based on prescribed calculation procedures

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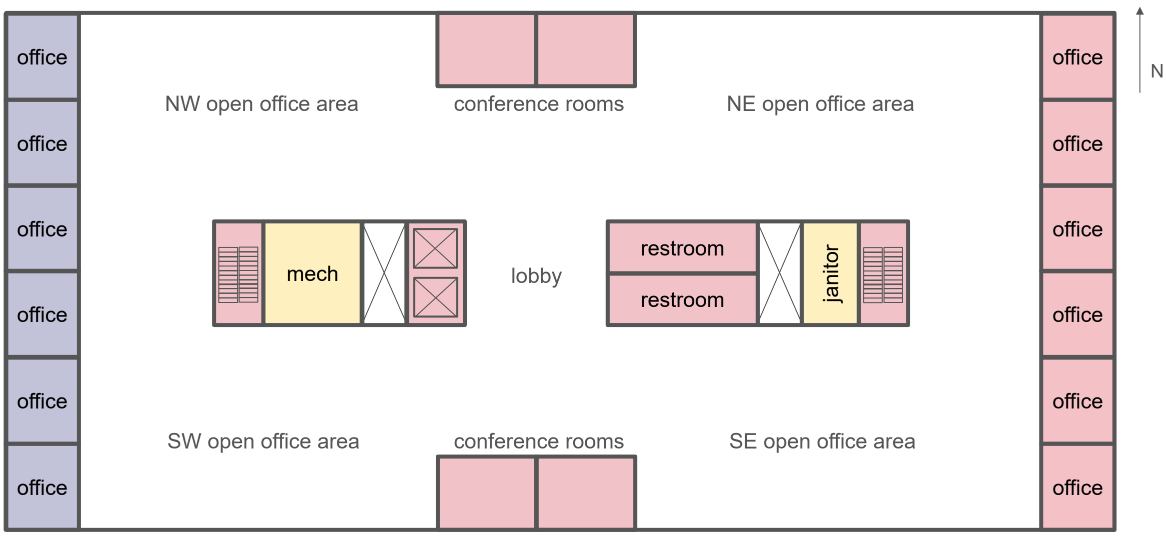
Example Office Building



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VRP: Zone Calculations

Breathing Zone Outdoor Airflow, V_{bz} (section 6.2.1.1)

To ensure breathing zone dilution with adequate ventilation:

$$V_{bz} = R_p \times P_z + R_a \times A_z$$

Where:
R_p = People-based ventilation rate from Table 6.2.2.1, cfm/p
P_z = The zone population
R_a = Area-based ventilation rate from Table 6.2.2.1, cfm/ft^2
A_z = The zone floor area, ft^2

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Section 6.2.1.1.7
Design Zone Population

6.2.1.1.7 Design Zone Population. Design zone population (*Pz*) shall equal the **largest (peak) number of people expected to occupy the ventilation zone during typical use**.

Exceptions to 6.2.1.1.7:

1. Where the number of people expected to occupy the ventilation zone fluctuates, zone population equal to the average number of people shall be permitted, provided such average is determined in accordance with Section 6.2.5.2.
2. Where the largest or average number of people expected to occupy the ventilation zone cannot be established for a specific design, an estimated value for zone population shall be permitted, provided such value is the product of the net occupiable area of the ventilation zone and the default occupant density listed in Table 6-1.

6.2.1.1.7.1 Design Zone Population for Dwelling Units with Transient Occupancy. Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.

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VRP: Zone Calculations
Breathing Zone Outdoor Airflow (Table 6-1)

Occupancy Category	People Outdoor Air Rate (R_p, cfm/person)	Area Outdoor Rate (R_a, cfm/ft^2)	Air Class	Occupied Standby
Conference/Meeting	5	0.06	1	Yes

$$V_{bz} = R_p \times P_z + R_a \times A_z$$

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VRP: Zone Calculations
Breathing Zone Outdoor Airflow (Table 6-1)

Occupancy Category	People Outdoor Air Rate (R_P, cfm/person)	Area Outdoor Rate (R_a, cfm/ft^2)	Air Class	Occupied Standby
Conference/Meeting	5	0.06	1	Yes
Breakrooms	5	0.12	1	
Main entry lobbies	5	0.06	1	Yes
Occupiable storage rooms for dry materials	5	0.06	1	
Office space	5	0.06	1	Yes
Reception areas	5	0.06	1	Yes
Telephone/data entry	5	0.06	1	Yes

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Example Office Building
Breathing Zone Outdoor Airflow, V_{bz}

Zone Name	People (P_z)	People-based rate (R_p, cfm/p)	People-based component (P_z x R_p, cfm)	Area (A_z, sqft)	Area-based rate (R_a, cfm/sqft)	Area-based component (A_z x Ra, cfm)	Breathing Zone Outdoor Airflow (V_{bz}, cfm)
W private offices	6	5	30	1575	0.06	95	125

$V_{bz} = R_p \times P_z + R_a \times A_z$

V_{bz} = 5 cfm / person × 6 people + 0.06 cfm/ft^2 × 1575 ft^2 = 30 + 95 = 125 cfm

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VRP: Zone Calculations

Zone Air Distribution Effectiveness, E_z
(section 6.2.1.2)

Determine the effectiveness (E_z) of the airside system's air distribution according to Table 6-4 or Appendix C:

E_z = (typically sourced from Table 6-4)

Air Distribution Configuration	E_z
Ceiling supply of cool air	1.0
Ceiling supply or warm air 15°F above space and ceiling return	0.8
Ceiling supply of warm air less than 15°F above average space temperature where the supply air-jet velocity is less than 150 fpm within 4.5 feet of the floor and ceiling return	0.8
Ceiling supply air warm air less than 15°F above average space temperature where the supply air-jet velocity is equal to or greater than 150 fpm within 4.5 feet of the floor and ceiling return	1.0
Floor supply of (low-velocity) cool air and ceiling return provided thermal stratification	1.2

Excerpt from Table 6-4

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VRP: Zone Calculations

Zone Outdoor Airflow, V_{oz} (section 6.2.1.3)

Determine the amount of outdoor air to be supplied to the zone:

$$V_{oz} = V_{bz} / E_z$$

Where:
V_{bz} = Breathing Zone Outdoor Airflow
E_z = Zone Air Distribution Effectiveness

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Example Office Building
Zone Outdoor Airflow, V_{oz}

Zone Name	Breathing Zone Outdoor Airflow (V_{bz}, cfm)	Zone Air Distribution Effectiveness, Cooling ($E_{z\text{-}clg}$)	Zone Outdoor Airflow, Cooling ($V_{oz\text{-}clg}$, cfm)
W private offices	125	1.0	125

$V_{oz\text{-}clg} = V_{bz} / E_z$
$V_{oz\text{-}clg}$ = 125 cfm / 1.0 = 125 cfm

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Example Office Building
Zone Outdoor Airflow, V_{oz}

Zone Name	Breathing Zone Outdoor Airflow (V_{bz}, cfm)	Zone Air Distribution Effectiveness, Cooling ($E_{z\text{-}clg}$)	Zone Outdoor Airflow, Cooling ($V_{oz\text{-}clg}$, cfm)	Zone Air Distribution Effectiveness, Heating ($E_{z\text{-}htg}$)	Zone Outdoor Airflow, Heating ($V_{oz\text{-}htg}$, cfm)
W private offices	125	1.0	125	0.8	156

$V_{oz\text{-}clg} = V_{bz} / E_z$
$V_{oz\text{-}clg}$ = 125 cfm / 1.0 = 125 cfm

$V_{oz\text{-}htg} = V_{bz} / E_z$
$V_{oz\text{-}htg}$ = 125 cfm / 0.8 = 156 cfm

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Example Office Building

Zone Outdoor Airflow, V_{oz}

Zone Name	Breathing Zone Outdoor Airflow (V_{bz}, cfm)	Zone Air Distribution Effectiveness, Cooling ($E_{z\text{-}clg}$)	Zone Outdoor Airflow, Cooling ($V_{oz\text{-}clg}$, cfm)	Zone Air Distribution Effectiveness, Heating ($E_{z\text{-}htg}$)	Zone Outdoor Airflow, Heating ($V_{oz\text{-}htg}$, cfm)
W private offices	125	1.0	**125**	0.8	**156**

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Example Office Building

Zone Outdoor Airflow, V_{oz}

Zone Name	Breathing Zone Outdoor Airflow (V_{bz}, cfm)	Zone Air Distribution Effectiveness, Cooling ($E_{z\text{-}clg}$)	Zone Outdoor Airflow, Cooling ($V_{oz\text{-}clg}$, cfm)	Zone Air Distribution Effectiveness, Heating ($E_{z\text{-}htg}$)	Zone Outdoor Airflow, Heating ($V_{oz\text{-}htg}$, cfm)
W private offices	125	1.0	125	0.8	156
E private offices	125	1.0	125	0.8	156
NW open offices	323	1.0	323	0.8	404
SW open offices	323	1.0	323	0.8	404
NE open offices	357	1.0	357	0.8	446
SE open offices	357	1.0	357	0.8	446
N conference rooms	186	1.0	186	0.8	233
S conference room	186	1.0	186	0.8	233
Elevator corridor	36	1.0	36	0.8	45

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Section 6.2
Ventilation Rate Procedure (VRP)

- **Zone calculations**
  - Determine breathing-zone outdoor airflow for each zone, based on prescribed rates in Table 6-1
- **System calculations**
  - Calculate outdoor-air intake flow for the entire system, based on prescribed calculation procedures

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Section 6.2
Ventilation System Configurations

- **Single-zone system**
- **100% outdoor air system** (i.e., dedicated OA system)
- **Multiple-zone recirculating system**

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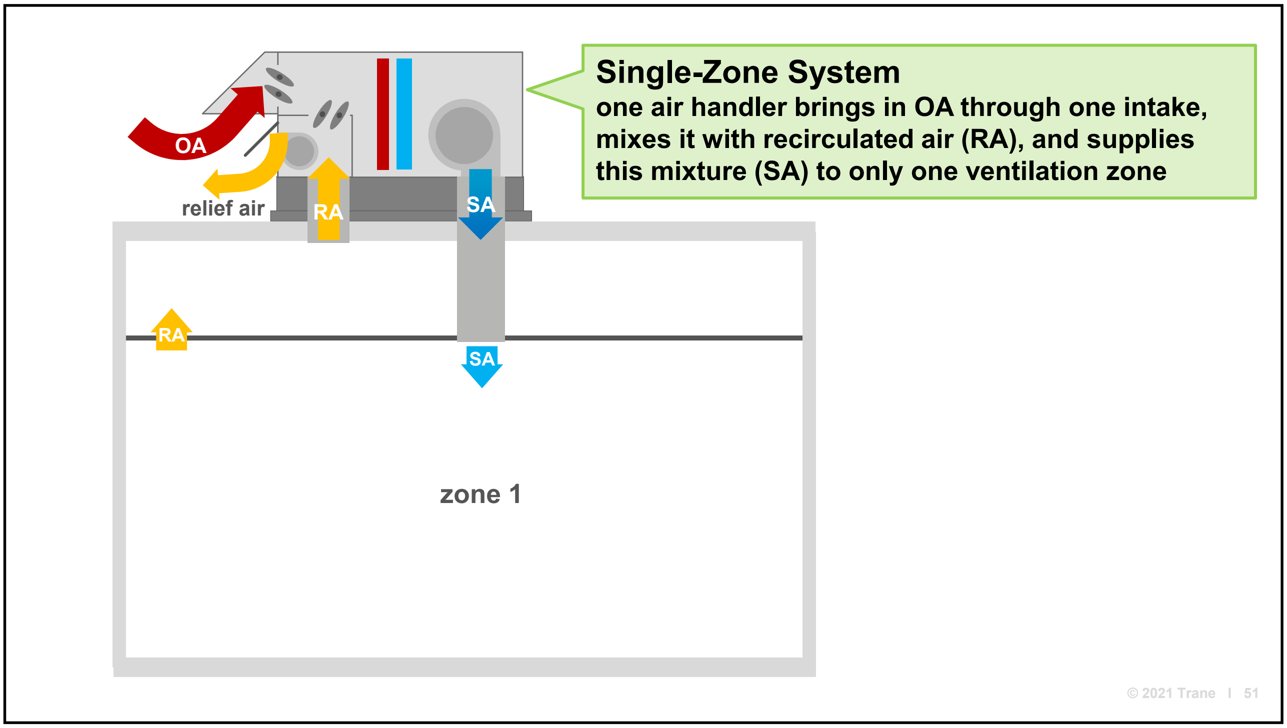
Single-Zone System
one air handler brings in OA through one intake, mixes it with recirculated air (RA), and supplies this mixture (SA) to only one ventilation zone
OA
relief air
RA
SA
RA
SA
zone 1
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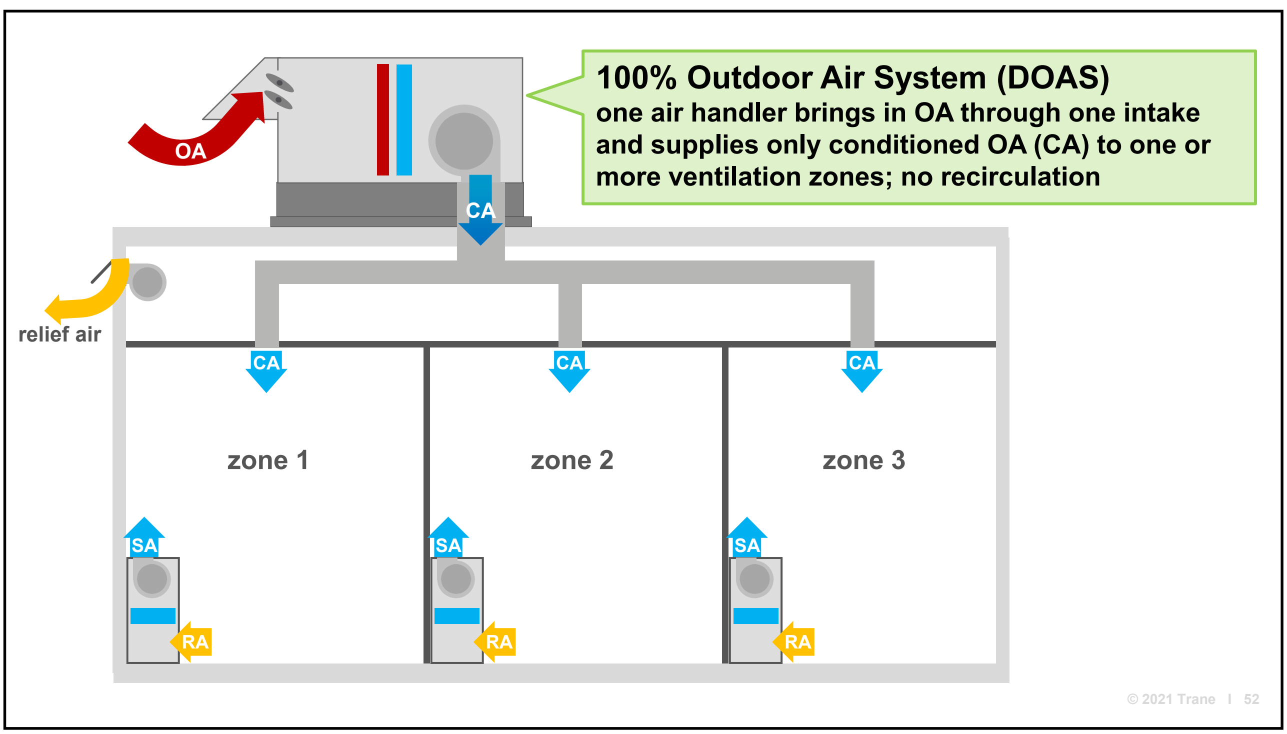
100% Outdoor Air System (DOAS)
one air handler brings in OA through one intake and supplies only conditioned OA (CA) to one or more ventilation zones; no recirculation
OA
CA
relief air
CA
CA
CA
zone 1
zone 2
zone 3
SA
SA
SA
RA
RA
RA
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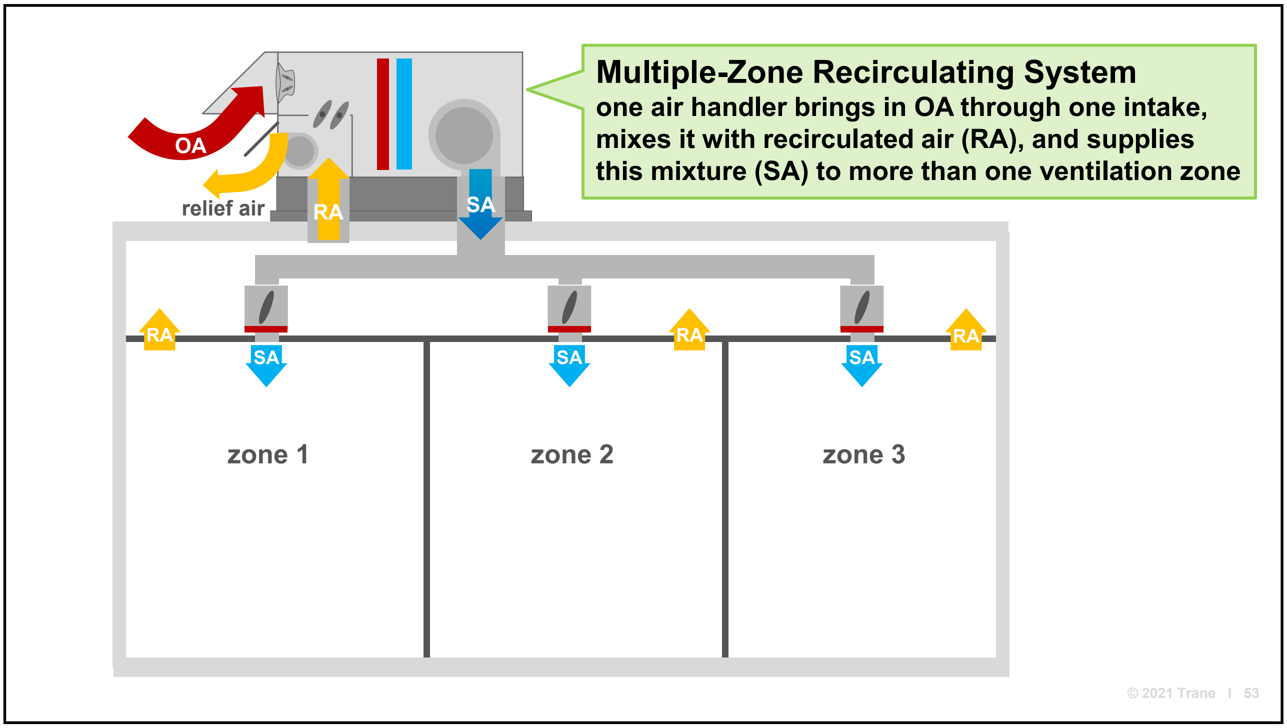
Multiple-Zone Recirculating System
one air handler brings in OA through one intake, mixes it with recirculated air (RA), and supplies this mixture (SA) to more than one ventilation zone
OA
relief air
RA
SA
zone 1
zone 2
zone 3
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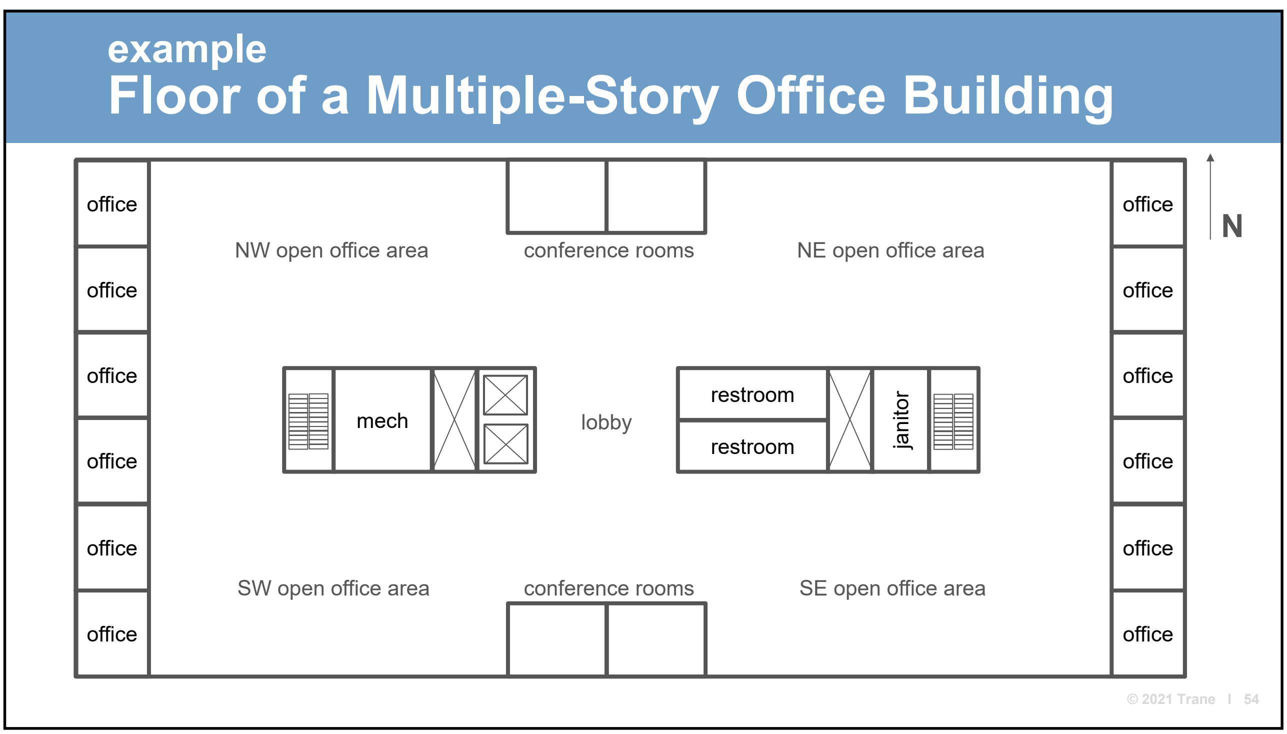
example
Floor of a Multiple-Story Office Building
office
NW open office area
conference rooms
NE open office area
N
mech
lobby
restroom
restroom
janitor
SW open office area
conference rooms
SE open office area
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zone	P_z (people)	R_p (cfm/p)	$P_z \times R_p$ (cfm)	A_z (ft²)	R_a (cfm/ft²)	$A_z \times R_a$ (cfm)	V_{bz} (cfm)	$E_{z\text{-clg}}$	$V_{oz\text{-clg}}$ (cfm)	$E_{z\text{-htg}}$	$V_{oz\text{-htg}}$ (cfm)
West private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
East private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
NW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
SW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
NE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
SE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
North conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
South conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
Elevator lobby	0	5	0	600	0.06	36	36	1.0	36	0.8	45

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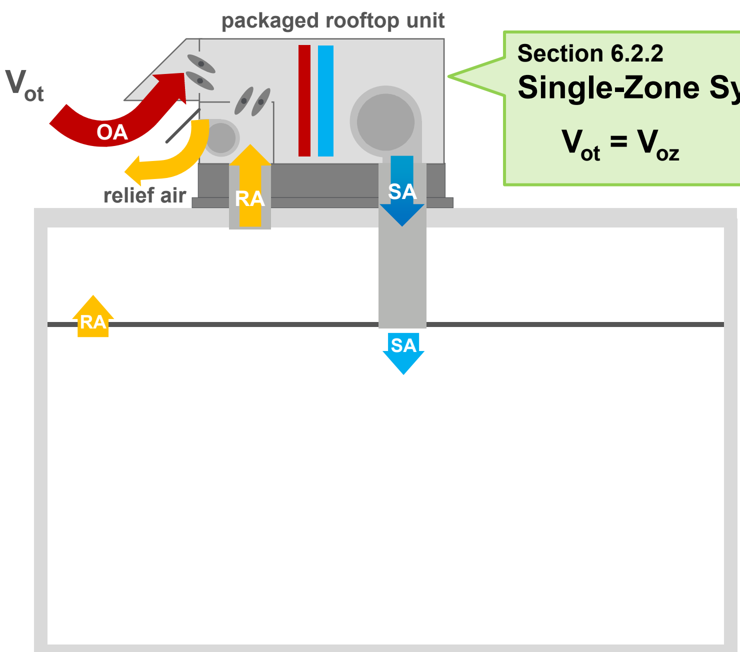

Section 6.2.2

Single-Zone System

$$V_{ot} = V_{oz}$$

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zone	P_z (people)	R_p (cfm/p)	$P_z \times R_p$ (cfm)	A_z (ft²)	R_a (cfm/ft²)	$A_z \times R_a$ (cfm)	V_{bz} (cfm)	$E_{z\text{-}clg}$	$V_{oz\text{-}clg}$ (cfm)	$E_{z\text{-}htg}$	$V_{oz\text{-}htg}$ (cfm)
West private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156

$V_{ot\text{-}clg} = V_{oz\text{-}clg} = 125$ cfm

$V_{ot\text{-}htg} = V_{oz\text{-}htg} = 156$ cfm

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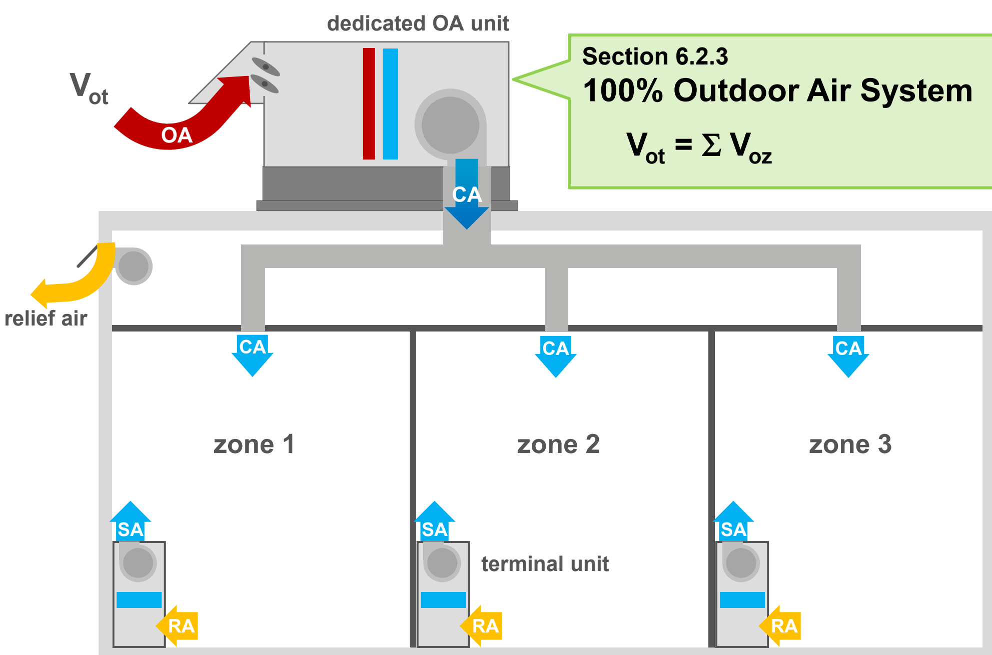

Section 6.2.3

100% Outdoor Air System

$V_{ot} = \Sigma V_{oz}$

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zone	P_z (people)	R_p (cfm/p)	$P_z \times R_p$ (cfm)	A_z (ft^2)	R_a (cfm/ft^2)	$A_z \times R_a$ (cfm)	V_{bz} (cfm)	$E_{z\text{-}clg}$	$V_{oz\text{-}clg}$ (cfm)	$E_{z\text{-}htg}$	$V_{oz\text{-}htg}$ (cfm)
West private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
East private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
NW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
SW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
NE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
SE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
North conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
South conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
Elevator lobby	0	5	0	600	0.06	36	36	1.0	36	0.8	45
								$\Sigma V_{oz\text{-}clg}$ =	**2017**	$\Sigma V_{oz\text{-}htg}$ =	**2521**

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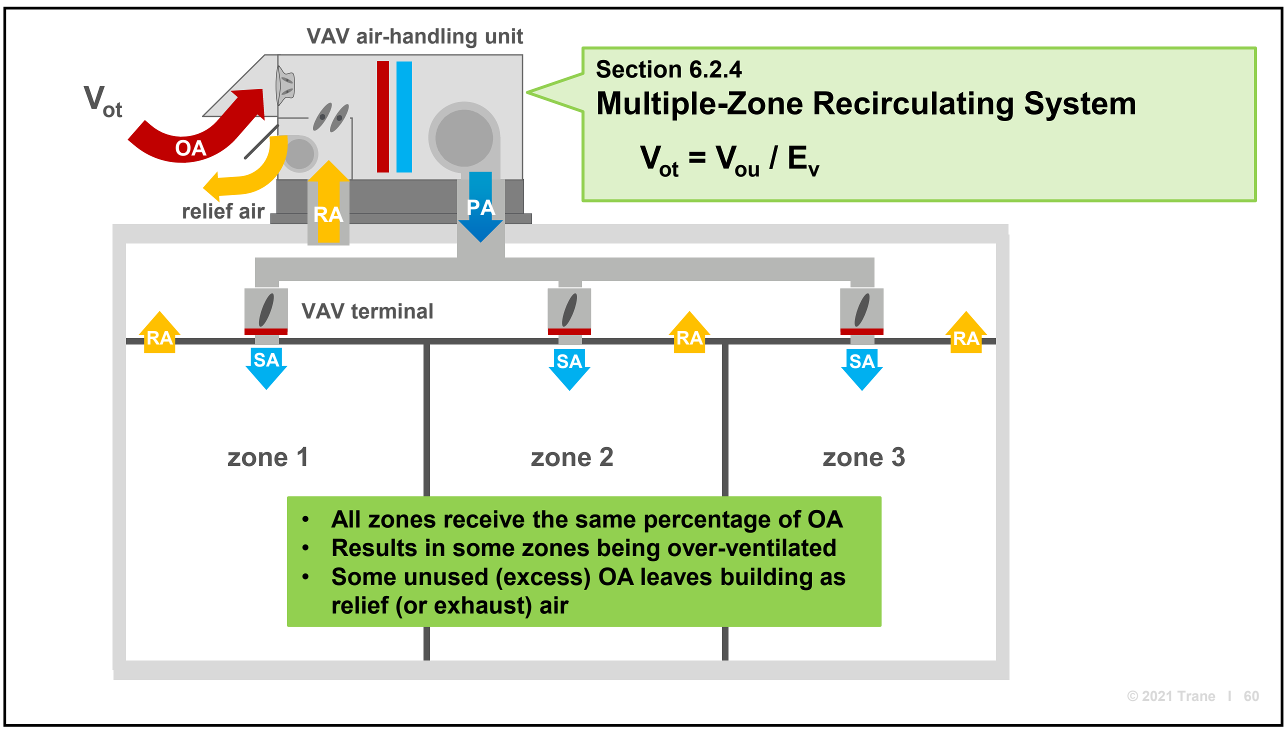

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section 6.2.4
Multiple-Zone Recirculating System

1. Calculate uncorrected outdoor air intake flow (V_{ou})
2. Determine system ventilation efficiency (E_v)
3. Calculate design outdoor air intake flow (V_{ot})

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1. Calculate Uncorrected OA Intake Flow

$$V_{ou} = D \times \sum (R_p \times P_z) + \sum (R_a \times A_z)$$

$$D = P_s / \sum P_z$$

where,

D = occupant diversity ratio

P_s = design "system" population

$\sum P_z$ = sum of design "zone" populations

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zone	P_z (people)	R_p (cfm/p)	$P_z \times R_p$ (cfm)	A_z (ft^2)	R_a (cfm/ft^2)	$A_z \times R_a$ (cfm)	V_{bz} (cfm)	$E_{z\text{-}clg}$	$V_{oz\text{-}clg}$ (cfm)	$E_{z\text{-}htg}$	$V_{oz\text{-}htg}$ (cfm)
West private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
East private offices	6	5	30	1575	0.06	95	125	1.0	125	0.8	156
NW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
SW open offices	19	5	95	3800	0.06	228	323	1.0	323	0.8	404
NE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
SE open offices	21	5	105	4200	0.06	252	357	1.0	357	0.8	446
North conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
South conf rooms	30	5	150	600	0.06	36	196	1.0	196	0.8	233
Elevator lobby	0	5	0	600	0.06	36	36	1.0	36	0.8	45
$\Sigma P_z =$ $P_s =$	**152** **102**	$\Sigma =$	**760**		$\Sigma =$	**1258**					

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1. Calculate Uncorrected OA Intake Flow

$$D = P_s / \sum P_z = 102 / 152 = 0.67$$

$$V_{ou} = D \times \sum (R_p \times P_z) + \sum (R_a \times A_z)$$
$$= 0.67 \times 760 \text{ cfm} + 1258 \text{ cfm}$$
$$= 1767 \text{ cfm}$$

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section 6.2.4

Multiple-Zone Recirculating System

1. Calculate uncorrected outdoor air intake flow (V_{ou})
2. Determine system ventilation efficiency (E_v)
   - Simplified procedure (Section 6.2.4.3)
   - Alternative procedure (Appendix A)
3. Calculate design outdoor air intake flow (V_{ot})

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Simplified Procedure

6.2.4.3 Simplified Procedure

6.2.4.3.1 System Ventilation Efficiency. *System ventilation efficiency (E_v) shall be determined in accordance with Equation 6-7 or 6-8:*

$E_v = 0.88 \times D + 0.22 \quad \text{for } D < 0.60$ *(Equation 6-7)*

$E_v = 0.75 \quad \text{for } D \geq 0.60$ *(Equation 6-8)*

6.2.4.3.2 Zone Minimum Primary Airflow. *For each zone, the minimum primary airflow ($V_{pz\text{-}min}$) shall be determined in accordance with Equation 6-9:*

$V_{pz\text{-}min} = V_{oz} \times 1.5$ *(Equation 6-9)*

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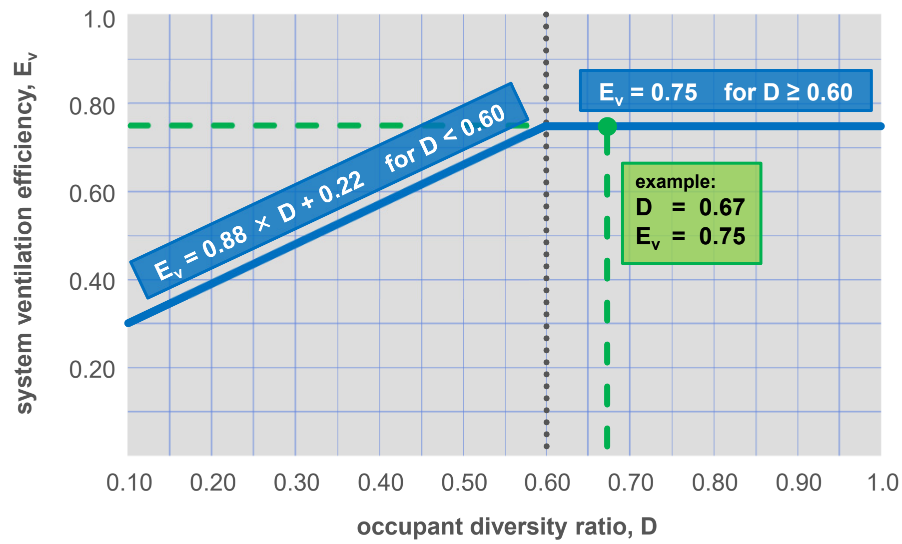
2. Determine System Ventilation Efficiency



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section 6.2.4
Multiple-Zone Recirculating System

1. Calculate uncorrected outdoor air intake flow (V_{ou})
2. Determine system ventilation efficiency (E_v)
   - Simplified procedure (Section 6.2.4.3)
   - Alternative procedure (Appendix A)
3. Calculate design outdoor air intake flow (V_{ot})

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section 6.2.4
Multiple-Zone Recirculating System

1. Calculate uncorrected outdoor air intake flow (V_{ou})
2. Determine system ventilation efficiency (E_v)
   - Simplified procedure (Section 6.2.4.3)
   - Alternative procedure (Appendix A)
3. Calculate design outdoor air intake flow (V_{ot})

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3. Calculate Design OA Intake Flow

$$V_{ot} = V_{ou} \;/\; E_v$$
$$= 1767 \text{ cfm} \;/\; 0.75$$
$$= 2356 \text{ cfm}$$

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simplified procedure
Zone Minimum Primary Airflow

6.2.4.3 Simplified Procedure

6.2.4.3.1 System Ventilation Efficiency. *System ventilation efficiency (E_v) shall be determined in accordance with Equation 6-7 or 6-8:*

$$E_v = 0.88 \times D + 0.22 \quad \text{for } D < 0.60 \qquad \text{(Equation 6-7)}$$

$$E_v = 0.75 \quad \text{for } D \geq 0.60 \qquad \text{(Equation 6-8)}$$

6.2.4.3.2 Zone Minimum Primary Airflow. *For each zone, the minimum primary airflow ($V_{pz\text{-}min}$) shall be determined in accordance with Equation 6-9:*

$$V_{pz\text{-}min} = V_{oz} \times 1.5 \qquad \text{(Equation 6-9)}$$

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zone	V_{bz} (cfm)	$E_{z\text{-}clg}$	$V_{oz\text{-}clg}$ (cfm)	$V_{pz\text{-}min\text{-}clg}$ (cfm)	$E_{z\text{-}htg}$	$V_{oz\text{-}htg}$ (cfm)	$V_{pz\text{-}min\text{-}htg}$ (cfm)
West private offices	125	1.0	125	187	0.8	156	233
East private offices	125	1.0	125	187	0.8	156	233
NW open offices	323	1.0	323	485	0.8	404	606
SW open offices	323	1.0	323	485	0.8	404	606
NE open offices	357	1.0	357	536	0.8	446	669
SE open offices	357	1.0	357	536	0.8	446	669
North conf rooms	196	1.0	196	279	0.8	233	349
South conf rooms	196	1.0	196	279	0.8	233	349
Elevator lobby	36	1.0	36	54	0.8	45	68

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zone minimum primary airflow
Corresponding Change to ASHRAE 90.1

6.5.2.1 Zone Controls. *Zone thermostatic control shall prevent reheating …*

Exceptions to 6.5.2.1:

2. *Zones with DDC that comply with all of the following:*

   a. The airflow rate in dead band between heating and cooling does not exceed the larger of the following:

   ~~*1) 20 percent of the zone design peak supply airflow*~~

   1) The minimum primary airflow rate required to meet the Simplified Procedure of ASHRAE Standard 62.1 for the zone…

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Agenda

- Section 4 (Outdoor Air Quality)
- Section 5 (Systems and Equipment)
- **Section 6 (Procedures)**
  - 6.2 Ventilation Rate Procedure
  - **6.3 IAQ Procedure**
  - 6.4 Natural Ventilation Procedure
  - 6.5 Exhaust
- Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)

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Section 6
Procedures

- **Ventilation Rate Procedure** (Section 6.2)
  - Prescriptive
  - Dictates ventilation rates and calculations based on "typical" spaces
- **IAQ Procedure** (Section 6.3)
  - Performance-based, mass balance analysis
  - Must ventilate to meet concentration limits for all contaminants of concern
- **Natural Ventilation** (Section 6.4)
  - Typically requires a "mixed-mode" system

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Why Use the IAQ Procedure?

Advantages

- To reduce outdoor (intake) airflow
  - ↓ equipment capacity, ↓ energy use
  - Use technology to clean recirculated air and bring in less outdoor airflow
- Location has poor outdoor air quality
- To actively control contaminants for improved IAQ

Disadvantage

- Requires design team judgement, rather than prescriptive rates in a table and calculations

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Step 1
Identify All Contaminants (and Mixtures) of Concern

COC
&
MOC

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Examples of Contaminants of Concern

contaminant	affected organ systems
acetone	mucous membranes, central nervous system
ammonia	respiratory
carbon monoxide	blood
formaldehyde	mucous membranes, carcinogen
hydrogen sulfide	mucous membranes, central nervous system
methyl alcohol	central nervous system
nitrogen dioxide	respiratory
ozone	respiratory
phenol	mucous membranes, central nervous system
sulfur dioxide	respiratory

sources: *Standard 62.1-2016 User's Manual*, ASHRAE, www.ashrae.org
Agency for Toxic Substances and Disease Registry, www.atsdr.cdc.gov

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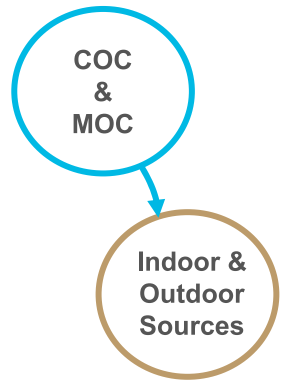
Step 2

Identify Indoor and Outdoor Sources of Each Contaminant



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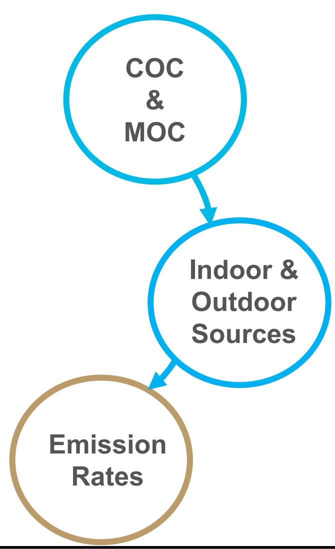
Step 3

Determine Emission Rate for Each Contaminant Source



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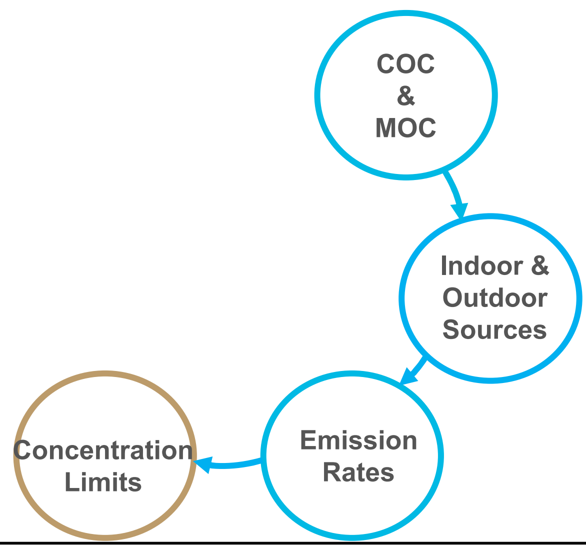
Step 4

Establish a Concentration Limit for Each Contaminant



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Steps 1-4: Example

contaminant	indoor emission rate[1]	outdoor air concentration[2]	concentration limit[3]
acetone	2.112 mg/h per person	0.007 ppm	7 mg/m^3
ammonia	1.344 mg/h per person	0.005 ppm	0.5 mg/m^3
carbon monoxide	0	2.2 ppm	9 ppm
formaldehyde	0.064 mg/h per m^2	0.0068 mg/m^3	0.009 mg/m^3
hydrogen sulfide	0.114 mg/h per person	0.00033 ppm	0.04 mg/m^3
methyl alcohol	3.102 mg/h per person	negligible	1.5 mg/m^3
nitrogen dioxide	0	0.014 ppm	0.053 ppm
ozone	0	0.084 ppm	0.08 ppm
phenol	0.396 mg/h per person	0.000091 ppm	0.1 mg/m^3
sulfur dioxide	0	0.002 ppm	0.03 ppm

1. Generation rates of bioeffluents from occupants (Wang, 1975)
2. Generation rates of building materials and process and outdoor air concentrations (Brightman, 1995; Girman, 1995; Womble, 1995)
3. Comparison of regulations and guidelines pertinent to indoor environments is posted in ASHRAE 62.1-2016

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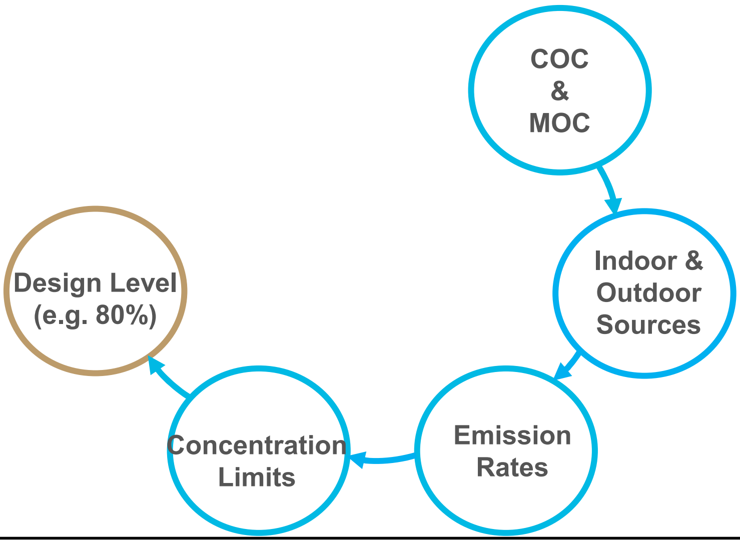
Step 5
Specify a Design Level for Perceived IAQ



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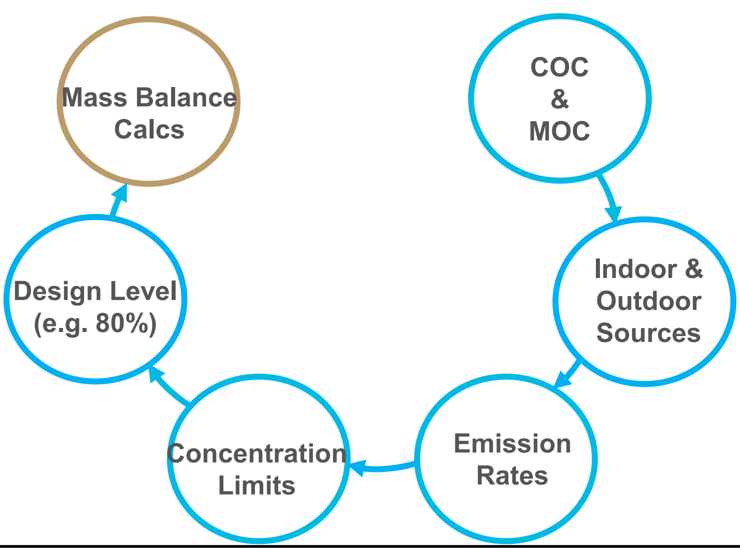
Step 6
Use Mass Balance Calculations to Determine V_{bz}



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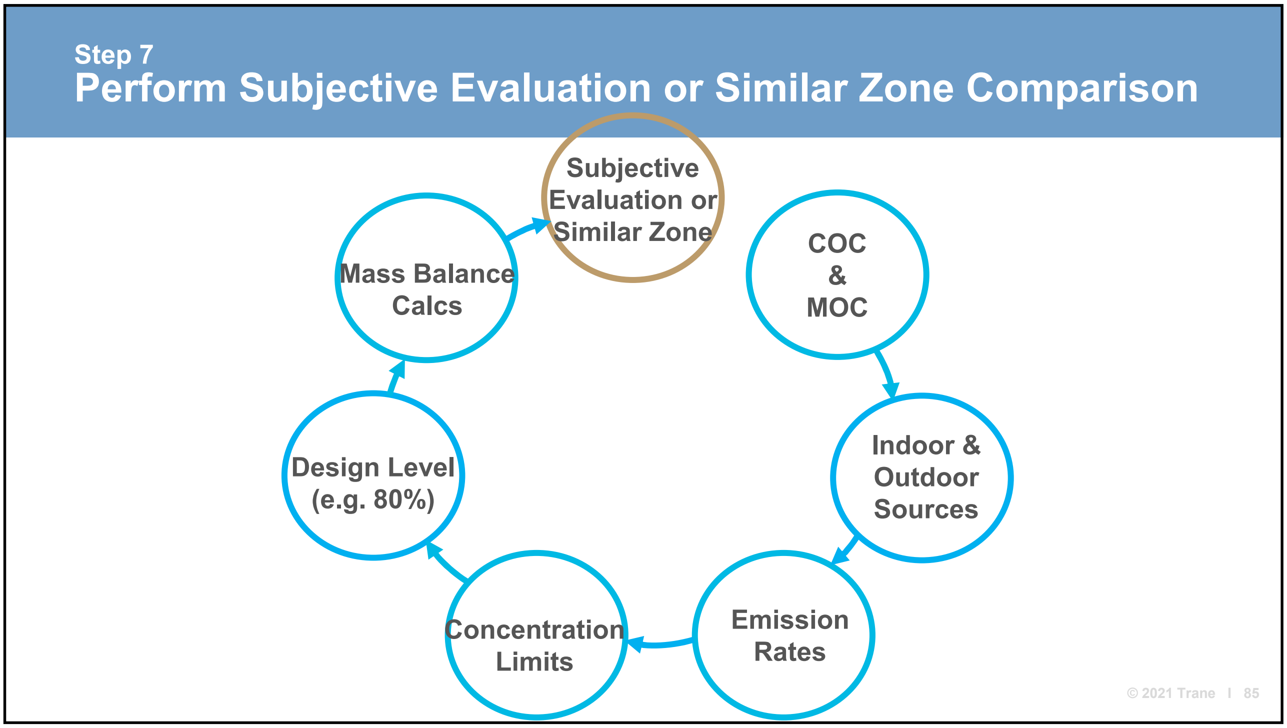
Step 7
Perform Subjective Evaluation or Similar Zone Comparison
Subjective Evaluation or Similar Zone
COC & MOC
Indoor & Outdoor Sources
Emission Rates
Concentration Limits
Design Level (e.g. 80%)
Mass Balance Calcs
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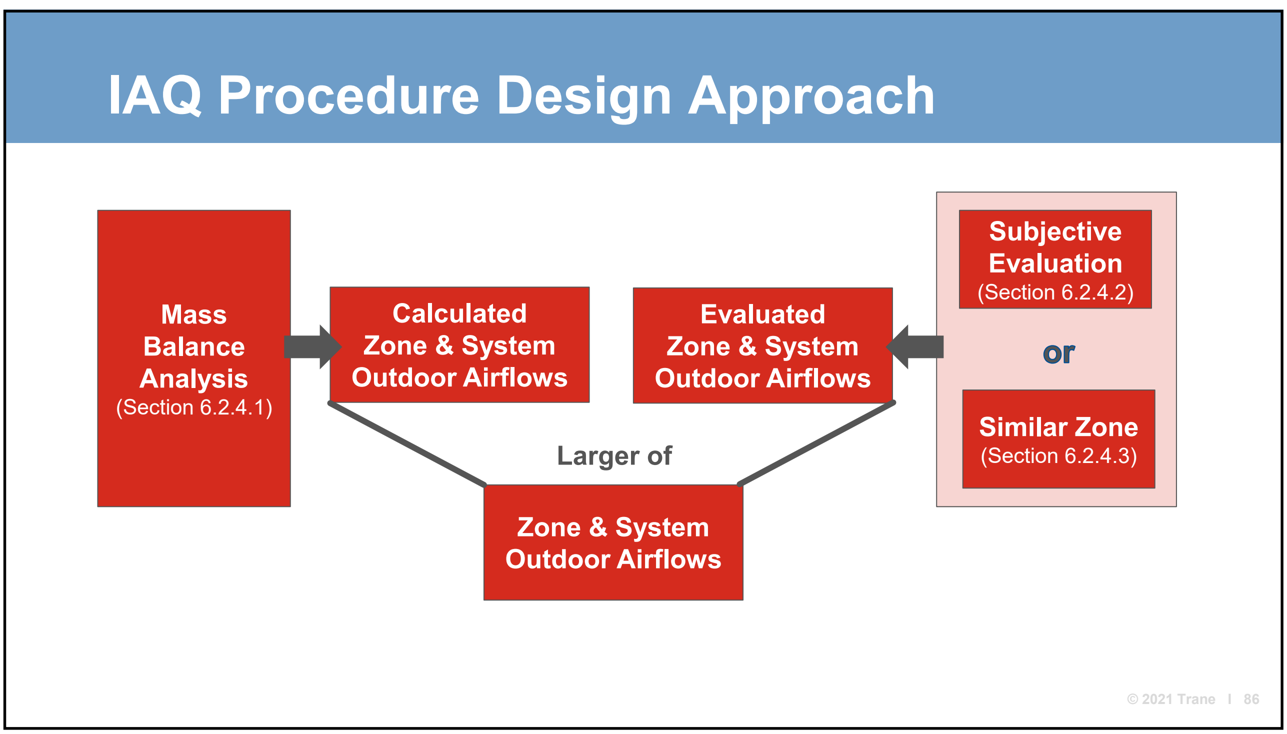
IAQ Procedure Design Approach
Mass Balance Analysis (Section 6.2.4.1)
Calculated Zone & System Outdoor Airflows
Evaluated Zone & System Outdoor Airflows
Subjective Evaluation (Section 6.2.4.2)
or
Similar Zone (Section 6.2.4.3)
Larger of
Zone & System Outdoor Airflows
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Mass Balance Analysis

- Can use steady-state or dynamic mass balance analysis
- Determine the OA rate that limits the concentration of each contaminant below the specified concentration limit
- Ensure that the sum of the ratios of contaminant concentration divided by its concentration limit is less than 1.0 for each contaminant mixture of concern

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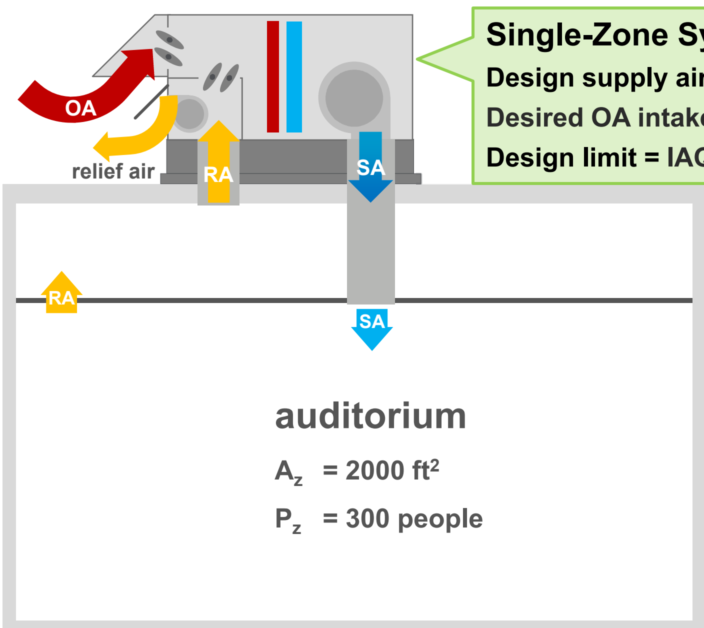

Single-Zone System

Design supply airflow = 6000 cfm (constant volume)

Desired OA intake flow = 3 cfm/person = 900 cfm

Design limit = IAQ acceptable to 80% of occupants

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IAQP Example: Auditorium

- Net occupiable floor area, A_Z = 2000 ft^2 (186 m^2)
- Peak zone population, P_Z = 300 people
- Served by a single-zone air handler with a constant-speed supply fan:
  - Design supply airflow = 6000 cfm (10,200 m^3/h)
  - Air cleaner mounted inside air handler at location B (see next slide)
- Location of supply-air diffusers = ceiling
- Location of return-air grilles = ceiling
- Desired OA intake flow = 3 cfm/person × 300 people = 900 cfm (1530 m^3/h)
- Design limit = perceived IAQ acceptable to 80% of occupants

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Appendix E: Mass Balance Equations

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

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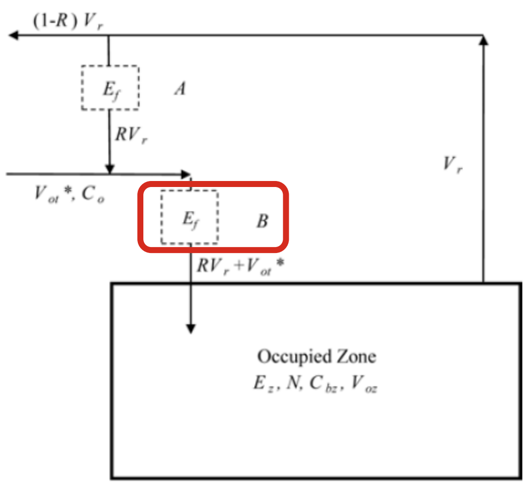

$$C_{bz} = \frac{N + E_z V_{oz}(1 - E_f)C_o}{E_z(V_{oz} + RV_r E_f)}$$

where,

C_{bz} = concentration of the contaminant in the breathing zone, mg/m^3
N = indoor generation rate of the contaminant, mg/h
E_z = zone air-distribution effectiveness
V_{oz} = zone outdoor airflow, m^3/h
E_f = air cleaner efficiency
C_o = concentration of the contaminant in the outdoor air, mg/m^3
RV_r = flow rate of recirculated air, m^3/h

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contaminant	indoor emission rate, N	outdoor air concentration, C_o	concentration limit
formaldehyde	0.064 mg/h per m^2	0.0068 mg/m^3	0.009 mg/m^3

N = 0.064 mg/h per m^2 × 186 m^2 = 11.9 mg/h
E_z = 0.8 (during heating)
V_{oz} = 1530 m^3/h (900 cfm)
E_f = 0.25 (25%)
C_o = 0.0068 mg/m^3
RV_r = 8665 m^3/h (5100 cfm)

$$C_{bz} = \frac{11.9 \text{ mg/h} + 0.8 \times 1530 \text{ m}^3\text{/h} \times (1 - 0.25) \times 0.0068 \text{ mg/m}^3}{0.8 \times (1530 \text{ m}^3\text{/h} + 8665 \text{ m}^3\text{/h} \times 0.25)} = 0.0061 \text{ mg/m}^3$$

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contaminant	breathing-zone concentration, C_{bz}
acetone	0.2195 mg/m^3
ammonia	0.1375 mg/m^3
carbon monoxide	0.6828 ppm
formaldehyde	0.0061 mg/m^3
hydrogen sulfide	0.0117 mg/m^3
methyl alcohol	0.3148 mg/m^3
nitrogen dioxide	0.0043 ppm
ozone	0.0261 ppm
phenol	0.0403 mg/m^3
sulfur dioxide	0.0006 ppm

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contaminant	breathing-zone concentration, C_{bz}	concentration limit	% of limit*	
acetone	0.2195 mg/m^3	7 mg/m^3	3%	
ammonia	0.1375 mg/m^3	0.5 mg/m^3	27%	
carbon monoxide	0.6828 ppm	9 ppm	8%	
formaldehyde	0.0061 mg/m^3	0.009 mg/m^3	68%	= (0.0061 / 0.009) × 100
hydrogen sulfide	0.0117 mg/m^3	0.04 mg/m^3	29%	
methyl alcohol	0.3148 mg/m^3	1.5 mg/m^3	21%	
nitrogen dioxide	0.0043 ppm	0.053 ppm	8%	
ozone	0.0261 ppm	0.08 ppm	33%	
phenol	0.0403 mg/m^3	0.1 mg/m^3	40%	
sulfur dioxide	0.0006 ppm	0.03 ppm	2%	

* % of limit = (C_{bz} / concentration limit) × 100

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contaminant	breathing-zone concentration, C_{bz}	concentration limit	% of limit*	affected organ systems
acetone	0.2195 mg/m^3	7 mg/m^3	3%	mucous membranes, central nervous system
ammonia	0.1375 mg/m^3	0.5 mg/m^3	27%	respiratory
carbon monoxide	0.6828 ppm	9 ppm	8%	blood
formaldehyde	0.0061 mg/m^3	0.009 mg/m^3	68%	mucous membranes, carcinogen
hydrogen sulfide	0.0117 mg/m^3	0.04 mg/m^3	29%	mucous membranes, central nervous system
methyl alcohol	0.3148 mg/m^3	1.5 mg/m^3	21%	central nervous system
nitrogen dioxide	0.0043 ppm	0.053 ppm	8%	respiratory
ozone	0.0261 ppm	0.08 ppm	33%	respiratory
phenol	0.0403 mg/m^3	0.1 mg/m^3	40%	mucous membranes, central nervous system
sulfur dioxide	0.0006 ppm	0.03 ppm	2%	respiratory

* % of limit = (C_{bz} / concentration limit) × 100

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contaminant	% of limit	mucous membranes	central nervous system	respiratory	blood	carcinogen
acetone	3%					
ammonia	27%					
carbon monoxide	8%					
formaldehyde	68%	68%				68%
hydrogen sulfide	29%					
methyl alcohol	21%					
nitrogen dioxide	8%					
ozone	33%					
phenol	40%					
sulfur dioxide	2%					

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contaminant	% of limit	mucous membranes	central nervous system	respiratory	blood	carcinogen
acetone	3%	3%	3%			
ammonia	27%			27%		
carbon monoxide	8%				8%	
formaldehyde	68%	68%				68%
hydrogen sulfide	29%	29%	29%			
methyl alcohol	21%		21%			
nitrogen dioxide	8%			8%		
ozone	33%			33%		
phenol	40%	40%	40%			
sulfur dioxide	2%			2%		
	sum =	140%	93%	70%	8%	68%

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Design Alternatives

1. Increase zone outdoor airflow (V_{oz})
2. Select different construction materials, finishes, or furnishings with lower contaminant emission rates (N)
3. Select an air cleaner with a higher efficiency (E_f)

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affected organ system	original design	Alternative 1: increase outdoor airflow (V_{oz}) to 2025 cfm
mucous membranes	140%	123%
central nervous system	93%	68%
respiratory	70%	89%
blood	8%	12%
carcinogen	68%	70%

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affected organ system	original design	Alternative 1: increase outdoor airflow (V_{oz}) to 2025 cfm	Alternative 2: reduce emission (N) of formaldehyde to 0.021 mg/h per m^2
mucous membranes	140%	123%	111%
central nervous system	93%	68%	94%
respiratory	70%	89%	70%
blood	8%	12%	8%
carcinogen	68%	70%	38%

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affected organ system	original design	Alternative 1: increase outdoor airflow (V_{oz}) to 2025 cfm	Alternative 2: reduce emission (N) of formaldehyde to 0.021 mg/h per m^2	Alternative 3: increase air cleaner efficiency (E_f) to 50%
mucous membranes	140%	123%	111%	84%
central nervous system	93%	68%	94%	59%
respiratory	70%	89%	70%	35%
blood	8%	12%	8%	3%
carcinogen	68%	70%	38%	38%

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Appendix K: Compliance

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX K COMPLIANCE

This appendix contains compliance suggestions that are intended to assist users and enforcement agencies in applying this standard.

K1. SECTION 4

- ❑ Is documentation of outdoor air quality included as required in Section 4.3?

K2. SECTION 5

- ❑ Are air balancing provisions included in design documentation as required in Section 5.1?
- ❑ If the system is a plenum system, are provisions for providing minimum breathing zone airflow specified?
- ❑ Do exhaust ducts comply with requirements of Section 5.2?
- ❑ Are ventilation systems controls specified as per Section 5.3?
- ❑ Do specifications include resistance to mold and erosion for airstream surfaces per Section 5.4?
- ❑ Are separation distances between outdoor air intakes and sources listed and in compliance with Section 5.5?
- ❑ Is there any noncombustion equipment that requires exhaust (Section 5.6)?
- ❑ Is combustion air provided for fuel-burning appliances (Section 5.8)?
- ❑ Are appropriate filters specified upstream of cooling coils or wetted surfaces (Section 5.9)?
- ❑ Are dehumidification capability and building exfiltration calculations provided (Section 5.10)?
- ❑ Do specifications for drain pans comply with requirements of Section 5.12?
- ❑ Are coils specified per requirements of Section 5.13?
- ❑ If present, do humidifiers and water spray systems comply with requirements of Section 5.14?

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Agenda

- Section 4 (Outdoor Air Quality)
- Section 5 (Systems and Equipment)
- **Section 6 (Procedures)**
  - 6.2 Ventilation Rate Procedure
  - 6.3 IAQ Procedure
  - **6.4 Natural Ventilation Procedure**
  - 6.5 Exhaust
- Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)

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Natural Ventilation Procedure

- **Prescriptive** compliance path (Section 6.4.1)
  - Tables 6-5 and 6-6 lists minimum opening sizes based on ceiling height and floor area to be ventilated
  - Typically requires a "mixed-mode" ventilation system
- **Engineered system** compliance path (Section 6.4.2)
  - Offers greater flexibility, as long as sufficient outdoor airflow (calculated using either the VRP or IAQP) reaches the breathing zone

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Prescriptive Compliance Path

6.4.1 Prescriptive Compliance Path. *Any zone designed for natural ventilation shall include a mechanical ventilation system designed in accordance with Section 6.2 (Ventilation Rate Procedure), Section 6.3 (IAQ Procedure), or both.*

Exceptions to 6.4.1:

1. *Zones in buildings that have all of the following:*
   a. *Natural ventilation openings that comply with requirements of Section 6.4.1.*
   b. *Controls that prevent the natural ventilation openings from being closed during periods of expected occupancy, or natural ventilation openings that are permanently open.*
2. *Zones that are not served by heating or cooling equipment.*

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For Either Compliance Path:

6.4.3 Control and Accessibility. *The means to open required openings shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems.*

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Agenda

- Section 4 (Outdoor Air Quality)
- Section 5 (Systems and Equipment)
- **Section 6 (Procedures)**
  - 6.2 Ventilation Rate Procedure
  - 6.3 IAQ Procedure
  - 6.4 Natural Ventilation Procedure
  - **6.5 Exhaust**
- Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)

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Exhaust

- **Prescriptive** compliance path (Section 6.5.1)
  - Table 6-2 lists design exhaust air flow rates
  - Exhaust system to be operated when the space is in use
- **Performance** compliance path (Section 6.5.2)
  - Identify contaminants (and mixtures) of concern
  - Requires monitoring contaminant levels and modulating exhaust airflow to avoid exceeding concentration limits

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Makeup (or Replacement) Air

> ***6.5 Exhaust Ventilation.*** *…Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air, or transfer air.*

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Excerpt from Table 6-2

occupancy category	exhaust rate (cfm/ft²)	exhaust rate (cfm/unit) *	air class
copy, printing room	0.50		2
janitor closet	1.0		3
kitchenette	0.30		2
locker room (athletic, industrial, health care)	0.50		2
locker room (all others)	0.25		2
toilet room (private)		25 (continuous) 50 (intermittent)	2
toilet room (public)		50 (normal use) 70 (heavy use)	2

* exhaust rate for toilet rooms is based on the number of water closets or urinals

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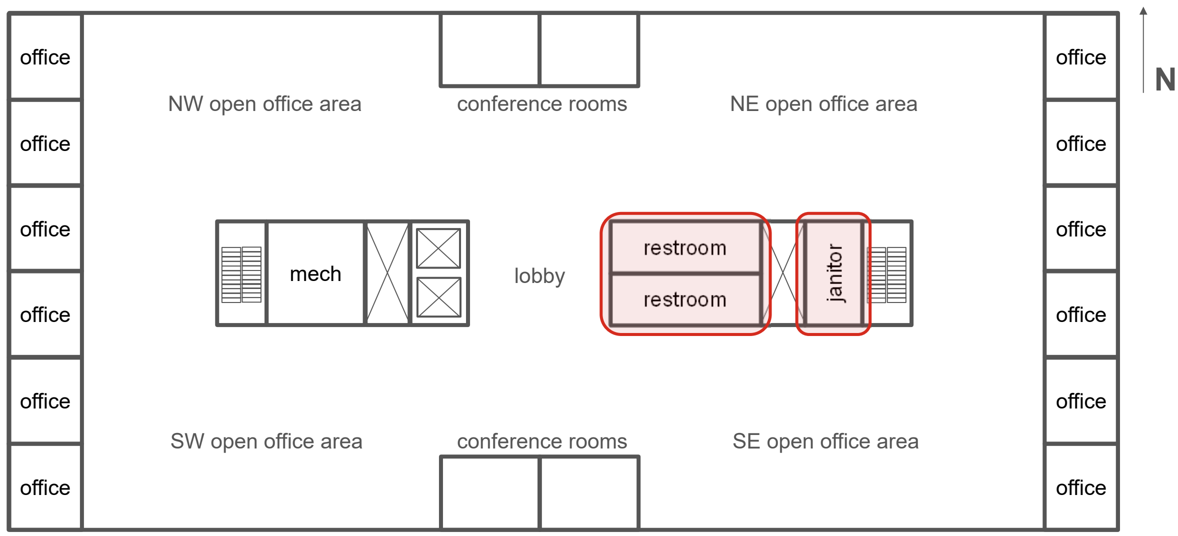
example
Floor of a Multiple-Story Office Building



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Excerpt from Table 6-2

zone	A_z (ft²)	number of units	exhaust rate (cfm/ft²)	exhaust rate (cfm/unit)	$V_{exhaust}$ (cfm)
Janitor's closet	200		1.0		200
Women's restroom		3		50	150
Men's restroom		3		50	150
				$\Sigma V_{exhaust}$ =	500

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Agenda

- Section 4 (Outdoor Air Quality)
- Section 5 (Systems and Equipment)
- Section 6 (Procedures)
  - 6.1 Ventilation Rate Procedure
  - 6.2 IAQ Procedure
  - 6.3 Natural Ventilation Procedure
  - 6.4 Exhaust
- **Section 7 (Construction and System Start-Up) and Section 8 (Operations and Maintenance)**

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Summary of Section 7 Requirements

- Systems shall not be operated without filters in place
- Protect building materials from rain and moisture
- Reduce migration of construction-generated contaminants into occupied areas
- Construct ductwork per SMACNA and NFPA standards
- Conduct air balancing and testing of OA dampers
- Test drain pans to verify drainage

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Summary of Section 8 Requirements

- Operate so *"spaces are ventilated in accordance with Section 6 during periods of expected occupancy"*
- Provide O&M manual to owner
- Follow inspection/maintenance tasks at the frequencies listed in Table 8-1

Excerpt from Table 8-1

inspection/maintenance task	frequency
Open cooling tower water systems, closed cooling tower water systems, and evaporative condensers shall be treated to limit the growth of microbiological contaminants	Monthly
Check pressure drop and scheduled replacement date of filters and air-cleaning devices. Clean or replace as necessary to ensure proper operation.	Quarterly
Visually inspect outdoor air intake louvers, bird screens, mist eliminators, and adjacent areas for cleanliness and integrity; clean as needed; remove all visible debris or visible biological material observed and repair physical damage to louvers, screens, or mist eliminators if such damage impairs the item from providing the required outdoor air entry.	Semiannually
Check drain pans, drain lines, and coils for biological growth. Check adjacent areas for evidence of unintended wetting. Repair and clean as needed.	Annually

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ASHRAE Standard 62.1-2019

Trane Engineers Newsletter Live Series

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Trane *Engineers Newsletter LIVE: ASHRAE Standard 62.1-2019*
APP-CMC077-EN QUIZ

1. TRUE or FALSE: ASHRAE Standard 62.1 requires the design team to conduct an assessment of the outdoor air quality at the building site.

2. The 2019 version of ASHRAE Standard 62.1 requires indoor humidity to be limited to no higher than 60°F dew point during ___________, with some exceptions.
   a. occupied hours only
   b. unoccupied hours only
   c. both occupied and unoccupied hours

3. Which of the following are design procedures allowed by ASHRAE Standard 62.1-2019? Select all that apply.
   a. Ventilation Rate Procedure
   b. Indoor Air Quality (IAQ) Procedure
   c. Transfer Function Procedure
   d. Natural Ventilation Procedure

4. TRUE or FALSE: For many occupancy categories, ASHRAE Standard 62.1 prescribes two ventilation rates; one for people-related contaminant sources plus one for building-related sources.

5. ASHRAE Standard 62.1 allows accounting for occupancy diversity (D) in which type of ventilation system?
   a. single-zone system
   b. 100% outdoor-air system
   c. multiple-zone recirculating system

6. TRUE or FALSE: When using the IAQ Procedure, the designer must determine all of the potential contaminants of concern for the space.

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ASHRAE Standard 62.1-2019

INDUSTRY STANDARDS AND ARTICLES

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