National Center for
Energy Management and
Building Technologies

Ventilation and IAQ
The *New* ASHRAE Std 62.1

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TABB
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Agenda

- What is and who defines IAQ?
- Why ventilate?
- Factors affecting IAQ
- ASHRAE Standard 62 today
- Basic dilution model
  - *Break*
- Ventilation rates and Ventilation Rate Procedure
- Other requirements (balancing, controls, ductwork)

Who and What Defines IAQ? /1

- There are no specific US laws or regulations
- There are only industry consensus standards
  - Definition of IAQ is a consensus statement
  - Most used definition is found in ANSI/ASHRAE Standard 62.1-2004, *Ventilation for Acceptable Indoor Air Quality*

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Who and What Defines IAQ? /2

Definition of Acceptable IAQ
per ASHRAE Std 62.1-2004

"*acceptable indoor air quality*:

HEALTH

air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities

COMFORT

and with which a substantial majority (80% or more) of people exposed to not express dissatisfaction."

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Why ventilate?

- Dilute contaminants
  - 6.2 Ventilation Rate Procedure
  - 6.3 Air Quality Procedure
- Dilute carbon dioxide
  - Appendix C
- Remove particulates
  - 5.9 Particulate Matter Removal (MERV 6+)
- Remove excess moisture
  - 5.10 Dehumidification Systems
- Remove excess heat
  - Outside of scope of Std 62

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Ventilation Standards in US

- ANSI/ASHRAE Standard 62
  - Most widely recognized standard of care in North America
- International Mechanical Code
  - In principal based on ANSI/ASHRAE Standard 62-1999
  - Uses only prescriptive approach (Table 2 1999 version)
  - Incorporated in ICC model building code

ASHRAE Standard 62 Today

- Two standards on continuous maintenance
  - Std 62.1-2004 which address commercial & institutional spaces
  - Std 62.2-2004 which addresses residential buildings
- Additional documents in development
  - User manual for 62.1
  - Guideline for 62.1

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ASHRAE Standard 62-2001

- The 2004 version is based on ASHRAE Std 62-2001 incorporates addenda
  - h, i, k, n, o, r, t, u, v, x, y, z, aa, ab, ad, ae, af

These addenda change fundamental aspects of the standard

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Addenda /1

- Major changes to the 2001 version
  - h: updates IAQ Procedure
  - i: deletes Section 4, Classification
  - k: adds Appendix K: *Application and Compliance*
  - n: rewrites *Ventilation Rate Procedures*, introduces additivity: building component+occupant component
  - o: adds Appendix I, *Guidelines For Ventilation In Smoking-permitted Areas*
  - r: adds new section 4, *Outdoor Air Quality*
  - t: clarifies issues related to liquid water in system
  - v: adds section 5.2, *Ventilation Air Distribution*
  - x: adds requirements related to indoor humidity and the building envelope

Addenda /2

- Major changes to the 2001 version (cont.)
  - y: adds new section 5.17, *Air Classification and Recirculation*
  - z: addresses air cleaning requirements for ozone (new section 6.2.1.2 *Ozone)*
  - aa: adds intake location and protection as mandatory requirement
  - ab: adds section 5.6, *Local Capture of Contaminants*
  - ad: writes new Appendix B*, Summary Of Selected Air Quality Guidelines*
  - ae: adds definitions ("cognizant authority"), adds requirements regarding air duct construction and revises Appendix D to be consistent with the revised Indoor Air Quality Procedure
  - af: implements changes to the "Purpose"and "Scope"

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ASHRAE Standard 62.1-2004 /1

- Purpose of Std 62.1
  - "… 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."
  - "… 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."
  - "… is intended to be used to guide the improvement of indoor air quality in existing buildings."

ASHRAE Standard 62.1-2004 /2

- Scope of Std 62.1
  - "… applies to all indoor or enclosed spaces that people may occupy …"
  - "… considers chemical, physical, and biological contaminants that can affect air quality."
  - "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:
    - ✓ because of the diversity of sources and contaminants in indoor air;
    - ✓ 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; and
    - ✓ because of the range of susceptibility in the population.

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Structure of Std 62.1-2004

1. Purpose
2. Scope
3. Definitions
4. Outdoor Air Quality
5. Systems and Equipment
6. Procedures
    1. General
    2. Ventilation Rate Procedure
    3. Indoor Air Quality Procedure
7. Construction and System Start-up
8. Operation and Maintenance
9. References

Appendices

- Multi-Zone Systems
- Summary of Selected Air Quality Guidelines
- Rationale For Minimum Physiological Requirements For Respiration Air Based On CO_2 Concentration
- Acceptable Mass Balance Equations For Use With Indoor Air Quality Procedure
- Ventilation Rates for Health Care Facilities, Residential Buildings, and Vehicles
- Separation of Exhaust Outlets and Outdoor Air Intakes
- Application and Compliance

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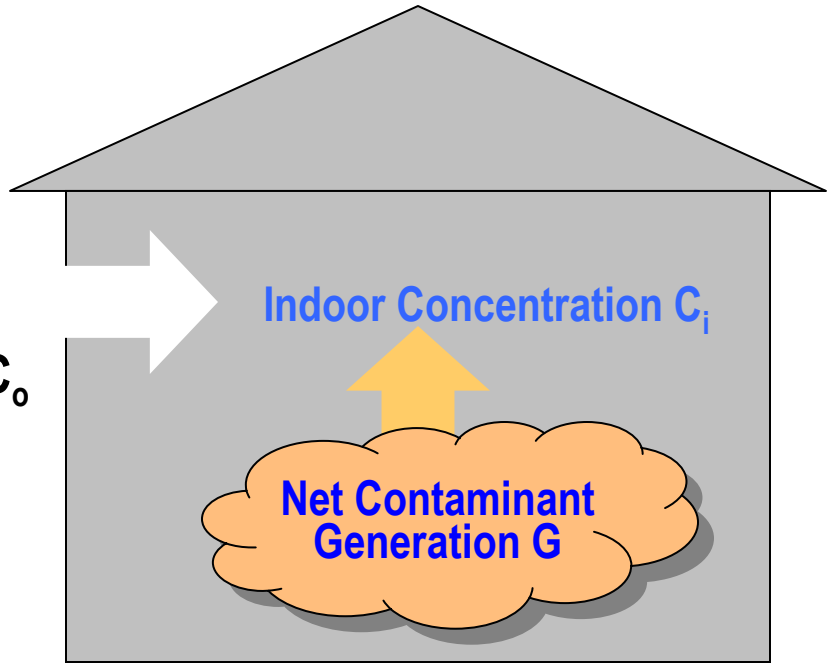
Basic Dilution Model /1

Ventilation
Airflow Rate V_o
At Concentration C_o



$$C_i = C_o + G / V_o$$

Basic Dilution Model /2

$C_i = C_o + G / V_o$ ..... Solved for V_o:

$$V_o = G / (C_i - C_o)$$

- Indoor Source Control
- Outdoor Source Control
- Dilution Goal = Desired Indoor Concentration

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Basic Dilution Model /3

Desired indoor concentration derived from definition of acceptable indoor air quality

> "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 people exposed to not express dissatisfaction"

Q: who defines what is harmful concentration?

Basic Dilution Model /4

... A: cognizant (health) authorities

- Issue
  - There are mandated levels (EPA, OSHA) vs.
  - Suggested and referenced levels (NIOSH, AGCIH)
- List of contaminants limited to ten
- HOWEVER, none are addressed in the Ventilation Rate Procedure; it assumes that C_i is acceptable if prescriptive rate is achieved

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Break ...

... until 10:30

(... opportunity to visit TABB in booth 308)

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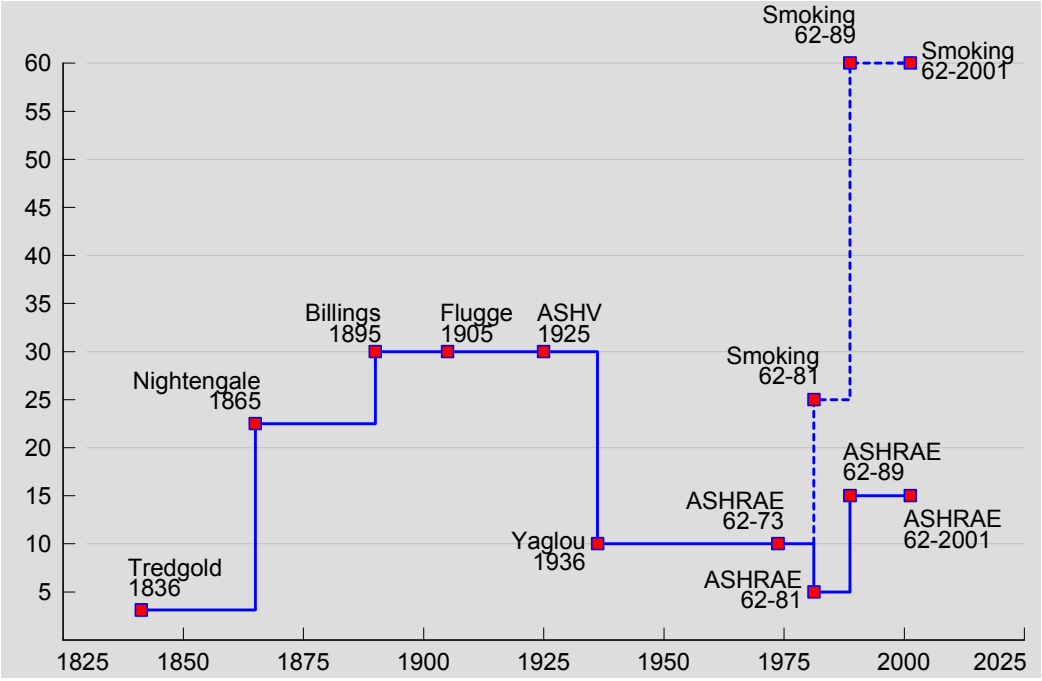
Ventilation Rates /1

- Historically derived
  - Initially health governed to avoid transmittal of infectious diseases
  - Later odor (comfort) driven



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Ventilation Rates /2

ASHRAE Standard 62 has two paths to design the ventilation system, i.e., determine the ventilation rate.

- **Ventilation Rate Procedure**
  - A prescriptive approach based on building usage, floor area and occupancy
  - Used in almost 100% of all designs
- **Air Quality Procedure**
  - A design approach based on desired indoor contaminant concentration and indoor source generation rate
  - Almost never used as too little information about contamination generation is known

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Ventilation Rate Procedure /1

- Prescriptive ventilation requirements
  - Based on the dilution model

$$V_o = G / (C_i - C_o)$$

  - Without quantifying C_o or G, assumes C_i is OK if prescribed outdoor airflow rate V_o is provided
  - Prescribes space (breathing zone) ventilation rates in Table 2

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Ventilation Rate Procedure /2

~~Dilution model: $V_o = G / (C_i - C_o)$~~

New Std 62.1 model assumes addivity of pollution sources:

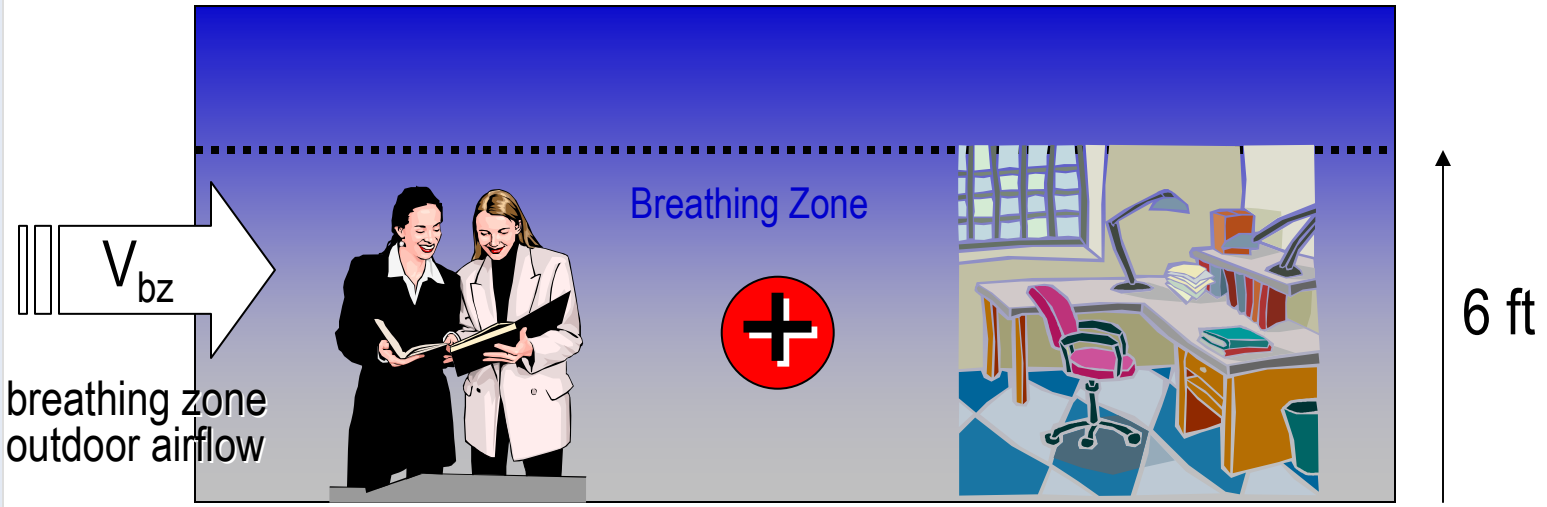
$$V_{bz} = R_p P_z - R_a A_z$$

where: $R_p P_z$ .... Source generation by occupants

$R_a A_z$ .... Source generation by building materials and furnishing

Ventilation Rate Procedure /3

New Std 62 Model: $V_{bz} = R_p P_z + R_a A_z$



R_p: OA airflow rate per person
P_z: zone population

R_a: OA airflow rate per unit area
A_z: zone floor area

New Table 2 prescribes rates (R_p cfm/p, R_a cfm/f²)

Ventilation Rate Procedure /4

Excerpt from new Table 2

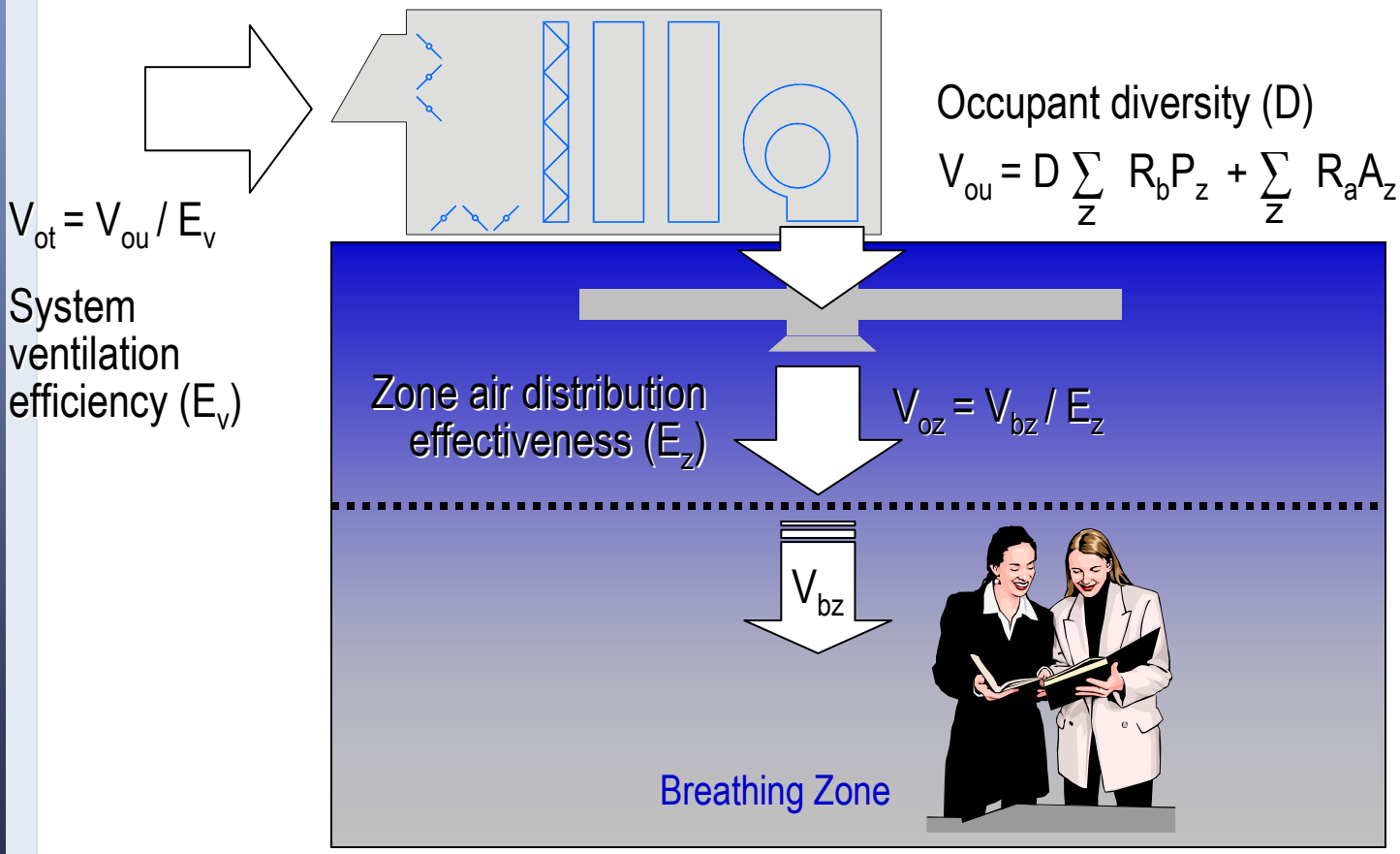
Occupancy Category	People Outdoor Rate R_p	Area Outdoor Rate R_a	Occupant Density	Combined Default Value	62-2001 Value	Air Class
	cfm/person	cfm/ft²	# / 1000 ft²	cfm/person	cfm/person	
Office space	5	0.06	5	17	20	1
Daycare (through age 4)	10	0.18	25	17	15	2
Classroom (age 5-8)	10	0.12	25	15	15	1
Classroom (age 9 plus)	10	0.12	35	13	15	1
Lecture classroom	7.5	0.06	65	8	15	1
Media center	10	0.12	25	15	--	1
Music/theater/dance	10	0.06	35	12	15	1
Restaurant dining rooms	7.5	0.18	70	10	20	2
Auditorium seating	5	0.06	150	5	15	1
Libraries	5	0.12	10	17	15	1

Ventilation Rate Procedure /5

- Factors affecting delivery of outdoor air to the breathing zone
  - Zone air distribution effectiveness (E_z) (Table 6-2)
  - System ventilation efficiency (E_v) (Table 6-3)
  - Occupant diversity (D)
    - ✓ Defined as $D = P_s \sum P_z$

where P_s = system population (peak)

Ventilation Rate Procedure /6



Ventilation System Control

Ventilation system …

- Must include controls
- Must maintain minimum outdoor airflow under any load condition
  - VAV system with fixed outdoor air damper must comply with this at minimum supply airflow
  - Air balancing is crucial (TABB)

Ventilation Air Distribution

5.2.1 Designing for Air Balancing

"The ventilation air distribution system shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow as required by Section 6 under any load condition."

- Include air balancing professional (TABB) in design stage

Varying Operating Conditions

If short-term conditions vary significantly (occupancy, ventilation rate), design may be based on average conditions over period T

$$T = 3v / V_{bz}$$

where: v …. Volume of the zone for which averaging is being applied

V_{bz} .. Breathing zone outdoor airflow

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Dynamic Reset

Design may reset outdoor air intake flow (V_{ot}) and/or zone airflow as operating conditions change

- Measures of estimating variations in occupancy
  - Occupancy schedule
  - Direct count of occupants
  - CO_2 sensing
- Variations in distribution efficiency
- Economizer operation

Air Duct System Construction

- Section 7.1.5

  "Air duct systems shall be constructed in accordance with the following standards, as applicable:"
  - SMACNA *HVAC Duct Construction Standards – Metal and Flexible*
  - SMACNA *FIBROUS Glass Duct Construction Standards*
  - NFPA Standards for Installation of Air-Conditioning and Ventilating Systems, NFPA 90A
- Include air balancing professional (TABB) in design stage

Air Balancing

- Section 7.2.2

  "… shall be balanced in accordance with ASHRAE Standard 111, SMACNA's *HVAC Systems – Testing Adjusting and Balancing* or equivalent … to verify conformance with the total outdoor air flow and space supply air flow …"
- Air balancing is crucial (TABB) to achieve and verify ventilation rates
- Consider continuous commissioning to maintain building operation at optimal, i.e., verify air balance on a periodic basis (TABB)

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