SPO Maine State Planning Office

Indoor Commercial Ventilation

Kennebec Valley Community College

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Agenda

- Title 16 Department of Public Safety
  635 (new) Bureau of Building Codes and Standards
- Course time 3 hours
- ASHRAE
- Overview of the Commercial Ventilation Code
- Resources for Information
- Navigating the Code

The New Standard

Title 16 Department of Public Safety
635 (new) Bureau of Building Codes and Standards - Maine Uniform Building and Energy Code

Chapter 1 Administrative Procedures

Purpose and Scope

- Chapter 1 sets forth procedures for each individual municipality to recognize and where applicable, enforce the MUBEC.

It further explains the code is a compilation of four different codes and four standards, which have been harmonized by identifying and resolving conflicts between the incorporated codes and standards.

Indoor Commercial Ventilation Code

- One of the referenced standards is ASHRAE Standard 62.1-2007

Ventilation for Acceptable Indoor Air Quality

ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers

Is a nationally recognized engineering organization whose standards are approved by the American National Standards Institute (ANSI).

ASHRAE

ASHRAEs standards are well known in the energy, indoor air quality, and building codes communities.

Overview of the ICVC

Incorporation by Reference

ASHRAE 62.1-2007 is included in the MUBEC as the adopted standard for ventilation.

Purpose

The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects.

Purpose

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.

Purpose

This standard is intended to be used to guide the improvement of indoor air quality in existing buildings.

Acceptable IAQ?

There are two ventilation considerations when determining indoor air quality.

1. Minimum required ventilation for the Occupants
2. Minimum required ventilation for the Building

Scope

This standard applies to spaces intended for human occupancy except those within single-family houses, multifamily structures of three stories or fewer above grade, vehicles and aircraft.

Scope

This standard defines requirements for ventilation and air-cleaning system design, installation, commissioning, and operation and maintenance.

Scope

Additional requirements for laboratory, industrial, health care, and other spaces may be dictated by workplace and other standards, as well as by the process occurring within the space.

Scope

Although the standard may be applied to both new and existing buildings, the provisions of this standard are not intended to be applied retroactively when the standard is used as a mandatory regulation or code.

Scope

This standard does not prescribe specific ventilation rate requirements for spaces that contain smoking or that do not meet the requirements in the standard for separation from spaces that contain smoking.

Scope

Ventilation requirements of this standard are based on chemical, physical, and biological contaminants that can affect air quality.

Scope

Consideration or control of thermal comfort is not included.

Scope

This standard contains requirements, in addition to ventilation, related to certain sources, including outdoor air, construction processes, moisture, and biological growth.

Scope

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;

Scope

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 many other factors that may affect occupant perception and acceptance of indoor air quality, such as air temperature, humidity, noise, lighting, and psychological stress;

Scope

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 range of susceptibility in the population; and

Scope

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 outdoor air brought into the building may be unacceptable or may not be adequately cleaned.

Resources for Information

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1791 Tullie Circle NE
Atlanta GA 30329
800-527-4723

www.ashrae.org

Resources for Information

Note the references described in Section 9.
Will review later in this course.

Navigating the Code

Let's take a closer look!

The Sections

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. References

All of the Sections in the standard are adopted in the MUBEC

Section 3

Definitions

A Few Important 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.

Definition per AHRAE 62.2-2007
Air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at a concentration that are known to pose a health risk.

A Few Important Definitions

Cognizant Authority

An agency or organization that has the expertise or jurisdiction to establish and regulate concentration limits for airborne contaminants; or an agency or organization that is recognized as authoritative and has the scope and expertise to establish guidelines, limit values, or concentration levels for airborne contaminants.

A Few Important Definitions

Air, Makeup

Any combination of outdoor and transfer air intended to replace exhaust air and exfiltration.

A Few Important Definitions

Air, Outdoor

Ambient air that enters a building through a ventilation system, through intentional openings for natural ventilation, or by infiltration.

A Few Important Definitions

Air, Recirculated

Air removed from a space and reused as supply air.

A Few Important Definitions

Air, Return

Air removed from a space to then be recirculated or exhausted.

A Few Important Definitions

Air, Supply

Air delivered by mechanical or natural ventilation to a space, composed of any combination of outdoor air, recirculated air, or transfer air.

A Few Important Definitions

Air, Transfer

Air moved from one indoor space to another.

A Few Important Definitions

Air, Ventilation

That portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

A Few Important Definitions

Breathing Zone

The region within an occupied space between planes 3 and 72 inches above the floor and more than two feet from the walls or fixed air-conditioning equipment.

A Few Important Definitions

Conditioned Space

That part of a building that is heated or cooled, or both, for the comfort of occupants.

The part of a building that is capable of being thermally conditioned for the comfort of occupants

A Few Important Definitions

Energy Recovery Ventilation System

A device or combination of devices applied to provide the outdoor air for ventilation in which energy is transferred between intake and exhaust airstreams.

A Few Important Definitions

Environmental Tobacco Smoke (ETS)

The “aged” and diluted combination of both side-stream smoke (smoke from the lit end of a cigarette or other tobacco product) and exhaled mainstream smoke (smoke that is exhaled by a smoker).

ETS is commonly referred to as second hand smoke.

A Few Important Definitions

ETS-Free Area

An area where no smoking occurs and that is separated from ETS areas according to the requirements of this standard.

A no-smoking area is not necessarily an ETS-free area.

A Few Important Definitions

ETS Area

Spaces where smoking is permitted, as well as those not separated from areas where smoking is permitted IAW the requirements of Section 5 of this standard.

A Few Important Definitions

Exfiltration

Uncontrolled outward air leakage from conditioned spaces through unintentional openings in ceilings, floors, and walls to unconditioned spaces or to the outdoors due to wind, inside – outside temperature differences (stack effect), and imbalances between supply and exhaust airflow rates.

A Few Important Definitions

Infiltration

Uncontrolled inward air leakage to conditioned spaces through unintentional openings in ceilings, floors, and walls from unconditioned spaces or the outdoors caused by the same pressure differences that induce exfiltration.

A Few Important Definitions

Mechanical Ventilation

Ventilation provided by mechanically powered equipment, such as motor driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows.

A Few Important Definitions

Natural Ventilation

Ventilation provided by thermal, wind, or diffusion effects through doors, windows or other intentional openings in the building .

A Few Important Definitions

Net Occupiable Space

The floor area of an occupiable space defined by the inside surfaces of it's walls but excluding shafts, column enclosures, and other permanently enclosed, inaccessible, and unoccupiable areas. Obstructions in the space such as furnishings, display or storage racks, and other obstructions whether temporary or permanent, may not be deducted from the space area.

A Few Important Definitions

Occupiable Space

An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only occupied occasionally and for short periods of time.

A Few Important Definitions

Ventilation

The process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space.

A Few Important Definitions

Zone

One occupied space or several occupied spaces with similar occupancy category (Table 6-1), occupant density, zone air distribution effectiveness (Section 6.2.2.2), and zone primary airflow (Section 6.2.5.1) per unit area.

A ventilation zone is not necessarily an independent thermal zone; however, spaces that can be combined for load calculations can often be combined into a single zone for ventilation calculations.

A Few Important Definitions

Heating Degree Day (HDD)

The difference in the temperature between the outdoor mean temperature over a 24 hour period and a given base temperature of a building space

Example: (for heating degree day based on 65 $^{F)}$ for any one day, when the mean temperature is less than 65 ^{F}, the heating degree days for that day are equal to the difference between the mean temperature and 65 ^{F}

Heating Degree Days

Acceptable Indoor Air Quality

Air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at a concentration that are known to pose a health risk

Heating Degree Days

"A unit of measurement used to define the amount of time the temperature is below 65 ^{F} during each day."

Heating Degree Days

HDD are determined by adding the high & low temperatures for the day, dividing that number by two and subtracting the result from 65 ^{F}.

Example: Today's high temp = 42 ^{F}
Today's low temp = 10 ^{F}

42 + 10 = 52 / 2 = 26. 65 ^{F} – 26 = 39 Heating Degree Days

Why 65 ^{F}? 65 ^{F} is the *balance point* at which indoor heating is no longer needed, due to internal gains. *Internal gain* is heat generated by appliances & occupants.

Heating Degree Days

Heating degree days can also be accumulated to average them over the course of weeks, months or years.

Annual Heating Degree Days are determined by summing all the degree days accrued over the heating season (year).

www.degreedays.net

www.degreedays.net

"A unit of measurement used to define the amount of time the temperature is below 65 ^{F} during each day."

Section 4

Outdoor Air Quality

Outdoor Air Quality

Shall be investigated IAW Sections 4.1 (Regional Air Quality) and Section 4.2 (Local Air Quality) prior to completion of ventilation system design.

Section 4.3 discusses documentation of the outdoor air quality investigation.

4.1 Regional Air Quality

Shall be investigated IAW Sections 4.1 (Regional Air Quality) and Section 4.2 (Local Air Quality) prior to completion of ventilation system design.

Section 4.3 discusses documentation of the outdoor air quality investigation.

4.1 Regional Air Quality

www.epa.gov/air/where.html

4.2 Local Air Quality

www.epa.gov/air/where.html

4.3 Documentation

Shall include reports on:

1. Regional Air Quality Compliance Status
2. Local Survey Information
3. Conclusions

Section 5

Systems and Equipment

5.1 Natural Ventilation

Use of natural ventilation systems designed IAW this section shall be permitted in lieu of or in conjunction with mechanical ventilation systems.

In certain cases, natural ventilation systems need not meet the requirements for Location and Size of Openings (5.1.1) and Control and Accessibility (5.1.2)

5.3 Exhaust Duct Location

Exhaust ducts that convey potentially harmful contaminants shall be negatively pressurized relative to spaces through which they pass, so that exhaust air cannot leak into the occupied spaces; supply, return or outdoor air ducts; or plenums.

Exception: Exhaust ducts that are sealed IAW SMACNA Seal Class A

Sheet Metal and Air Conditioning Contractors Association, Inc.
Reference HVAC Air Duct Leakage Test Manual

5.5 Airstream Surfaces

All airstream surfaces in equipment and ducts in the heating, ventilating, and air-conditioning system shall be designed and constructed to:

Resist Mold Growth

- Weather, rain entrainment, stagnation, etc

Resist Erosion

- Chemicals, structural failure, etc

5.6 Outdoor Air Intakes

Let's try an example!

A boat builder is constructing a new facility to manufacture composite parts and assemblies. A local exhaust system will be installed to remove fumes generated in the composites manufacturing process, and exhaust those fumes to the outside.

Using Table 5-1, what is the minimum distance required between the exhaust outlet of the above system, and the outdoor air intake for the building HVAC system?

5.6.2 and 5.6.3

Rain Entrainment and Rain Intrusion?

What's the difference between rain entrainme and rain intrusion?

5.6.2 and 5.6.3

Rain **Entrainment** and Rain Intrusion?

Entrainment
The movement of one fluid by another

i.e. rain being carried in via the air flow

5.6.2 and 5.6.3

Rain Entrainment and Rain **Intrusion**?

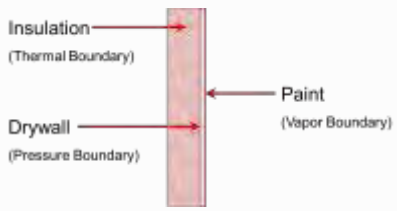
Intrusion
Rain entering the air intake structure via leaks, physical characteristics and shapes, bird screens, drip edges, etc

i.e. rain being carried in via structural leakage

5.7 Local Capture of Contaminants

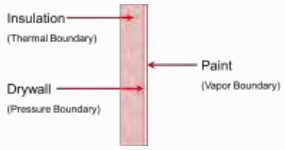
The discharge from non-combustion equipment that captures the contaminants generated by the equipment shall be directed directly to the outdoors

5.15 Building Envelope and Interior Wall Surfaces



5.15 Building Envelope and Interior Wall Surfaces

The building envelope and interior surfaces within shall be designed IAW the following:



5.15.1 Building Envelope

The building envelope, including roofs, walls, fenestration systems, and foundations shall comply with the following:

1. Weather barrier
2. Vapor retarder
3. Air sealing

5.15.2 Condensation on Interior Surfaces

Pipes, ducts, and other surfaces within the building envelope whose surface temperature are expected to fall below the surrounding dew point temperature shall be insulated.

The insulation system thermal resistance (R) and material characteristics shall be sufficient to prevent condensation from forming on the exposed surface and within the insulating material.

5.15.2 Condensation on Interior Surfaces

Pipes, ducts, and other surfaces within the building envelope whose surface temperature are expected to fall below the surrounding dew point temperature shall be insulated.

The insulation system thermal resistance (R) and material characteristics shall be sufficient to prevent condensation from forming on the exposed surface and within the insulating material.

Exceptions:

1. Where condensate will wet only surfaces that can be managed to prevent or control mold growth
2. Where local practice has demonstrated that condensation does not result in mold growth

5.17 Air Classification and Recirculation

Air shall be classified, and it's recirculation shall be limited IAW the following sections:

5.17.1 Classification

Return, transfer or exhaust air leaving each space or location shall be designated at an expected air quality classification not less than that shown in Tables 5-2 or 6-1 or as approved by the authority having jurisdiction.

5.17.1 Classification

Classification of air from smoking spaces is not addressed

Air Classifications

CLASS 1

Air with low contaminant concentration, low sensory irritation intensity, and offensive odor.

Air Classifications

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 Classifications

CLASS 3

Air with significant contaminant concentration, significant sensory irritation intensity, or offensive odor.

Air Classifications

CLASS 4

Air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases, at concentrations high enough to be considered harmful.

5.17.2 Re-designation

It is possible to re-designate air, and put it to effective use, rather than discharge it as exhaust air.

The following is a brief discussion on this.

5.17.2.1 Air Cleaning

Air leaving a space or location may be cleaned and reclassified in accordance with this section.

5.17.2.2 Energy Recovery

Class 2 air may be re-designated as Class 1 air in the process of recovering energy when it is diluted with outdoor air such that no more than 10% of the resulting airstream is Class 2 air.

5.17.2.2 Energy Recovery

Class 3 air may be re-designated as Class 1 air in the process of recovering energy when it is diluted with outdoor air such that no more than 5% of the resulting airstream is Class 3 air.

5.17.2.3 Transfer

A mixture of air that has been transferred through or returned from more than one classification of space must be re-designated with the classification appropriate for the part of the mixture that has the highest contamination concentration.

Example:

Air returned from both a Class 1 and Class 2 space served by a common system must be designated as Class 2 air.

New Terms

Our next discussion addresses some new terms, so we will chat about those first.

New Terms

These involve the two methods of compliance.

Ventilation Rate Procedure

A *prescriptive* procedure in which outdoor air intake rates are determined based on

- Space type/application
- Occupancy level
- Floor area

New Terms

These involve the two methods of compliance.

Indoor Air Quality (IAQ) Procedure

A *design* procedure in which outdoor air intake rates and other system design parameters are based on

- Analysis of contaminant sources
- Concentration targets
- Perceived acceptability targets

New Terms

These involve the two methods of compliance.

Ventilation Rate Procedure

IAQ Procedure

These were the simplified descriptions.
More on this later!

5.17.3 Recirculation Limitations

When the Ventilation Rate Procedure is used to determine air flow values, recirculation of air shall be IAW the following

Class 1 Air may be recirculated or transferred to any space

5.17.3.2 Recirculation Limitations

When the Ventilation Rate Procedure is used to determine air flow values, recirculation of air shall be IAW the following

Class 2 Air may be

- Recirculated within it's origin space
- Transferred or transferred to similar Class 2 or 3 areas
- Recirculated or transferred to Class 4 spaces

Class 2 Air shall not be recirculated or transferred to Class 1 spaces

5.17.3.3 Recirculation Limitations

When the Ventilation Rate Procedure is used, recirculation of air shall be IAW the following

Class 3 Air recirculated within it's origin space

Class 3 Air shall not be recirculated or transferred to any other space

5.17.3.4 Recirculation Limitations

When the Ventilation Rate Procedure is used, recirculation of air shall be IAW the following

Class 4 Air shall not be recirculated or transferred to any space nor recirculated within the space of origin

Section 6

Procedures

General

This section does not apply to natural ventilation systems, as they were covered in Section 5.1.

6.1 General

Two options to comply with ventilation requirements

Ventilation Rate Procedure

Indoor Air Quality Procedure

6.1.1

Ventilation Rate Procedure

This is a *prescriptive* procedure in which outdoor air intake rates are based on

- Space type/application
- Occupancy level
- Floor area

6.1.1

Ventilation Rate Procedure

These air flow rates are based on contaminant sources and strengths that are typical for those areas, such as…

- Restaurants
- Wood shops
- Classrooms
- Beauty salons, etc

6.1.2

Indoor Air Quality (IAQ) Procedure

This is a *design* procedure in which outdoor air intake rates and other system design parameters are based on analysis of

- Contaminant sources
- Contaminant concentration targets
- Perceived acceptability targets

6.1.2

Indoor Air Quality (IAQ) Procedure

The IAQ Procedure allows credit to be taken for controls that remove contaminants or for other design techniques that can be reliably demonstrated to result in indoor contaminant concentrations equal to or lower than those achieved using the Ventilation Rate Procedure

This gets a little more sophisticated, as we still have to know the requirements of the Ventilation rate procedure!

6.2 Ventilation Rate Procedure

The design Outdoor Air Intake Flow (V_{ot}) for a ventilation system shall be determined IAW sections 6.2.1 through 6.2.9

- 6.2.1 Outdoor air treatment - when outdoor air is unacceptable
- 6.2.2 Zone calculations – for multi zone systems
- 6.2.3 Single zone systems
- 6.2.4 100% outdoor air systems
- 6.2.5 Multi zone recirculating systems
- 6.2.6 Design for varying operating conditions
- 6.2.7 Dynamic reset
- 6.2.8 Exhaust ventilation
- 6.2.9 Ventilation in smoking areas

6.2 Ventilation Rate Procedure

- 6.2.1 Outdoor air treatment - when outdoor air is unacceptable
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- 6.2.6 Design for varying operating conditions
- 6.2.7 Dynamic reset
- 6.2.8 Exhaust ventilation
- 6.2.9 Ventilation in smoking areas

Each Section contains an equation to determine required *outdoor air intake flow*

6.2 Ventilation Rate Procedure

- 6.2.1 Outdoor air treatment - when outdoor air is unacceptable
- 6.2.2 Zone calculations – for multi zone systems
- 6.2.3 Single zone systems
- 6.2.4 100% outdoor air systems
- 6.2.5 Multi zone recirculating systems
- 6.2.6 Design for varying operating conditions
- 6.2.7 Dynamic reset
- 6.2.8 Exhaust ventilation
- 6.2.9 Ventilation in smoking areas

Let's take a look at a single zone system for example

6.3 Single Zone Systems

- 6.2.3 Single zone systems

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

V_{ot} Outdoor air intake flow
(design outdoor airflow required at the air intake)

V_{oz} Zone outdoor airflow
(design airflow required in the zone)
$V_{oz} = V_{bz} / E_z$

Appendix A – Definitions *See page 22*

6.3 Single Zone Systems

- 6.2.3 Single zone systems

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

V_{oz} Zone outdoor airflow
(design airflow required in the zone)
$V_{oz} = V_{bz} / E_z$

First thing we have to do is figure out V_{bz}

6.3 Single Zone Systems

First thing we have to do is figure out V_{bz}

$V_{bz} = R_p \times P_z + R_a \times A_z$ (Breathing Zone Outdoor Airflow)

862.5 + 864 = 1726.5

Table 6-1

R_p	People Outdoor Air Rate	7.5 cfm
P_z	Zone Population (largest number expected)	115
R_a	Area Outdoor Air Rate (outdoor airflow per unit)	0.18 cfm/ft^2
A_z	Zone Floor Area (net occupiable floor area)	4,800 ft^2

"We'll use a 4,800 square foot cocktail lounge as our example"

6.3 Single Zone Systems

- 6.2.3 Single zone systems

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

V_{oz} Zone outdoor airflow (design airflow required in the zone)

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

So V_{bz} = 1726.5

Now we just have to figure out E_Z. That's easy. Just look at Table 6.2. In this case, we'll use a ceiling supply (15 ^{F} or more above space temp) and ceiling return.

6.3 Single Zone Systems

- 6.2.3 Single zone systems

Equation: Outdoor intake Airflow (V_{ot}) = V_{oz}

V_{oz} Zone outdoor airflow (design airflow required in the zone)

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

V_{bz} = 1726.5

Divide that by E_Z(.8) = 2158

So now we know that V_{oz} is 2158

Which means that V_{ot} is 2158 cfm

6.3 Single Zone Systems

- 6.2.3 Single zone systems

Equation: Outdoor Intake Airflow (V_{ot}) = Zone Outdoor Airflow (V_{oz})

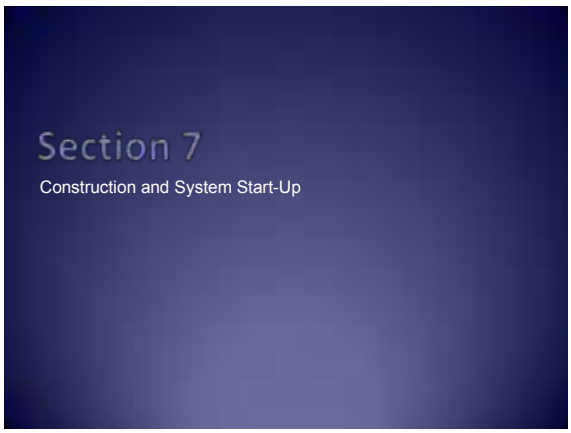
So using the Ventilation Rate Procedure, the required Outdoor Intake Airflow for our cocktail lounge is 2158 cfm.

6.2.7 Dynamic Reset

Another method to meet required ventilation using the Ventilation Rate Procedure is to install a Dynamic Reset System.

These systems are designed to reset the required intake airflow by using

- Time of day schedules
- Direct count of occupants
- Occupant sensors (CO_2 concentration sensors)



7.1.5 Air Duct Construction

Notice that the construction of ducting is regulated under SMACNA and NFPA directives

Sheet Metal and Air Conditioning Contractors National Association

7.2 System Start-Up

General commissioning procedures apply to

1. Newly installed air handling systems
2. Existing air handling systems undergoing supply air or outdoor airflow reduction
3. Existing air handling distribution systems undergoing alterations affecting more than 25% of the floor area served by the system

(only the requirements of section 7.2.2 shall apply to items 2 and 3 above)

Section 8

Operations and Maintenance

8.1.3

Building Alterations or Change of Use

Ventilation system design, operation, and maintenance shall be reevaluated when changes in building use or occupancy category, significant building alterations, significant changes in occupancy density, or other changes inconsistent with system design assumptions are made

Section 9

References

Review of References

Appendix A - I

Detailed page by page group discussion on the appendices

Indoor Commercial Ventilation

Questions?
Comments?
Discussion?