

# CHAPTER 4

## VENTILATION

### SECTION 401 GENERAL

**401.1 Scope.** This chapter shall govern the ventilation of spaces within a building intended to be occupied. Mechanical exhaust systems, including exhaust systems serving clothes dryers and cooking appliances; hazardous exhaust systems; dust, stock and refuse conveyor systems; subslab soil exhaust systems; smoke control systems; energy recovery ventilation systems and other systems specified in Section 502 shall comply with Chapter 5.

**401.2 Ventilation required.** Every occupied space shall be ventilated by natural means in accordance with Section 402 or by mechanical means in accordance with Section 403. Where the air infiltration rate in a dwelling unit is less than 5 air changes per hour when tested with a blower door at a pressure of 0.2-inch water column (50 Pa) in accordance with Section 402.4.1.2 of the *International Energy Conservation Code*, the dwelling unit shall be ventilated by mechanical means in accordance with Section 403.

**401.3 When required.** Ventilation shall be provided during the periods that the room or space is occupied.

**401.4 Intake opening location.** Air intake openings shall comply with all of the following:

1. Intake openings shall be located a minimum of 10 feet (3048 mm) from lot lines or buildings on the same lot.
2. Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) horizontally from any hazardous or noxious contaminant source, such as vents, streets, alleys, parking lots and loading docks, except as specified in Item 3 or Section 501.2.1. Outdoor air intake openings shall be permitted to be located less than 10 feet (3048 mm) horizontally from streets, alleys, parking lots and loading docks provided that the openings are located not less than 25 feet (7620 mm) vertically above such locations. Where openings front on a street or public way, the distance shall be measured from the closest edge of the street or public way.
3. Intake openings shall be located not less than 3 feet (914 mm) below contaminant sources where such sources are located within 10 feet (3048 mm) of the opening.
4. Intake openings on structures in flood hazard areas shall be at or above the elevation required by Section 1612 of the *International Building Code* for utilities and attendant equipment.

**401.5 Intake opening protection.** Air intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles. Openings in louvers, grilles and screens shall be sized in accordance with Table 401.5, and shall be protected against local weather conditions. Louvers

that protect air intake openings in structures located in hurricane-prone regions, as defined in the *International Building Code*, shall comply with AMCA 550. Outdoor air intake openings located in exterior walls shall meet the provisions for exterior wall opening protectives in accordance with the *International Building Code*.

**TABLE 401.5  
OPENING SIZES IN LOUVERS, GRILLES AND SCREENS  
PROTECTING AIR INTAKE OPENINGS**

OUTDOOR OPENING TYPE	MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION
Intake openings in residential occupancies	Not < 1/4 inch and not > 1/2 inch
Intake openings in other than residential occupancies	> 1/4 inch and not > 1 inch

For SI: 1 inch = 25.4 mm.

**401.6 Contaminant sources.** Stationary local sources producing airborne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 5 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an *approved* location at the exterior of the building.

### SECTION 402 NATURAL VENTILATION

**[B] 402.1 Natural ventilation.** *Natural ventilation* of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

**[B] 402.2 Ventilation area required.** The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.

**[B] 402.3 Adjoining spaces.** Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the opening to the adjoining rooms shall be unobstructed and shall have an area not less than 8 percent of the floor area of the interior room or space, but not less than 25 square feet (2.3 m<sup>2</sup>). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

**Exception:** Exterior openings required for ventilation shall be permitted to open into a thermally isolated sunroom addition or patio cover, provided that the openable area between the sunroom addition or patio cover and the interior room has an area of not less than 8 percent of the floor area of the interior room or space, but not less than 20 square feet (1.86 m<sup>2</sup>). The minimum openable area to

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the outdoors shall be based on the total floor area being ventilated.

**[B] 402.4 Openings below grade.** Where openings below grade provide required *natural ventilation*, the outside horizontal clear space measured perpendicular to the opening shall be one and one-half times the depth of the opening. The depth of the opening shall be measured from the average adjoining ground level to the bottom of the opening.

### SECTION 403 MECHANICAL VENTILATION

**403.1 Ventilation system.** Mechanical ventilation shall be provided by a method of supply air and return or *exhaust air*. The amount of supply air shall be approximately equal to the amount of return and *exhaust air*. The system shall not be prohibited from producing negative or positive pressure. The system to convey *ventilation air* shall be designed and installed in accordance with Chapter 6.

**403.2 Outdoor air required.** The minimum outdoor airflow rate shall be determined in accordance with Section 403.3. Ventilation supply systems shall be designed to deliver the required rate of outdoor airflow to the *breathing zone* within each *occupiable space*.

**Exception:** Where the *registered design professional* demonstrates that an engineered ventilation system design will prevent the maximum concentration of contaminants from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design.

**403.2.1 Recirculation of air.** The outdoor air required by Section 403.3 shall not be recirculated. Air in excess of that required by Section 403.3 shall not be prohibited from being recirculated as a component of supply air to building spaces, except that:

1. Ventilation air shall not be recirculated from one *dwelling* to another or to dissimilar occupancies.
2. Supply air to a swimming pool and associated deck areas shall not be recirculated unless such air is dehumidified to maintain the relative humidity of the area at 60 percent or less. Air from this area shall not be recirculated to other spaces where more than 10 percent of the resulting supply airstream consists of air recirculated from these spaces.
3. Where mechanical exhaust is required by Note b in Table 403.3, recirculation of air from such spaces shall be prohibited. All air supplied to such spaces

shall be exhausted, including any air in excess of that required by Table 403.3.

4. Where mechanical exhaust is required by Note g in Table 403.3, mechanical exhaust is required and recirculation is prohibited where more than 10 percent of the resulting supply airstream consists of air recirculated from these spaces.

**403.2.2 Transfer air.** Except where recirculation from such spaces is prohibited by Table 403.3, air transferred from occupiable spaces is not prohibited from serving as *makeup air* for required exhaust systems in such spaces as kitchens, baths, toilet rooms, elevators and smoking lounges. The amount of transfer air and *exhaust air* shall be sufficient to provide the flow rates as specified in Section 403.3. The required outdoor airflow rates specified in Table 403.3 shall be introduced directly into such spaces or into the occupied spaces from which air is transferred or a combination of both.

**403.3 Outdoor airflow rate.** Ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with this section. The occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3. Ventilation rates for occupancies not represented in Table 403.3 shall be those for a listed *occupancy* classification that is most similar in terms of occupant density, activities and building construction; or shall be determined by an *approved* engineering analysis. The ventilation system shall be designed to supply the required rate of *ventilation air* continuously during the period the building is occupied, except as otherwise stated in other provisions of the code.

With the exception of smoking lounges, the ventilation rates in Table 403.3 are based on the absence of smoking in occupiable spaces. Where smoking is anticipated in a space other than a smoking lounge, the ventilation system serving the space shall be designed to provide ventilation over and above that required by Table 403.3 in accordance with accepted engineering practice.

**Exception:** The occupant load is not required to be determined based on the estimated maximum occupant load rate indicated in Table 403.3 where *approved* statistical data document the accuracy of an alternate anticipated occupant density.

**403.3.1 Zone outdoor airflow.** The minimum outdoor airflow required to be supplied to each zone shall be determined as a function of *occupancy* classification and space air distribution effectiveness in accordance with Sections 403.3.1.1 through 403.3.1.3.

**TABLE 403.3  
MINIMUM VENTILATION RATES**

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT <sup>2</sup> <sup>a</sup>	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R <sub>p</sub> CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R <sub>a</sub> CFM/FT <sup>2</sup> <sup>a</sup>	EXHAUST AIRFLOW RATE CFM/FT <sup>2</sup> <sup>a</sup>
<b>Correctional facilities</b>				
Cells				
without plumbing fixtures	25	5	0.12	—
with plumbing fixtures <sup>g</sup>	25	5	0.12	1.0
Dining halls (see food and beverage service)	—	—	—	—
Guard stations	15	5	0.06	—
Day room	30	5	0.06	—
Booking/waiting	50	7.5	0.06	—
<b>Dry cleaners, laundries</b>				
Coin-operated dry cleaner	20	15	—	—
Coin-operated laundries	20	7.5	0.06	—
Commercial dry cleaner	30	30	—	—
Commercial laundry	10	25	—	—
Storage, pick up	30	7.5	0.12	—
<b>Education</b>				
Auditoriums	150	5	0.06	—
Corridors (see public spaces)	—	—	—	—
Media center	25	10	0.12	—
Sports locker rooms <sup>g</sup>	—	—	—	0.5
Music/theater/dance	35	10	0.06	—
Smoking lounges <sup>b</sup>	70	60	—	—
Day care (through age 4)	25	10	0.18	—
Classrooms (ages 5-8)	25	10	0.12	—
Classrooms (age 9 plus)	35	10	0.12	—
Lecture classroom	65	7.5	0.06	—
Lecture hall (fixed seats)	150	7.5	0.06	—
Art classroom <sup>g</sup>	20	10	0.18	0.7
Science laboratories <sup>g</sup>	25	10	0.18	1.0
Wood/metal shops <sup>g</sup>	20	10	0.18	0.5
Computer lab	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Locker/dressing rooms <sup>g</sup>	—	—	—	0.25
<b>Food and beverage service</b>				
Bars, cocktail lounges	100	7.5	0.18	—
Cafeteria, fast food	100	7.5	0.18	—
Dining rooms	70	7.5	0.18	—
Kitchens (cooking) <sup>b</sup>	—	—	—	0.7
<b>Hospitals, nursing and convalescent homes</b>				
Autopsy rooms <sup>b</sup>	—	—	—	0.5
Medical procedure rooms	20	15	—	—
Operating rooms	20	30	—	—
Patient rooms	10	25	—	—
Physical therapy	20	15	—	—
Recovery and ICU	20	15	—	—

(continued)

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TABLE 403.3—continued  
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT <sup>2 a</sup>	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R <sub>p</sub> CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R <sub>a</sub> CFM/FT <sup>2 a</sup>	EXHAUST AIRFLOW RATE CFM/FT <sup>2 a</sup>
<b>Hotels, motels, resorts and dormitories</b>				
Multipurpose assembly		5	0.06	—
Bathrooms/toilet—private <sup>d</sup>		—	—	25/50 <sup>f</sup>
Bedroom/living room		5	0.06	—
Conference/meeting		5	0.06	—
Dormitory sleeping areas		5	0.06	—
Gambling casinos		7.5	0.18	—
Lobbies/prefunction		7.5	0.06	—
<b>Offices</b>				
Conference rooms	50	5	0.06	—
Office spaces	5	5	0.06	—
Reception areas	30	5	0.06	—
Telephone/data entry	60	5	0.06	—
Main entry lobbies	10	5	0.06	—
<b>Private dwellings, single and multiple</b>				
Garages, common for multiple units <sup>b</sup>	—	—	—	0.75
Garages, separate for each dwelling <sup>b</sup>	—	—	—	100 cfm per car
Kitchens <sup>b</sup>	—	—	—	25/100 <sup>f</sup>
Living areas <sup>c</sup>	Based upon number of bedrooms. First bed- room, 2; each addi- tional bedroom, 1	0.35 ACH but not less than 15 cfm/person	—	—
Toilet rooms and bathrooms <sup>e</sup>	—	—	—	20/50 <sup>f</sup>
<b>Public spaces</b>				
Corridors	—	—	0.06	—
Elevator car	—	—	—	1.0
Shower room (per shower head) <sup>g</sup>	—	—	—	50/20 <sup>f</sup>
Smoking lounges <sup>b</sup>	70	60	—	—
Toilet rooms — public <sup>e</sup>	—	—	—	50/70 <sup>e</sup>
Places of religious worship	120	5	0.06	—
Courtrooms	70	5	0.06	—
Legislative chambers	50	5	0.06	—
Libraries	10	5	0.12	—
Museums (children's)	40	7.5	0.12	—
Museums/galleries	40	7.5	0.06	—
<b>Retail stores, sales floors and showroom floors</b>				
Sales (except as below)	15	7.5	0.12	—
Dressing rooms	—	—	—	0.25
Mall common areas	40	7.5	0.06	—
Shipping and receiving	—	—	0.12	—
Smoking lounges <sup>b</sup>	70	60	—	—
Storage rooms	—	—	0.12	—
Warehouses (see storage)	—	—	—	—

(continued)

TABLE 403.3—continued  
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT <sup>2</sup> <sup>a</sup>	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, <i>R<sub>p</sub></i> CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, <i>R<sub>a</sub></i> CFM/FT <sup>2</sup> <sup>a</sup>	EXHAUST AIRFLOW RATE CFM/FT <sup>2</sup> <sup>a</sup>
<b>Specialty shops</b>				
Automotive motor-fuel dispensing stations <sup>b</sup>	—	—	—	1.5
Barber	25	7.5	0.06	0.5
Beauty salons <sup>b</sup>	25	20	0.12	0.6
Nail salons <sup>b, h</sup>	25	20	0.12	0.6
Embalming room <sup>b</sup>	—	—	—	2.0
Pet shops (animal areas) <sup>b</sup>	10	7.5	0.18	0.9
Supermarkets	8	7.5	0.06	—
<b>Sports and amusement</b>				
Disco/dance floors	100	20	0.06	—
Bowling alleys (seating areas)	40	10	0.12	—
Game arcades	20	7.5	0.18	—
Ice arenas without combustion engines	—	—	0.30	0.5
Gym, stadium, arena (play area)	—	—	0.30	—
Spectator areas	150	7.5	0.06	—
Swimming pools (pool and deck area)	—	—	0.48	—
Health club/aerobics room	40	20	0.06	—
Health club/weight room	10	20	0.06	—
<b>Storage</b>				
Repair garages, enclosed parking garages <sup>b, d</sup>	—	—	—	0.75
Warehouses	—	—	0.06	—
<b>Theaters</b>				
Auditoriums (see education)	—	—	—	—
Lobbies	150	5	0.06	—
Stages, studios	70	10	0.06	—
Ticket booths	60	5	0.06	—
<b>Transportation</b>				
Platforms	100	7.5	0.06	—
Transportation waiting	100	7.5	0.06	—
<b>Workrooms</b>				
Bank vaults/safe deposit	5	5	0.06	—
Darkrooms	—	—	—	1.0
Copy, printing rooms	4	5	0.06	0.5
Meat processing <sup>c</sup>	10	15	—	—
Pharmacy (prep. area)	10	5	0.18	—
Photo studios	10	5	0.12	—
Computer (without printing)	4	5	0.06	—

For SI: 1 cubic foot per minute = 0.0004719 m<sup>3</sup>/s, 1 ton = 908 kg, 1 cubic foot per minute per square foot = 0.00508 m<sup>3</sup>/(s · m<sup>2</sup>), °C = [(°F) - 32]/1.8, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Based upon *net occupiable floor area*.
- b. Mechanical exhaust required and the recirculation of air from such spaces is prohibited (see Section 403.2.1, Item 3).
- c. Spaces unheated or maintained below 50°F are not covered by these requirements unless the occupancy is continuous.
- d. Ventilation systems in enclosed parking garages shall comply with Section 404.
- e. Rates are per water closet or urinal. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.
- f. Rates are per room unless otherwise indicated. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.
- g. Mechanical exhaust is required and recirculation is prohibited except that recirculation shall be permitted where the resulting supply airstream consists of not more than 10 percent air recirculated from these spaces (see Section 403.2.1, Items 2 and 4).
- h. For nail salons, each nail station shall be provided with a *source capture system* capable of exhausting not less than 50 cfm per station.

**403.3.1.1 Breathing zone outdoor airflow.** The outdoor airflow rate required in the *breathing zone* ( $V_{bz}$ ) of the *occupiable space* or spaces in a zone shall be determined in accordance with Equation 4-1.

$$V_{bz} = R_p P_z + R_a A_z \quad \text{(Equation 4-1)}$$

where:

$A_z$  = Zone floor area: the *net occupiable floor area* of the space or spaces in the zone.

$P_z$  = Zone population: the number of people in the space or spaces in the zone.

$R_p$  = People outdoor air rate: the outdoor airflow rate required per person from Table 403.3.

$R_a$  = Area outdoor air rate: the outdoor airflow rate required per unit area from Table 403.3.

**403.3.1.2 Zone air distribution effectiveness.** The zone air distribution effectiveness ( $E_z$ ) shall be determined using Table 403.3.1.2.

**TABLE 403.3.1.2**  
**ZONE AIR DISTRIBUTION EFFECTIVENESS<sup>a,b,c,d,e</sup>**

Air Distribution Configuration	$E_z$
Ceiling or floor supply of cool air	1.0 <sup>f</sup>
Ceiling or floor supply of warm air and floor return	1.0
Ceiling supply of warm air and ceiling return	0.8 <sup>g</sup>
Floor supply of warm air and ceiling return	0.7
Makeup air drawn in on the opposite side of the room from the exhaust and/or return	0.8
Makeup air drawn in near to the exhaust and/or return location	0.5

For SI: 1 foot = 304.8 mm, 1 foot per minute = 0.00506 m/s,

$$^{\circ}\text{C} = [(^{\circ}\text{F}) - 32]/1.8.$$

- a. "Cool air" is air cooler than space temperature.
- b. "Warm air" is air warmer than space temperature.
- c. "Ceiling" includes any point above the breathing zone.
- d. "Floor" includes any point below the breathing zone.
- e. "Makeup air" is air supplied or transferred to a zone to replace air removed from the zone by exhaust or return systems.
- f. Zone air distribution effectiveness of 1.2 shall be permitted for systems with a floor supply of cool air and ceiling return, provided that low-velocity displacement ventilation achieves unidirectional flow and thermal stratification.
- g. Zone air distribution effectiveness of 1.0 shall be permitted for systems with a ceiling supply of warm air, provided that supply air temperature is less than 15°F above space temperature and provided that the 150 foot-per-minute supply air jet reaches to within 4 1/2 feet of floor level.

**403.3.1.3 Zone outdoor airflow.** The zone outdoor airflow rate ( $V_{oz}$ ), shall be determined in accordance with Equation 4-2.

$$V_{oz} = \frac{V_{bz}}{E_z} \quad \text{(Equation 4-2)}$$

**403.3.2 System outdoor airflow.** The outdoor air required to be supplied by each ventilation system shall be determined in accordance with Sections 403.3.2.1 through 403.3.2.3 as a function of system type and zone outdoor airflow rates.

**403.3.2.1 Single zone systems.** Where one air handler supplies a mixture of outdoor air and recirculated return air to only one zone, the system outdoor air intake flow rate ( $V_{ot}$ ) shall be determined in accordance with Equation 4-3.

$$V_{ot} = V_{oz} \quad \text{(Equation 4-3)}$$

**403.3.2.2 100-percent outdoor air systems.** Where one air handler supplies only outdoor air to one or more zones, the system outdoor air intake flow rate ( $V_{ot}$ ) shall be determined using Equation 4-4.

$$V_{ot} = \sum_{\text{all zones}} V_{oz} \quad \text{(Equation 4-4)}$$

**403.3.2.3 Multiple zone recirculating systems.** Where one air handler supplies a mixture of outdoor air and recirculated return air to more than one zone, the system outdoor air intake flow rate ( $V_{ot}$ ) shall be determined in accordance with Sections 403.3.2.3.1 through 403.3.2.3.4.

**403.3.2.3.1 Primary outdoor air fraction.** The primary outdoor air fraction ( $Z_p$ ) shall be determined for each zone in accordance with Equation 4-5.

$$Z_p = \frac{V_{oz}}{V_{pz}} \quad \text{(Equation 4-5)}$$

where:

$V_{pz}$  = Primary airflow: The airflow rate supplied to the zone from the air-handling unit at which the outdoor air intake is located. It includes outdoor intake air and recirculated air from that air-handling unit but does not include air transferred or air recirculated to the zone by other means. For design purposes,  $V_{pz}$  shall be the zone design primary airflow rate, except for zones with variable air volume supply and  $V_{pz}$  shall be the lowest expected primary airflow rate to the zone when it is fully occupied.

**403.3.2.3.2 System ventilation efficiency.** The system ventilation efficiency ( $E_s$ ) shall be determined using Table 403.3.2.3.2 or Appendix A of ASHRAE 62.1.

**TABLE 403.3.2.3.2  
SYSTEM VENTILATION EFFICIENCY<sup>a,b</sup>**

<i>Max</i> ( $Z_p$ )	$E_v$
≤ 0.15	1
≤ 0.25	0.9
≤ 0.35	0.8
≤ 0.45	0.7
≤ 0.55	0.6
≤ 0.65	0.5
≤ 0.75	0.4
> 0.75	0.3

a. *Max* ( $Z_p$ ) is the largest value of  $Z_p$  calculated using Equation 4-5 among all the zones served by the system.

b. Interpolating between table values shall be permitted.

**403.3.2.3.3 Uncorrected outdoor air intake.** The uncorrected outdoor air intake flow rate ( $V_{ou}$ ) shall be determined in accordance with Equation 4-6.

$$V_{ou} = D \sum_{all\ zones} R_p P_z + \sum_{all\ zones} R_a A_z \quad \text{(Equation 4-6)}$$

where:

$D$  = Occupant diversity: the ratio of the system population to the sum of the zone populations, determined in accordance with Equation 4-7.

$$D = \frac{P_s}{\sum_{all\ zones} P_z} \quad \text{(Equation 4-7)}$$

where:

$P_s$  = System population: The total number of occupants in the area served by the system. For design purposes,  $P_s$  shall be the maximum number of occupants expected to be concurrently in all zones served by the system.

**403.3.2.3.4 Outdoor air intake flow rate.** The outdoor air intake flow rate ( $V_{oi}$ ) shall be determined in accordance with Equation 4-8.

$$V_{oi} = \frac{V_{ou}}{E_v} \quad \text{(Equation 4-8)}$$

**403.4 Exhaust ventilation.** Exhaust airflow rate shall be provided in accordance with the requirements in Table 403.3. Exhaust *makeup air* shall be permitted to be any combination of outdoor air, recirculated air and transfer air, except as limited in accordance with Section 403.2.

**403.5 System operation.** The minimum flow rate of outdoor air that the ventilation system must be capable of supplying during its operation shall be permitted to be based on the rate per person indicated in Table 403.3 and the actual number of occupants present.

**403.6 Variable air volume system control.** Variable air volume air distribution systems, other than those designed to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow rate of outdoor air at a rate of not less than that required by Section 403.3 over the entire range of supply air operating rates.

**403.7 Balancing.** The *ventilation air* distribution system shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow rate as required by Sections 403.3 and 403.4. Ventilation systems shall be balanced by an *approved* method. Such balancing shall verify that the ventilation system is capable of supplying and exhausting the airflow rates required by Sections 403.3 and 403.4.

## SECTION 404 ENCLOSED PARKING GARAGES

**404.1 Enclosed parking garages.** Mechanical ventilation systems for enclosed parking garages shall be permitted to operate intermittently in accordance with Item 1, Item 2 or both.

1. The system shall be arranged to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.
2. The system shall be arranged to operate automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Such detectors shall be installed in accordance with their manufacturers' recommendations.

**404.2 Minimum ventilation.** Automatic operation of the system shall not reduce the ventilation airflow rate below 0.05 cfm per square foot (0.00025 m<sup>3</sup>/s • m<sup>2</sup>) of the floor area and the system shall be capable of producing a ventilation airflow rate of 0.75 cfm per square foot (0.0038 m<sup>3</sup>/s • m<sup>2</sup>) of floor area.

**404.3 Occupied spaces accessory to public garages.** Connecting offices, waiting rooms, ticket booths and similar uses that are accessory to a public garage shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 403.3.

## SECTION 405 SYSTEMS CONTROL

**405.1 General.** Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air-conditioning systems that supply required *ventilation air* shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

**SECTION 406**  
**VENTILATION OF UNINHABITED SPACES**

**406.1 General.** Uninhabited spaces, such as crawl spaces and attics, shall be provided with *natural ventilation* openings as required by the *International Building Code* or shall be provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.02 cfm per square foot ( $0.00001 \text{ m}^3/\text{s} \cdot \text{m}^2$ ) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.