

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.

Ventilation supply systems shall be designed to deliver the required rate of supply air to the occupied zone within an occupied space. The occupied zone shall have boundaries measured at 3 inches (76 mm) and 72 inches (1829 mm) above the floor and 24 inches (610 mm) from the enclosing walls.

403.2 Outdoor air required. The minimum ventilation rate of outdoor air shall be determined in accordance with Section 403.3.

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 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 10 percent or more 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 h in Table 403.3, mechanical exhaust is required and recirculation is prohibited where 10 percent or more 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 occupied 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 Sections 403.3 and 403.3.1. The required outdoor air 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 Ventilation rate. Ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with Table 403.3 based on the occupancy of the space and the occupant load or other parameter as stated therein. 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 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.

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 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.

403.3.2 Common ventilation system. Where spaces having different ventilation rate requirements are served by a common ventilation system, the ratio of outdoor air to total supply air for the system shall be determined based on the space having the largest outdoor air requirement or shall be determined in accordance with the following formula:

$$Y = \frac{X}{(1 + X - Z)} \quad \text{(Equation 4-1)}$$

where

$Y = V_{ot} / V_{st}$ = Corrected fraction of outdoor air in system supply.

$X = V_{on} / V_{st}$ = Uncorrected fraction of outdoor air in system supply.

$Z = V_{oc} / V_{sc}$ = Fraction of outdoor air in critical space. The critical space is that space with the greatest required fraction of outdoor air in the supply to this space.

V_{ot} = Corrected total outdoor airflow rate.

V_{st} = Total supply flow rate, i.e., the sum of all supply for all branches of the system.

V_{on} = Sum of outdoor airflow rates for all branches on system.

V_{oc} = Outdoor airflow rate required in critical spaces.

V_{sc} = Supply flow rate in critical space.

403.3.3 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 of outdoor air at a rate of not less than that required by Section 403 over the entire range of supply air operating rates.

403.3.4 Balancing. Ventilation systems shall be balanced by an approved method. Such balancing shall verify that the ventilation system is capable of supplying the airflow rates required by Section 403.

**SECTION 404
ENCLOSED PARKING GARAGES**

404.1 Enclosed parking garages. Mechanical ventilation systems for enclosed parking garages are not required to operate continuously where the system is arranged to operate automatically upon detection of a concentration of carbon monoxide of 25 parts per million (ppm) by approved automatic detection devices. Upon activation such systems shall operate for 30 minutes.

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404.2 Minimum ventilation. Automatic operation of the system shall not reduce the ventilation rate below 0.05 cfm per square foot ($0.00025 \text{ m}^3/\text{s} \cdot \text{m}^2$) of the floor area and the system shall be capable of producing a ventilation rate of 1.5 cfm per square foot ($0.0076 \text{ m}^3/\text{s} \cdot \text{m}^2$) 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.

**TABLE 403.3
REQUIRED OUTDOOR VENTILATION AIR**

| OCCUPANCY CLASSIFICATION | ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a | OUTDOOR AIR [Cubic feet per minute (cfm) per person] UNLESS NOTED ^e |
|--|---|--|
| Correctional facilities | | |
| Cells | | |
| without plumbing fixtures | 20 | 20 |
| with plumbing fixtures ^{g, h} | 20 | 20 |
| Dining halls | 100 | 15 |
| Guard stations | 40 | 15 |
| Dry cleaners, laundries | | |
| Coin-operated dry cleaner | 20 | 15 |
| Coin-operated laundries | 20 | 15 |
| Commercial dry cleaner | 30 | 30 |
| Commercial laundry | 10 | 25 |
| Storage, pick up | 30 | 35 |
| Education | | |
| Auditoriums | 150 | 15 |
| Classrooms | 50 | 15 |
| Corridors | — | 0.10 cfm/ft ² |
| Laboratories | 30 | 20 |
| Libraries | 20 | 15 |
| Locker rooms ^h | — | 0.50 cfm/ft ² |
| Music rooms | 50 | 15 |
| Smoking lounges ^{h, g} | 70 | 60 |
| Training shops | 30 | 20 |
| Food and beverage service | | |
| Bars, cocktail lounges | 100 | 30 |
| Cafeteria, fast food | 100 | 20 |
| Dining rooms | 70 | 20 |
| Kitchens (cooking) ^{f, g} | 20 | 15 |
| Hospitals, nursing and convalescent homes | | |
| Autopsy rooms ^b | — | 0.50 cf m/ft ² |
| Medical procedure rooms | 20 | 15 |
| Operating rooms | 20 | 30 |
| Patient rooms | 10 | 25 |
| Physical therapy | 20 | 15 |
| Recovery and ICU | 20 | 15 |
| Hotels, motels, resorts and dormitories | | |
| Assembly rooms | 120 | 15 |
| Bathrooms ^{g, h} | — | 35 |
| Bedrooms | — | 30 cfm per room |
| Conference rooms | 50 | 20 |
| Dormitory sleeping areas | 20 | 15 |
| Gambling casinos | 120 | 30 |
| Living rooms | — | 30 cfm per room |
| Lobbies | 30 | 15 |
| Offices | | |
| Conference rooms | 50 | 20 |
| Office spaces | 7 | 20 |
| Reception areas | 60 | 15 |
| Telecommunication centers and data entry | 60 | 20 |

(continued)

**TABLE 403.3—continued
REQUIRED OUTDOOR VENTILATION AIR**

| OCCUPANCY CLASSIFICATION | ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a | OUTDOOR AIR (Cubic feet per minute (cfm) per person) UNLESS NOTED ^e |
|--|---|---|
| Private dwellings, single and multiple | | |
| Garages, common for multiple units ^b | — | 1.5 cfm/ft ² |
| Garages, separate for each dwelling | — | 100 cfm per car |
| Kitchens ^g | — | 100 cfm intermittent or 25 cfm continuous |
| Living areas ^c | Based upon number of bedrooms, first bedroom: 2; each additional bedroom: 1 | 0.35 air changes per hour ^a or 15 cfm per person, whichever is greater |
| Toilet rooms and bathrooms ^{f, h} | — | Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous |
| Public spaces | | |
| Corridors and utilities | — | 0.05 cfm/ft ² |
| Elevator car ^g | — | 1.00 cfm/ft ² |
| Locker rooms ^h | — | 0.5 cfm/ft ² |
| Shower rooms (per shower head) ^{g, h} | — | 50 cfm intermittent or 20 cfm continuous |
| Smoking lounges ^{h, g} | 70 | 60 |
| Toilet rooms ^{g, h} | — | 75 cfm per water closet or urinal |
| Retail stores, sales floors and showroom floors | | |
| Basement and street | — | 0.30 cfm/ft ² |
| Dressing rooms | — | 0.20 cfm/ft ² |
| Malls and arcades | — | 0.20 cfm/ft ² |
| Shipping and receiving | — | 0.15 cfm/ft ² |
| Smoking lounges ^b | 70 | 60 |
| Storage rooms | — | 0.15 cfm/ft ² |
| Upper floors | — | 0.20 cfm/ft ² |
| Warehouses | — | 0.05 cfm/ft ² |
| Specialty shops | | |
| Automotive motor-fuel-dispensing stations | — | 1.5 cfm/ft ² |
| Barber | 25 | 15 |
| Beauty | 25 | 25 |
| Clothiers, furniture | — | 0.30 cfm/ft ² |
| Embalming room ^b | — | 2.0 cfm/ft ² |
| Florists | 8 | 15 |
| Hardware, drugs, fabrics | 8 | 15 |

(continued)

**TABLE 403.3—continued
REQUIRED OUTDOOR VENTILATION AIR**

| OCCUPANCY CLASSIFICATION | ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a | OUTDOOR AIR (Cubic feet per minute (cfm) per person) UNLESS NOTED ^e |
|---|---|--|
| Specialty shops—continued | | |
| Nail salon ^{b, i} | — | 50 cfm intermittent or 20 cfm continuous per station |
| Pet Shops | — | 1.00 cfm/ft ² |
| Reducing salons | 20 | 15 |
| Supermarkets | 8 | 15 |
| Sports and amusement | | |
| Ballrooms and discos | 100 | 25 |
| Bowling alleys (seating areas) | 70 | 25 |
| Game rooms | 70 | 25 |
| Ice arenas | — | 0.50 cfm/ft ² |
| Playing floors (gymnasiums) | 30 | 20 |
| Spectator areas | 150 | 15 |
| Swimming pools (pool and deck area) | — | 0.50 cfm/ft ² |
| Storage | | |
| Repair garages, enclosed parking garages ^d | — | 1.5 cfm/ft ² |
| Warehouses | — | 0.05 cfm/ft ² |
| Theaters | | |
| Auditoriums | 150 | 15 |
| Lobbies | 150 | 20 |
| Stages, studios | 70 | 15 |
| Ticket booths | 60 | 20 |
| Transportation | | |
| Platforms | 100 | 15 |
| Vehicles | 150 | 15 |
| Waiting rooms | 100 | 15 |
| Workrooms | | |
| Bank vaults | 5 | 15 |
| Darkrooms | — | 0.50 cfm/ft ² |
| Duplicating, printing | — | 0.50 cfm/ft ² |
| Meat processing ^c | 10 | 15 |
| Pharmacy | 20 | 15 |
| Photo studios | 10 | 15 |

For SI: 1 cubic foot per minute = 0.0004719 m³/s, 1 ton = 908 kg,
1 cubic foot per minute per square foot = 0.00508 m³/(s • m²),
°C = [(°F) - 32]/1.8, 1 square foot = 0.0929 m².

- a. Based upon net floor area.
- b. Mechanical exhaust required and the recirculation of air from such spaces as permitted by Section 403.2.1 is prohibited (see Section 403.2.1, Items 1 and 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. Where the ventilation rate is expressed in cfm/ft², such rate is based upon cubic feet per minute per square foot of the floor area being ventilated.
- f. The sum of the outdoor and transfer air from adjacent spaces shall be sufficient to provide an exhaust rate of not less than 1.5 cfm/ft².
- g. Transfer air permitted in accordance with Section 403.2.2.
- h. 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).
- i. The required exhaust system shall capture the contaminants and odors at their source.