

# CHAPTER 4

## VENTILATION

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**User note:**

**About this chapter:** Chapter 4 intends to provide an indoor atmosphere that protects the health and well-being of building occupants. Both mechanical and natural ventilation are addressed. Mechanical ventilation provides what is considered to be acceptable indoor air quality. Mechanical ventilation minimizes adverse health effects and provides an atmosphere that generally is not objectionable to occupants.

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### 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; slab soil exhaust systems; smoke control systems; energy recovery ventilation systems and other systems specified in Section 502 shall comply with Chapter 5.

**[W][S] 401.2 Ventilation required.** Every occupied space other than enclosed parking garages, loading docks and motor vehicle repair garages shall be ventilated in accordance with Section 401.2.1, 401.2.2, or 401.2.3. Enclosed parking garages, loading docks and motor vehicle repair garages shall be ventilated by mechanical means in accordance with sections 403 and 404.

**401.2.1 Group R occupancies.** Ventilation in Group R occupancies shall be provided in accordance with Section 403.4.

**401.2.2 Ambulatory care facilities and Group I-2 occupancies.** Ambulatory care facilities and Group I-2 occupancies shall be ventilated by mechanical means in accordance with Section 407.

**401.2.3 All other occupancies.** Ventilation in all other occupancies shall be provided 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 R402.4.1.2 of the *International Energy Conservation Code*, the dwelling unit shall be ventilated by mechanical means in accordance with Section 403. Ambulatory care facilities and Group I-2 occupancies shall be ventilated by mechanical means in accordance with Section 407-))~~

**[W] 401.3 When required.** Group R occupancies shall be vented continuously or intermittently in accordance with Section 403.4. Ventilation in all other occupancies shall be provided during the periods that the room or space is occupied.

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

1. Intake openings shall be located not less than 10 feet (3048 mm) from lot lines or buildings on the same lot. Where openings front on a street or public way, the distance shall be measured from the opposite side of the street or public way.
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 501.3.1. 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.

**Exception:** Enclosed parking garage and repair garage intakes are permitted to be located less than 10 feet horizontally of the street, alley, parking lots and loading docks.

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.

**Exception:** Separation is not required between intake air openings and living space relief air exhaust air openings of an individual dwelling unit or sleeping unit, not to include common areas outside of the dwelling or sleeping unit, where a factory-built intake/exhaust combination termination fitting, listed and installed in accordance with the manufacturer's instructions, is used to separate the air streams. A minimum of 5 feet (914 mm) horizontal separation between other environmental air exhaust outlets and other dwelling or sleeping unit factory-built intake/exhaust combination termination fittings shall be maintained.

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.
5. Intake openings shall not be located:
  - 5.1. In a crawl space;

## VENTILATION

5.2. Less than one foot (305 mm) above a roof, adjacent grade, or other surface directly below the intake; or

5.3. Under a deck having a surface height less than three feet above grade or other surface directly below the intake.

**Interpretation:** For purposes of this section, lot line includes any property line separating one lot from another lot, but does not include any property line separating a lot from a public street or alley right-of-way.

**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 <sup>a</sup>
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.

a. For rectangular openings, the table requirements apply to the shortest side. For round openings, the table requirements apply to the diameter. For square openings, the table requirements apply to any side.

**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.

**[W][S] 401.7 Compliance and commissioning.** Compliance with Sections 402 through 403.4 shall be demonstrated through engineering calculations. Documentation of calculations shall be submitted with the permit plan sets. Testing and commissioning shall be performed and documented in accordance with the International Energy Conservation Code.

## SECTION 402 NATURAL VENTILATION

**[S][BG] 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.

**Exception:** Automatically controlled *natural ventilation* systems do not require ready access and control by building occupants.

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

**[BG] 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 the outdoors shall be based on the total floor area being ventilated.

**[BG] 402.4 Openings below grade.** Where openings below grade provide required *natural ventilation*, the outdoor 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

**[W] 403.1 Ventilation system.** Mechanical ventilation shall be provided by a method of supply air and return or *exhaust air*, ~~((except that mechanical ventilation air requirements for Group R-2, R-3 and R-4 occupancies three stories and less in height above grade plane shall be provided by an exhaust system, supply system or combination thereof.))~~ 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.

**[W][S] 403.2 Outdoor air required.** The minimum outdoor ((airflow)) flow rate shall be determined in accordance with Section 403.3.

**Exceptions:**

1. 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.
2. Alternate systems designed in accordance with ASHRAE Standard 62.1 Section 6.2, Ventilation Rate Procedure, shall be permitted.

**[W] 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 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 403.3.1.1, recirculation of air from such spaces shall be prohibited. ((Recirculation of air that is contained completely within such spaces shall not be prohibited. Where recirculation of air is prohibited, all)) All air supplied to such spaces shall be exhausted, including any air in excess of that required by Table 403.3.1.1.

~~[W][S] 4. ((Where mechanical exhaust is required by Note g in Table 403.3.1.1, mechanical exhaust is required and recirculation from such spaces is prohibited where more than 10 percent of the resulting supply airstream consists of air recirculated from these spaces.))~~ Air used as transfer for heat removal may be circulated. Return air from such spaces shall only be permitted to be recirculated when returned to an energy recovery ventilation system complying with Section 514. Recirculation of air that is contained completely within such spaces shall not be prohibited.

**403.2.2 Transfer air.** Except where recirculation from such spaces is prohibited by Table 403.3.1.1, 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 403.3.1.1. The required outdoor airflow rates specified in Table 403.3.1.1 shall be introduced directly into such spaces or into the occupied spaces from which air is transferred or a combination of both.

**[W] 403.3 Outdoor air and local exhaust airflow rates.** Group ((R-2, R-3 and R-4)) R occupancies ((three stories and less in height above grade plane)) shall be provided with outdoor air and local exhaust in accordance with Section ((403.3.2)) 403.4. ((Other)) All other buildings intended to be occupied shall be provided with outdoor air and local exhaust in accordance with Section 403.3.1.

**403.3.1 Other buildings intended to be occupied.** The design of local exhaust systems and ventilation systems for outdoor air for occupancies other than Group R-2, R-3 and R-4 three stories and less above grade plane shall comply with Sections 403.3.1.1 through 403.3.1.5.

**[W] 403.3.1.1 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. In each occupiable space, the ventilation system shall be designed to deliver the required rate of outdoor airflow to the *breathing zone*. Outdoor air shall be supplied directly to each occupiable space from an air handling unit through a fully ducted path or ducted to within 12 inches of the return air opening of a fan-powered terminal unit used to transfer the outdoor air to the occupiable space.

The occupant load utilized for design of the ventilation system shall be not less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3.1.1. Ventilation rates for occupancies not represented in Table 403.3.1.1 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, including transfer fan-powered terminal units, 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 403.3.1.1 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 403.3.1.1 in accordance with accepted engineering practice.

**VENTILATION**

**Exception:** ((The occupant load is not required to be determined based on the estimated maximum occupant load rate indicated in Table 403.3.1.1 where *approved* statistical data document the accuracy of an alternate anticipated occupant density.)) Where *occupancy* density is known and documented in the plans, the outside air rate may be based on the design occupant density. Under no circumstance shall the *occupancies* used result in outside air less than one-half that resulting from application of TABLE 403.3.1.1 estimated maximum *occupancy* rates.

**[W][S] TABLE 403.3.1.1  
((MINIMUM VENTILATION RATES)) REQUIRED OUTDOOR VENTILATION AIR**

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>				
Booking/waiting	50	7.5	0.06	—
Cells				
without plumbing fixtures	25	5	0.12	—
[S] with plumbing fixtures <sup>g, o</sup>	25	5	0.12	1.0
Day room	30	5	0.06	—
Dining halls (see “Food and beverage service”)	—	—	—	—
Guard stations	15	5	0.06	—
<b>Dry cleaners, laundries</b>				
Coin-operated dry cleaner	20	15	—	—
Coin-operated laundries	20	7.5	0.12	—
Commercial dry cleaner	30	30	—	—
Commercial laundry	10	25	—	—
Storage, pick up	30	7.5	0.12	—
<b>Education</b>				
Art classroom <sup>g</sup>	20	10	0.18	0.7
Auditoriums	150	5	0.06	—
Classrooms (ages 5-8)	25	10	0.12	—
Classrooms (age 9 plus)	35	10	0.12	—
Computer lab	25	10	0.12	—
Corridors (see “Public spaces”)	—	—	—	—
Day care (through age 4)	25	10	0.18	—
Lecture classroom	65	7.5	0.06	—
Lecture hall (fixed seats)	150	7.5	0.06	—
[S] Locker/dressing rooms <sup>g, o</sup>	—	—	—	0.25
Media center	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Music/theater/dance	35	10	0.06	—
[S] Science laboratories <sup>g, o</sup>	25	10	0.18	1.0
[S] ((Smoking lounges <sup>b</sup>	70	60	—	—))
Sports locker rooms <sup>g, o</sup>	—	—	—	0.5
Wood/metal shops <sup>g, o</sup>	20	10	0.18	0.5
<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>	20	7.5	0.12	0.7

[W][S] TABLE 403.3.1.1—continued  
 ((MINIMUM VENTILATION RATES)) REQUIRED OUTDOOR VENTILATION AIR

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>Hotels, motels, resorts and dormitories</b>				
[S] Bathrooms/toilet—private <sup>g,h</sup>	—	—	—	25/50 <sup>f</sup>
Bedroom/living room	10	5	0.06	—
Conference/meeting	50	5	0.06	—
Dormitory sleeping areas	20	5	0.06	—
Gambling casinos	120	7.5	0.18	—
Lobbies/prefunction	30	7.5	0.06	—
Multipurpose assembly	120	5	0.06	—
<b>Offices</b>				
Conference rooms	50	5	0.06	—
[W] Kitchenettes <sup>k</sup>	<u>25</u>	<u>5</u>	<u>0.06</u>	<u>0.30</u>
Main entry lobbies	10	5	0.06	—
Office spaces	5	5	0.06	—
Reception areas	30	5	0.06	—
Telephone/data entry	60	5	0.06	—
<b>Private dwellings, single and multiple</b>				
Garages, common for multiple units <sup>b</sup>	—	—	—	0.75
[W] Kitchens <sup>b</sup>	—	—	—	((25/100 <sup>f</sup> )) See Table 403.4.7
[W] Living areas <sup>c</sup>	Based on number of bedrooms. First bedroom, 2; each additional bedroom, 1	((0.35 ACH but not less than 15 cfm/person)) See Table 403.4.2	—	—
[W] Toilet rooms, ((and)) bathrooms <sup>d</sup> and laundry areas <sup>g,i</sup>	—	—	—	((20/50 <sup>f</sup> )) See Table 403.4.7
<b>Public spaces</b>				
[W] Corridors <u>servicing other than Group R occupancies</u>	—	—	0.06	—
[W] Corridors <u>servicing Group R dwelling or sleeping units with whole house exhaust system</u>	—	—	<u>0.12</u>	—
[W] Corridors <u>servicing Group R dwelling or sleeping units with other than whole house exhaust system</u>	—	—	<u>0.06</u>	—
Courtrooms	70	5	0.06	—
Elevator car	—	—	—	1.0
[W][S] Elevator lobbies in parking garages <sup>h</sup>	—	—	<u>1.0<sup>e</sup></u>	—
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	—
Places of religious worship	120	5	0.06	—
Shower room (per shower head) <sup>e</sup>	—	—	—	50/20 <sup>f</sup>
[S] ((Smoking lounges <sup>b</sup>	<u>70</u>	<u>60</u>	—	—))
Toilet rooms — public <sup>g</sup>	—	—	—	50/70 <sup>e</sup>

VENTILATION

[W][S] TABLE 403.3.1.1—continued  
 ((MINIMUM VENTILATION RATES)) REQUIRED OUTDOOR VENTILATION AIR

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>Retail stores, sales floors and showroom floors</b>				
Dressing rooms	—	—	—	0.25
Mall common areas	40	7.5	0.06	—
Sales	15	7.5	0.12	—
Shipping and receiving	2	10	0.12	—
[S] ((Smoking lounges <sup>b</sup>	<del>70</del>	<del>60</del>	—	(—))
Storage rooms	—	—	0.12	—
Warehouses (see “Storage”)	—	10	0.06	—
<b>Specialty shops</b>				
Automotive motor-fuel dispensing stations <sup>b</sup>	—	—	—	1.5
[S] Barber	25	<del>(7.5)</del> <u>20</u>	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>				
Bowling alleys (seating areas)	40	10	0.12	—
Disco/dance floors	100	20	0.06	—
Game arcades	20	7.5	0.18	—
[W] Gym, stadium, arena (play area) <sup>i</sup>	<del>(7)</del> =	<del>(20)</del> =	<del>(0.18)</del> <u>0.30</u>	—
Health club/aerobics room	40	20	0.06	—
Health club/weight room	10	20	0.06	—
Ice arenas without combustion engines <sup>i</sup>	—	—	0.30	0.5
Spectator areas	150	7.5	0.06	—
Swimming pools (pool and deck area)	—	—	0.48	—
<b>Storage</b>				
[W] Janitor closets, trash rooms, recycling rooms	=	=	=	<u>1.0</u>
[W] Repair garages <sup>d</sup> ((-enclosed parking garages <sup>b,d</sup> ))	—	—	—	0.75
[S] Enclosed loading docks <sup>d</sup>	=	=	=	<u>1.5</u>
[S] Enclosed parking garages <sup>d</sup>	=	=	=	<u>0.75</u>
[S] Ticket booths (within enclosed parking garages) <sup>i</sup>	<u>60</u>	=	=	=
[W] Storage rooms, chemical	=	=	=	<u>1.5</u>
[S] Refrigerated warehouses/freezers <sup>m</sup>	—	10	—	—
Warehouses	—	10	0.06	—
[S] Non-retail storage spaces >100 sf <sup>a</sup>	=	=	<u>0.06</u>	=
<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	—

[W][S] TABLE 403.3.1.1—continued  
 ((MINIMUM VENTILATION RATES)) REQUIRED OUTDOOR VENTILATION AIR

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>Workrooms</b>				
Bank vaults/safe deposit	5	5	0.06	—
Computer (without printing)	4	5	0.06	—
Copy, printing rooms	4	5	0.06	0.5
Darkrooms	—	—	—	1.0
[W] Freezer and refrigerated spaces (<50°F) <sup>m</sup>	0	10	0	0
Meat processing <sup>c</sup>	10	15	—	—
Pharmacy (prep. area)	10	5	0.18	—
Photo studios	10	5	0.12	—

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. Recirculation of air that is contained completely within such spaces shall not be 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.
- [W][S] g. Mechanical exhaust is required and recirculation from such spaces 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. Recirculation of air that is contained completely within such spaces shall not be prohibited (see Section 403.2.1, Items 2 and 4).))
- h. For nail salons, each manicure and pedicure station shall be provided with a source capture system capable of exhausting not less than 50 cfm per station. Exhaust inlets shall be located in accordance with Section 502.20. Where one or more required source capture systems operate continuously during occupancy, the exhaust rate from such systems shall be permitted to be applied to the exhaust flow rate required by Table 403.3.1.1 for the nail salon.
- [W] i. A laundry area within a kitchen or bathroom is not required to have local exhaust. For the laundry area to qualify as being within the kitchen, the laundry room door must be open directly into the kitchen and not into an adjacent corridor. Where there are doors that separate the laundry area from the kitchen or bathroom the door shall be louvered.
- [W] j. When combustion equipment is intended to be used on the playing surface, additional dilution ventilation and/or source control shall be provided.
- [W] k. Kitchenettes require exhaust when they contain a domestic cooking appliance range or oven that is installed in accordance with Table 507.2.1. Kitchenettes that only contain a microwave cooking appliance are not required to have exhaust. A kitchenette may not contain commercial cooking appliances that require Type I or Type II exhaust as these occupancies are required to be exhausted to the kitchen category in Table 403.3.1.1.
- [S] l. This space shall be maintained at a positive pressure.
- [S] m. For occupied freezer and refrigerated spaces utilize proposed occupant density for outdoor airflow rates.
- [S] n. The required outdoor airflow rate shall be introduced directly into such spaces or into the occupied space from which the air is transferred or a combination of both.
- [S] o. Transfer air permitted in accordance with Section 403.2.2. For non-retail storage areas, transfer air is also permitted from an adjacent open parking garage, or an enclosed parking garage or loading dock that is mechanically ventilated in accordance with Section 404

**403.3.1.1.1 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 403.3.1.1.1.1 through 403.3.1.1.1.3.

**403.3.1.1.1.1 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.

$$V_{bz} = R_p P_z + R_a A_z \tag{Equation 4-1}$$

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 403.3.1.1.

$R_a$  = Area outdoor air rate: the outdoor airflow rate required per unit area from Table 403.3.1.1.

VENTILATION

**403.3.1.1.1.2 Zone air distribution effectiveness.** The zone air distribution effectiveness ( $E_z$ ) shall be determined using Table 403.3.1.1.1.2.

**TABLE 403.3.1.1.1.2  
ZONE AIR DISTRIBUTION EFFECTIVENESS<sup>a,b,c,d</sup>**

AIR DISTRIBUTION CONFIGURATION	$E_z$
Ceiling or floor supply of cool air	1.0 <sup>e</sup>
Ceiling or floor supply of warm air and floor return	1.0
Ceiling supply of warm air and ceiling return	0.8 <sup>f</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 or return	0.8
Makeup air drawn in near to the exhaust 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. 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.
- f. 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.

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

$$V_{oz} = \frac{V_{bz}}{E_z} \tag{Equation 4-2}$$

**403.3.1.1.2 System outdoor airflow.** The outdoor air required to be supplied by each ventilation system shall be determined in accordance with Sections 403.3.1.1.2.1 through 403.3.1.1.2.3.4 as a function of system type and zone outdoor airflow rates.

**403.3.1.1.2.1 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.

$$V_{ot} = V_{oz} \tag{Equation 4-3}$$

**403.3.1.1.2.2 100-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.

$$V_{ot} = \sum_{\text{all zones}} V_{oz} \tag{Equation 4-4}$$

**[W] 403.3.1.1.2.3 Multiple zone recirculating systems.** ~~((Where))~~ For ventilation systems wherein one or more air handlers ~~((supplies))~~ supply a mixture of outdoor air and recirculated ~~((return))~~ air to more than one ventilation zone, the system outdoor air intake flow rate ( $V_{ot}$ ) shall be determined in accordance with Sections 403.3.1.1.2.3.1 through 403.3.1.1.2.3.4.

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

$$Z_p = \frac{V_{oz}}{V_{pz}} \tag{Equation 4-5}$$



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.)) The uncorrected outdoor air intake flow ( $V_{ou}$ ) shall be determined in accordance with Equation 4-5.

$$V_{ou} = D \sum_{\text{all zones}} (R_p \times P_z) + \sum_{\text{all zones}} (R_a \times A_z) \tag{Equation 4-5}$$

**403.3.1.1.2.3.1.1 Occupant diversity.** The occupant diversity ratio (D) shall be determined in accordance with Equation 4-6 to account for variations in population within the ventilation zones served by the system.

$$D = P_s / \sum_{\text{all zones}} P_z \tag{Equation 4-6}$$

where:  $P_s$  = System population: The total population in the area served by the system.

**Exception:** Alternative methods to account for occupant diversity shall be permitted, provided the resulting  $V_{ou}$  value is no less than that determined using Equation 4-5.

**403.3.1.1.2.3.1.2 Design system population.** Design system population ( $P_s$ ) shall equal the largest (peak) number of people expected to occupy all ventilation zones served by the ventilation system during use.

**Note:** Design system population is always equal to or less than the sum of design zone population for all zones in the area served by the system because all zones may or may not be simultaneously occupied at design population.

[W] **403.3.1.1.2.3.2 System ventilation efficiency.** The system ventilation efficiency ( $E_v$ ) shall be determined ((using Table 403.3.1.1.2.3.2)) in accordance with Section 403.3.1.1.2.3.3 or Appendix A of ASHRAE 62.1 for the Alternative Procedure.

**Note:** These procedures also establish zone minimum primary air-flow rates for VAV systems.

TABLE 403.3.1.1.2.3.2  
SYSTEM VENTILATION EFFICIENCY<sup>a,b</sup>

Max ( $Z_p$ )	$E_v$
≤ 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.

[W] **403.3.1.1.2.3.3 ((Uncorrected outdoor air intake)) Simplified procedure.** ((The uncorrected outdoor air intake flow rate ( $V_{ou}$ ) shall be determined in accordance with Equation 4-6.

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

where:

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

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

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.))

**403.3.1.1.2.3.3.1 System ventilation efficiency.** System ventilation efficiency ( $E_v$ ) shall be determined in accordance with Equation 4-6a or 4-6b.

$$E_v = 0.88 \times D + 0.22 \text{ for } D < 0.60 \quad \text{(Equation 4-6a)}$$

$$E_v = 0.75 \text{ for } D \geq 0.60 \quad \text{(Equation 4-6b)}$$

**403.3.1.1.2.3.3.2 Zone minimum primary airflow.** For each zone, the minimum primary airflow ( $V_{pz-min}$ ) shall be determined in accordance with Equation 4-7.

$$V_{pz-min} = V_{oz} \times 1.5 \quad \text{(Equation 4-7)}$$

[W] **403.3.1.1.2.3.4 Outdoor air intake flow rate.** The design outdoor air intake flow rate ( $V_{ot}$ ) shall be determined in accordance with Equation 4-8.

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

**403.3.1.2 Exhaust ventilation.** Exhaust airflow rate shall be provided in accordance with the requirements of Table 403.3.1.1. Outdoor air introduced into a space by an exhaust system shall be considered as contributing to the outdoor airflow required by Table 403.3.1.1.

**403.3.1.3 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 403.3.1.1 and the actual number of occupants present.

[S] **403.3.1.4 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. Calculations and a description of controls operation shall be submitted with the permit drawings.

**403.3.1.5 Balancing.** The *ventilation* air distribution system shall be provided with means to adjust the system to achieve not less than the minimum ventilation airflow rate as required by Sections 403.3 and 403.3.1.2. 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 403.3.1.2.

[W] **403.3.2 Group R-2, R-3 and R-4 occupancies, three stories and less.** ((The design of local exhaust systems and ventilation systems for outdoor air in Group R-2, R-3 and R-4 occupancies three stories and less in height above grade plane shall comply with Sections 403.3.2.1 through 403.3.2.5.)) Sections 403.3.2 through 403.3.2.5 are not adopted, see Section 403.4.

~~((403.3.2.1 Outdoor air for dwelling units. An outdoor air ventilation system consisting of a mechanical exhaust system, supply system or combination thereof shall be installed for each dwelling unit. Local exhaust or supply systems, including outdoor air ducts connected to the return side of an air handler, are permitted to serve as such a system. The outdoor air ventilation system shall be designed to provide the required rate of outdoor air continuously during the period that the building is occupied. The minimum continuous outdoor airflow rate shall be determined in accordance with Equation 4-9.~~

$$Q_{OA} = 0.01A_{floor} + 7.5(N_{br} + 1) \quad \text{(Equation 4-9)}$$

where:

$Q_{OA}$  = outdoor airflow rate, cfm

$A_{floor}$  = floor area, ft<sup>2</sup>

$N_{br}$  = number of bedrooms; not to be less than one

**Exception:** The outdoor air ventilation system is not required to operate continuously where the system has controls that enable operation for not less than 1 hour of each 4-hour period. The average outdoor airflow rate over the 4-hour period shall be not less than that prescribed by Equation 4-9.

**403.3.2.2 Outdoor air for other spaces.** Corridors and other common areas within the conditioned space shall be provided with outdoor air at a rate of not less than 0.06 cfm per square foot of floor area.

**403.3.2.3 Local exhaust.** Local exhaust systems shall be provided in kitchens, bathrooms and toilet rooms and shall have the capacity to exhaust the minimum airflow rate determined in accordance with Table 403.3.2.3.))

~~((TABLE 403.3.2.3  
MINIMUM REQUIRED LOCAL EXHAUST RATES FOR GROUP R-2, R-3, AND R-4 OCCUPANCIES~~

AREA TO BE EXHAUSTED	EXHAUST RATE CAPACITY
<del>Kitchens</del>	<del>100 cfm intermittent or 25 cfm continuous</del>
<del>Bathrooms and toilet rooms</del>	<del>50 cfm intermittent or 20 cfm continuous</del>

For SI: 1 cubic foot per minute = 0.0004719 m<sup>3</sup>/s.))

~~((403.3.2.4 System controls.~~ Where provided within a dwelling unit, controls for outdoor air ventilation systems shall include text or a symbol indicating the system's function.

**403.3.2.5 Ventilating equipment.** Exhaust equipment serving single dwelling units shall be listed and labeled to provide the minimum required air flow in accordance with ANSI/AMCA 210 ANSI/ASHRAE 51.))

**[W] 403.4 Group R whole house mechanical ventilation system.** Each dwelling unit or sleeping unit shall be equipped with a whole house mechanical ventilation system that complies with Sections 403.4.1 through 403.4.6.

Each dwelling unit or sleeping unit shall be equipped with local exhaust complying with Section 403.4.7. All occupied spaces, including public corridors, other than the Group R dwelling units and/or sleeping units, that support these Group R occupancies shall meet the ventilation requirement of natural ventilation requirements of Section 402 or the mechanical ventilation requirements of Sections 403.1 through 403.3.

**[W] 403.4.1 System design.** The whole house ventilation system shall consist of one or more supply fans, one or more exhaust fans, or an ERV/HRV with integral fans; and the associated ducts and controls. Local exhaust fans shall be permitted to serve as part of the whole house ventilation system when provided with the proper controls in accordance with Section 403.4.5. The systems shall be designed and installed to supply and exhaust the minimum outdoor airflow rates per Section 403.4.2 as corrected by the balanced and/or distributed whole house ventilation system coefficients in accordance with Section 403.4.3 where applicable.

**[W] 403.4.2 Whole house mechanical ventilation rates.** The sleeping unit whole house mechanical ventilation minimum outdoor airflow rate shall be determined in accordance with the breathing zone ventilation rates minimum outdoor airflow rate shall be determined in accordance with the breathing zone ventilation rates requirements of Section 403.3.1.1.2 using Equation 4-2. The dwelling unit whole house mechanical ventilation minimum outdoor airflow rate shall be determined in accordance with Equation 4-10 or Table 403.4.2.

**[W] TABLE 403.4.2  
WHOLE HOUSE MECHANICAL VENTILATION AIRFLOW RATE  
(CONTINUOUSLY OPERATING SYSTEMS)**

FLOOR AREA (ft <sup>2</sup> )	BEDROOMS <sup>a</sup>				
	1	2	3	4	5
< 500	30	30	35	45	50
500 – 1000	30	35	40	50	55
1001 – 1500	30	40	45	55	60
1501 – 2000	35	45	50	60	65
2001 – 2500	40	50	55	65	70
2501 – 3000	45	55	60	70	75
3001 – 3500	50	60	65	75	80
3501 – 4000	55	65	70	80	85
4001 – 4500	60	70	75	85	90
4501 – 5000	65	75	80	90	95

a. Minimum airflow (Q<sub>v</sub>) is set at not less than 30 cfm for each dwelling unit.

$$Q_v = 0.01 \times A_{\text{floor}} + 7.5 \times (N_{\text{br}} + 1)$$

**(Equation 4-10)**

## VENTILATION

where:

$Q_v$  = Ventilation airflow rate, cubic feet per minute (cfm) but not less than 30 cfm for each dwelling unit.

$A_{\text{floor}}$  = Conditioned floor area, square feet (ft<sup>2</sup>)

$N_{\text{br}}$  = Number of bedrooms, not less than one.

**[W] 403.4.3 Ventilation quality adjustment.** The minimum whole house ventilation rate from Section 403.4.2 shall be adjusted by the system coefficient in Table 403.4.3 based on the system type not meeting the definition of a *balanced whole house ventilation* system and/or not meeting the definition of a *distributed whole house ventilation* system.

**[W] TABLE 403.4.3  
SYSTEM COEFFICIENT ( $C_{\text{system}}$ )**

SYSTEM TYPE	DISTRIBUTED	NOT DISTRIBUTED
Balanced	1.0	1.25
Not Balanced	1.25	1.5

$$Q_v = Q_t \times C_{\text{system}}$$

**(Equation 4-11)**

where:

$Q_v$  = Quality-adjusted ventilation airflow rate in cubic feet per minute (cfm)

$Q_t$  = Ventilation airflow rate, cubic feet per minute (cfm) from Equation 4-10 or Table 403.4.1

$C_{\text{system}}$  = System coefficient from Table 403.4.2

**Interpretation:** Per the definition of *distributed whole house ventilation* system and per Section 403.4.4.1 and 403.4.4.2 the whole house supply fan shall provide ducted outdoor ventilation to each habitable space within the residential unit. The intent is that whole house ventilation systems are only allowed to have exhaust that is “Not Distributed.” Therefore, the “Not Distributed” system coefficients in Table 403.4.3 are only applied to the residential unit whole house ventilation airflows when intermittent local exhaust that is not part of the unit whole house ventilation system is provided in one or more of the bathrooms or kitchen of the residential unit.

**[W] 403.4.4 Whole house ventilation residential occupancies.** Residential dwelling and sleeping unit whole house ventilation systems shall meet the requirements of Sections 403.4.4.1 or 403.4.4.2 depending on the occupancy of the residential unit.

**403.4.4.1 Whole house ventilation in Group R-2 occupancies.** Residential dwelling and sleeping units in Group R-2 occupancies system shall include supply and exhaust fans and be a *balanced whole house ventilation* system in accordance with Section 403.4.6.3. The system shall include a heat or energy recovery ventilator with a sensible heat recovery effectiveness as prescribed in Section C403.3.6 of the *Seattle Energy Code*. The whole house ventilation system shall operate continuously at the minimum ventilation rate determined in accordance with Section 403.4. The whole house supply fan shall provide ducted outdoor ventilation air to each habitable space within the residential unit.

**403.4.4.2 Whole house ventilation for other than Group R-2 occupancies.** Residential dwelling and sleeping units in other than Group R-2 occupancies, including I-1 condition 2 occupancies, shall have a whole house mechanical ventilation system with supply and exhaust fans in accordance with Section 403.4.6.1, 403.4.6.2, 403.4.6.3, or 403.4.6.4. The whole house ventilation system shall operate continuously at the minimum ventilation rate determined in accordance with Section 403.4.2 unless configured with intermittent off controls in accordance with Section 403.4.6.5. The whole house supply fan shall provide ducted outdoor ventilation air to each habitable space within the residential unit.

**[W] 403.4.5 Whole house ventilation system controls.**

1. The whole house ventilation system shall be controlled with manual switches, timers or other means that provide for automatic operation of the ventilation system that are readily accessible by the occupant.
2. Whole house mechanical ventilation system shall be provided with controls that enable manual override off of the system by the occupant during periods of poor outdoor air quality. Controls shall include permanent text or a symbol indicating their function. Recommended control permanent labeling to include text similar to the following “Leave on unless outdoor air quality is very poor.” Manual controls shall be provided with ready access for the occupant.

**[W] 403.4.6 Whole house ventilation system component requirements.** Whole house ventilation supply and exhaust fans specified in this section shall have a minimum efficacy as prescribed in the *Washington State Energy Code*. The fans shall be rated for sound at a maximum of 1.0 sone at design airflow and static pressure conditions. Design and installation of the system or equipment shall be carried out in accordance with manufacturer’s installation instructions.

**Exceptions:**

1. Central supply or exhaust fans serving multiple residential units do not need to comply with the maximum fan sone requirements.

2. Interior joining spaces provided with a 30 cfm transfer fan or a 25-square-foot permanent opening do not require supply ventilation air directly to the space. Transfer fans shall meet the same rating above and have whole house ventilation controls in accordance with Section 403.4.5.

**403.4.6.1 Exhaust fans.** Exhaust fans required shall be ducted directly to the outside in accordance with Section 501.3. Exhaust air outlets shall be designed to limit the pressure difference to the outside to limiting the outlet free area maximum velocity to 500 feet per minute and equipped with backdraft dampers or motorized dampers in accordance with *Washington State Energy Code*. Exhaust fans shall be tested and rated in accordance with HVI 915, HVI 916, and HVI 920. Exhaust fans required in this section may be used to provide local ventilation. Exhaust fans that are designed for intermittent exhaust airflow rates higher than the continuous exhaust airflow rates in Table 403.4.3 shall be provided with occupancy sensors or humidity sensors to automatically override the fan to the high speed airflow rate. The exhaust fans shall be tested and the testing results shall be submitted and posted in accordance with Section 403.4.6.7.

**Exception:** Central exhaust fans serving multiple residential units do not need to comply with the HVI testing requirements.

**403.4.6.2 Supply fans.** Supply fans used in meeting the requirements of this section shall supply outdoor air from intake openings in accordance with Sections 401.4 and 401.5. Intake air openings shall be designed to limit the pressure difference to the outside to limiting the inlet free area maximum velocity to 500 feet per minute and when designed for intermittent off operation shall be equipped with motorized dampers in accordance with the *Washington State Energy Code*. Supply fans shall be tested and rated in accordance with HVI 915, HVI 916, and HVI 920. Where outdoor air is provided to each habitable dwelling unit or sleeping unit by supply fan systems the outdoor air shall be filtered. The filter shall be provided with access for regular maintenance and replacement. The filter shall have a Minimum Efficiency Rating Value (MERV) of at least 8.

**Exception:** Central supply fans serving multiple residential units do not need to comply with the HVI testing requirements.

**403.4.6.3 Balanced whole house ventilation system.** A *balanced whole house ventilation* system shall include both supply and exhaust fans. The supply and exhaust fans shall have airflow that is within 10 percent of each other. The tested and balanced total mechanical exhaust airflow rate is within 10 percent or 5 cfm, whichever is greater, of the total mechanical supply airflow rate. The flow rate test results shall be submitted and posted in accordance with Section 403.4.6.6. The exhaust fan shall meet the requirements of Section 403.4.6.1. The supply fan shall meet the requirements of Section 403.4.6.2. For R-2 dwelling and sleeping units, the system is required to have *balanced whole house ventilation* but is not required to have *distributed whole house ventilation* where the not distributed system coefficient from Table 403.4.2 is utilized to correct the whole house mechanical ventilation rate. The system shall be design and balanced to meet the pressure equalization requirements of Section 501.4. Intermittent dryer exhaust, intermittent range hood exhaust, and intermittent toilet room exhaust airflow rates above the residential dwelling or sleeping unit minimum ventilation rate are exempt from the balanced airflow calculation.

**403.4.6.4 Furnace integrated supply.** Systems using space condition heating and/or cooling air handler fans for outdoor air supply air distribution are not permitted.

**Exception:** Air handler fans shall be permitted that have multi-speed or variable speed supply airflow control capability with a low speed operation not greater than 25 percent of the rated supply air flow capacity during ventilation only operation. Outdoor air intake openings must meet the provisions of Sections 401.4 and 401.5 and must include a motorized damper that is activated by the whole house ventilation system controller. Intake air openings shall be designed to limit the pressure difference to the outside to limiting the inlet free area maximum velocity to 500 ft per min. The motorized damper must be controlled to maintain the outdoor airflow intake airflow within 10 percent of the whole house mechanical exhaust airflow rate. The supply air handler shall provide supply air to each habitable space in the residential unit. The whole house ventilation system shall include exhaust fans in accordance with Section 403.4.6.1 to meet the pressure equalization requirements of Section 501.4. The flow rate for the outdoor air intake must be tested and verified at the minimum ventilation fan speed and the maximum heating or cooling fan speed. The results of the test shall be submitted and posted in accordance with Section 403.4.6.6.

**403.4.6.5 Intermittent off operation.** Whole house mechanical ventilation systems shall be provided with advanced controls that are configured to operate the system with intermittent off operation and shall operate for a least two hours in each four-hour segment. The whole house ventilation airflow rate determined in accordance with Section 403.4.2 as corrected by Section 403.4.3 shall be multiplied by the factor determined in accordance with Table 403.4.6.5.

**[W] TABLE 403.4.6.5  
INTERMITTENT WHOLE HOUSE MECHANICAL VENTILATION RATE FACTORS<sup>a,b</sup>**

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	50%	66%	75%	100%
Factor <sup>a</sup>	2	1.5	1.3	1.0

a. For ventilation system run-time values between those given, the factors are permitted to be determined by interpolation.

b. Extrapolation beyond the table is prohibited.

**403.4.6.6 Testing.** Whole house mechanical ventilation systems shall be tested, balanced and verified to provide a flow rate not less than the minimum required by Sections 403.4.2 and 403.4.3. Testing shall be performed according to the ventilation equipment manufacturer’s instructions, or by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan’s inlet terminals, outlet terminals or grilles or in the connected ventilation ducts. Where required by the building official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the building official and shall be posted in the residential unit in accordance with Section 403.4.6.7.

**403.4.6.7 Certificate.** A permanent certificate shall be completed by the mechanical contractor, test and balance contractor or other approved party and posted on a wall in the space where the furnace is located, a utility room, or an approved location inside the building. When located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label, or other required labels. The certificate shall list the flow rate determined from the delivered airflow of the whole house mechanical ventilation system as installed and the type of mechanical whole house ventilation system used to comply with Section 403.4.3.

**[W] 403.4.7 Local exhaust.** Bathrooms, toilet rooms and kitchens shall include a local exhaust system. Such local exhaust systems shall have the capacity to exhaust the minimum airflow rate in accordance with Table 403.4.7 and Table 403.3.1.1, including notes. Fans required by this section shall be provided with controls that enable manual override or automatic occupancy sensor, humidity sensor or pollutant sensor controls. An “on/off” switch shall meet this requirement for manual controls. Manual fan controls shall be provided with ready access in the room served by the fan.

**[W] TABLE 403.4.7  
MINIMUM EXHAUST RATES**

AREA TO BE EXHAUSTED	EXHAUST RATE	
	INTERMITTENT	CONTINUOUS
Kitchens	100 cfm	30 cfm
Bathrooms-Toilet rooms	50 cfm	20 cfm

**[W][S] 403.4.7.1 Combined local exhaust and whole house ventilation controls.** If the local exhaust fan is included in a whole house ventilation system in accordance with Section 403.4.6, the exhaust fan shall be controlled to operate as specified in Section 403.4.5.

**403.4.7.2 Local exhaust fans.** Exhaust fans shall meet the following criteria:

1. Exhaust fans shall be tested and rated in accordance with HVI 915, HVI 916, and HVI 920.

**Exception:** Where a range hood or down draft exhaust fan is used for local exhaust for a kitchen, the device is not required to be rated per these standards.

2. Fan airflow rating and duct system shall be designed and installed to deliver at least the exhaust airflow required by Table 403.4.7. The airflows required refer to the delivered airflow of the system as installed and tested using a flow hood, flow grid, or other airflow measurement device. Local exhaust systems shall be tested, balanced and verified to provide a flow rate not less than the minimum required by this section.

**Exceptions:**

1. An exhaust airflow rating at a pressure of 0.25 in. w.g. may be used, provided the duct sizing meets the prescriptive requirements of Table 403.4.7.2.
2. Where a range hood or down draft exhaust fan is used to satisfy the local ventilation requirements for kitchens, the range hood or down draft exhaust shall not be less than 100 cfm at 0.10 in. w.g.
3. Design and installation of the system or equipment shall be carried out in accordance with manufacturers’ installation instructions.

**[W] TABLE 403.4.7.2  
PRESCRIPTIVE EXHAUST DUCT SIZING**

<b>FAN TESTED CFM AT 0.25 INCHES W.G.</b>	<b>MINIMUM FLEX DIAMETER</b>	<b>MAXIMUM LENGTH IN FEET</b>	<b>MINIMUM SMOOTH DIAMETER</b>	<b>MAXIMUM LENGTH IN FEET</b>	<b>MAXIMUM ELBOWS<sup>a</sup></b>
50	4 inches	25	4 inches	70	3
50	5 inches	90	5 inches	100	3
50	6 inches	No Limit	6 inches	No Limit	3
80	4 inches <sup>b</sup>	NA	4 inches	20	3
80	5 inches	15	5 inches	100	3
80	6 inches	90	6 inches	No Limit	3
100	5 inches <sup>b</sup>	NA	5 inches	50	3
100	6 inches	45	6 inches	No Limit	3
125	6 inches	15	6 inches	No Limit	3
125	7 inches	70	7 inches	No Limit	3

a. For each additional elbow, subtract 10 feet from length.

b. Flex ducts of this diameter are not permitted with fans of this size.

**[S] SECTION 404**

**ENCLOSED PARKING GARAGES, LOADING DOCKS AND MOTOR VEHICLE REPAIR GARAGES**

**[S] 404.1 Enclosed parking garages.** Mechanical ventilation systems for enclosed parking garages shall operate continuously or shall be automatically operated by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Such detectors shall be listed in accordance with UL 2075 and installed in accordance with their listing and the manufacturers’ instructions. Loss of communication with the carbon monoxide or nitrogen dioxide detectors shall cause the exhaust fans to operate continuously at full-on design airflow. Automatic operation shall cycle the ventilation system between the following two modes of operation:

1. Full-on at an airflow rate of not less than 0.75 cfm per square foot [0.0038 m<sup>3</sup>/(s • m<sup>2</sup>)] of the floor area served.
2. Standby at an airflow rate of not less than 0.05 cfm per square foot [0.00025 m<sup>3</sup>/(s • m<sup>2</sup>)] of the floor area served.

**404.2 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 403.3.1.

**404.3 Enclosed loading dock.** Mechanical ventilation systems for enclosed parking garages shall operate continuously or shall be automatically operated by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Such detectors shall be listed in accordance with UL 2075 and installed in accordance with their listing and the manufacturers’ instructions. Loss of communication with the carbon monoxide or nitrogen dioxide detectors shall cause the exhaust fans to operate continuously at full-on design airflow. Automatic operation shall cycle the ventilation system between the following two modes of operation:

1. Full-on at an airflow rate of not less than 1.5 cfm per square foot [0.0076 m<sup>3</sup>/(s • m<sup>2</sup>)] of the floor area served.
2. Standby at an airflow rate of not less than 0.30 cfm per square foot [0.00017 m<sup>3</sup>/(s • m<sup>2</sup>)] of the floor area served.

**404.4 Enclosed automated parking system areas.** Mechanical ventilation systems for enclosed automated parking system areas where the engines of the motor vehicles are not operating shall operate continuously to provide a minimum airflow rate of 50 cfm per parking stall. This does not apply to the vehicle drop off area where vehicles are operating as these area shall comply with Section 404.1.

**404.5 Motor vehicle repair garages.** In buildings used for the repair of motor vehicles, each repair stall or stand shall be equipped with an exhaust capture system that connects directly to the repair engine exhaust source and prevents the escape of fumes. The exhaust system shall exhaust to the outdoor atmosphere. See Section 502.15 for additional requirements. Ventilation shall be provided for the motor vehicle repair garage in accordance with Section 404.1.

**SECTION 405  
SYSTEMS CONTROL**

**[S] 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

## VENTILATION

controls designed to automatically maintain the required outdoor air supply rate during occupancy. Additional mechanical system control requirements are contained in the International Energy Conservation Code.

### SECTION 406 VENTILATION OF UNINHABITED SPACES

[S] **406.1 General.** (~~Uninhabited spaces, such as crawl~~) 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 m<sup>3</sup>/s · m<sup>2</sup>) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.

### SECTION 407 AMBULATORY CARE FACILITIES AND GROUP I-2 OCCUPANCIES

[W] **407.1 General.** Mechanical ventilation for healthcare facilities licensed by Washington state shall be designed and installed in accordance with this code and the following provisions of the Washington Administrative Code (WAC):

1. Mechanical ventilation in ambulatory care facilities shall comply with chapter 246-330 WAC.
2. Mechanical ventilation for acute care hospitals shall comply with chapter 246-320 WAC.
3. Mechanical ventilation for nursing homes shall comply with chapter 388-97 WAC.

Mechanical ventilation for unlicensed ambulatory care facilities (~~(and Group I-2 occupancies)~~) shall be designed and installed in accordance with this code and ASHRAE 170.