# CHAPTER 4
# VENTILATION

## SECTION 401
## GENERAL

**401.1 Scope.** This chapter shall govern the ventilation of spaces within a building intended to be occupied. This chapter does not govern the requirements for smoke control systems.

See Chapter 5 for mechanical 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.

⇨ **401.2 Ventilation required.** Every occupied space shall be ventilated.

**401.2.1 Group R occupancies four stories or less.** Ventilation in Group R occupancies four stories or less shall be provided in accordance with the *Washington State Ventilation and Indoor Air Quality Code*.

**401.2.2 Group R occupancies over four stories.** Ventilation in Group R occupancies over four stories shall be provided in accordance with Section 403.3.6.

**401.2.3 All other occupancies.** All other occupancies shall be ventilated by natural means in accordance with Section 402 or 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 Opening location.** Outdoor air exhaust and intake openings shall be located a minimum of 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 to the ((~~centerline~~)) opposite side of the street or public way.

**Exceptions:**

1. Group R-3.
2. Exhaust outlets for environmental air exhaust openings shall be located not less than 3 feet (914 mm) from property lines and not less than 3 feet (914 mm) from openings into the building.

**Interpretation:** For purposes of this section, property 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.

**401.4.1 Intake openings.** Mechanical and gravity outdoor air intake openings shall be located a minimum of 10 feet (3048 mm) horizontally from any hazardous or noxious contaminant source, such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks, except as otherwise specified in this code. Where a source of contaminant is located within 10 feet (3048 mm) horizontally of an intake opening, such opening shall be located a minimum of 2 feet (610 mm) below the contaminant source.

The exhaust from a bathroom, clothes dryer or kitchen in a residential dwelling shall not be considered to be a hazardous or noxious contaminant.

Intake openings shall not be located:

1. In a crawlspace;
2. Less than 1 foot (305 mm) above a roof, adjacent grade or other surface directly below the intake; or
3. Under a deck having a surface height less than 3 feet (914 mm) above grade or other surface directly below the intake.

**401.4.2 Exhaust openings.** Outdoor exhaust openings ⇦ shall be located ((~~so as not to create a nuisance~~)) in accordance with Chapter 5. Exhaust air shall not be directed onto walkways in such a manner that the users of the walkway are subjected to the exhaust air stream.

**Note:** *Seattle Land Use Code* (Municipal Code Title 23) requires that the venting of odors, vapors, smoke, cinders, dust, gas and fumes shall be at least 10 feet (3048 mm) above finished sidewalk grade, and directed away as much as possible from residential uses within 50 feet (15 240 mm) of the vent. This requirement has been interpreted to apply to garage exhaust systems.

**[B] 401.4.3 Flood hazard.** For structures located in flood hazard areas, outdoor exhaust openings shall be at or above the design flood elevation.

**401.5 Outdoor opening protection.** Air exhaust and 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. Outdoor air exhaust and 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 OUTDOOR EXHAUST AND AIR INTAKE OPENINGS**

| OUTDOOR OPENING TYPE | MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION |
|---|---|
| Exhaust openings | Not < $^1/_4$ inch and not > $^1/_2$ inch |
| 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 air-borne 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.

## [B] SECTION 402
## NATURAL VENTILATION

**402.1 Natural ventilation.** Natural ventilation of an occupied space shall be designed to occur 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.

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

**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 $m^{2)}$. 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 $m^2$). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

**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.

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~~)) is designed in accordance with ASHRAE Standard 62.1-2004.

**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.~~)) Building HVAC air used as transfer air for heat removal may be recirculated.

**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 and 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.

**403.2.3 Outdoor air delivery.** The outdoor air shall be ducted in a fully enclosed path directly to every air handling unit in each zone not provided with sufficient operable opening area for natural ventilation to occur.

**Exception:** Ducts may terminate within 12 inches (305 mm) of the intake to an HVAC unit if they are physically fastened so that the outside air duct is directed into the unit intake.

**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.~~)) 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 estimated maximum occupancy rates.

**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:

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

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. Calculations and a description of controls operation shall be submitted with the permit drawings.

**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~~[b,g])) [j] | ((~~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~~)) 1.0 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[g, ((~~(h)~~))] and laundry areas[k] | — | 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[b,g]~~)) [i] | ((~~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]~~)) [i] | ((~~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 |
| 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 |

*(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] |
|---|---|---|
| **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~~)) | | |
| Enclosed loading docks[d] | | 1.5 cfm/ft$^2$ |
| Enclosed parking garages[d] | — | 1.0 cfm/ft$^2$ |
| Repair garages | | 1.5 cfm/ft$^2$ |
| Warehouses | — | 0.05 cfm/ft$^2$ |
| Nonretail storage spaces (> 100 ft$^2$)[g] | | 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 m$^3$/s, 1 ton = 908 kg,
1 cubic foot per minute per square foot = 0.00508 m$^3$/(s • m$^2$),
°C = [(°F) -32]/1.8, 1 square foot = 0.0929 m$^2$.

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/ft$^2$, 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/ft$^2$.

g. Transfer air permitted in accordance with Section 403.2.2.

h. **[W] Reserved**. ((~~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.

j. RCW 70.160.030 states: "No person may smoke in a public place or in any place of employment."

k. A laundry area contained within a kitchen or bathroom is not required to have source specific exhaust. When door(s) separate the area from the room, the door(s) shall be louvered.

**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.

**403.3.5 Ventilation of occupied spaces accessory to the maintenance and repair of vehicles.** Offices and waiting rooms connected to buildings used for the maintenance and repair of vehicles shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 403.

**403.3.6 Ventilation systems for Group R occupancies over 4 stories.** Each dwelling unit or guest room in a building over 4 stories shall be equipped with source specific and whole house ventilation systems and shall comply with Sections 403.3.6.1 through 403.3.6.7.

**403.3.6.1 Compliance and commissioning.** Compliance with Section 403.3.6 shall be demonstrated through engineering calculations. Documentation of calculations shall be submitted on the permit plan sets.

Testing and commissioning shall be performed and documented in accordance with Section 1416 of the *Washington State Energy Code with Seattle Amendments*.

**403.3.6.2 Minimum ventilation performance.** Ventilation systems shall be designed and installed to satisfy the ventilation requirements of Table 403.3.

**403.3.6.3 Controls.** Ventilation system controls shall be readily accessible by the dwelling unit occupants.

1. Source specific ventilation systems shall be controlled by manual switches, dehumidistats, timers or other approved means.
2. Whole house ventilation system controls shall be capable of operating the ventilation system without energizing other energy-consuming appliances. Intermittently operated whole house ventilation systems shall be capable of continuous operation. The system shall have a manual control and an automatic control, such as a clock timer. At the time of final inspection, the automatic control shall be set to operate the whole house fan for no less than 8 hours a day. A label shall be affixed to the control that reads "Whole House Ventilation (see operating instructions)."

**403.3.6.4 Source specific ventilation requirements.** Source specific exhaust ventilation as required in Table 403.3 shall be provided in each kitchen, bathroom, water closet, laundry area, indoor swimming pool, spa and other rooms where excess water vapor or cooking odor is produced. Source specific ventilation ducts shall terminate outdoors. Outlets shall comply with Section 401.4. Exhaust ducts in systems that are designed to operate intermittently shall be equipped with back-draft dampers.

**403.3.6.5 Whole house ventilation requirements.** Whole house ventilation systems shall be capable of providing the volume of outdoor ventilation air required in Table 403.3.

Outdoor air shall be distributed to each habitable space. Outdoor air distribution is permitted to be provided through the use of individual inlets, separate duct systems or a forced-air system. Where outdoor air supplies are separated from exhaust vents by doors, air distribution to separated habitable spaces is permitted to use distribution ducts, installed grilles, transoms, doors undercut to a minimum of $^1/_2$-inch above the surface of the finish floor covering or similar means where permitted by the *International Building Code*.

**403.3.6.5.1 Outdoor air.** A mechanical system shall supply the volume of outdoor air required in Table 403.3. The mechanical system is permitted to consist of exhaust fans, supply fans or both.

Exhaust-fan-only ventilation systems shall provide outdoor air through one of the following methods.

1. Operable windows, doors and other openings shall have a minimum openable area to the outdoors of 4 percent of the floor area being ventilated. Exit doors that open into a corridor, court or public way shall not be used to provide outdoor air. For adjoining spaces without openings to the outdoors, the opening to the adjoining room shall be unobstructed and shall have an area of not less than 8 percent of the floor area of the interior room or space, but not less than 25 square feet (2.3 $m^2$); or
2. Air inlets installed in walls or windows shall have controllable, secure openings and shall be designed to not compromise the thermal properties of the building envelope. Inlets shall provide not less than 4 square inches (25 $cm^2$) of net free area of opening for each 10 cfm of outdoor air required in Table 403.3. Inlets shall also comply with Section 401. Any inlet or combination of inlets that provides 10 cfm (4.7 L/s) at 10 Pascals as determined by the Home Ventilation Institute Air Flow Test Standard (HVI 901 [November 1996]) are deemed equivalent to 4 square inches (25 $cm^2$) of net free area.

**403.3.6.5.2 Ventilation integrated with forced-air systems**. Where outdoor air is provided by a forced-air system, the outdoor air connection to the return air stream shall be located upstream of the forced-air system blower and, in order to prevent thermal shock to the heat exchanger, shall not be connected directly to the furnace cabinet.

**403.3.6.6 Corridors.** Air movement in corridors shall comply with Section 601 of this code and the *International Building Code*.

**403.3.6.7 Fan noise.** Whole house fans located 4 feet (1219 mm) or less from the interior grille shall have a sone rating of 1.5 or less measured at 0.10 inch water gauge (25 Pa). Manufacturer's noise ratings shall be

determined according to HVI 915 (October 1995). Remotely mounted fans shall be acoustically isolated from the structural elements of the building and from attached ductwork using insulated flexible duct or other approved material.

**Exception:** Whole house ventilation systems that are integrated with forced-air heating systems or heat-recovery ventilation systems are exempt from the sone rating requirements of this section.

## SECTION 404
## ENCLOSED LOADING DOCKS AND PARKING GARAGES

**404.1 Enclosed loading dock and parking garage((s)) exhaust ventilation systems.** Mechanical ventilation systems for enclosed loading docks and parking garages shall be permitted to operate intermittently where the system is equipped with a control device that ((~~is arranged to~~)) operates the system automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices. Each of the following types of controllers shall be capable of shutting off fans or modulating fan speed.

1. Gas sensor controllers used to activate the exhaust ventilation system shall stage or modulate fan speed upon detection of specified gas levels. All equipment used in sensor controlled systems shall be designed for the specific use and installed in accordance with the manufacturer's recommendations. The following are minimum gas sensor system requirements:
   1.1. Garages and loading docks used predominantly by gasoline-powered vehicles shall be equipped with a controller and a full array of carbon monoxide (CO) sensors set to maintain levels of carbon monoxide below 35 parts per million (ppm). Spacing and location of the sensors shall be in accordance with manufacturer specifications.
   1.2. Where more than 20 percent of the vehicles using the garage or loading dock are powered by nongasoline fuels, the area exposed to nongasoline fueled vehicle exhaust shall be equipped with a controller and fuel-appropriate sensors. The setpoint for the nongasoline sensors shall be no less than the standard used by OSHA for eight hour exposure. The controller shall activate the ventilation system when sensor setpoint is reached. Spacing and location of the sensors shall be in accordance with manufacturer specifications.
2. Automatic time clocks used to activate the system during occupied periods shall be capable of scheduling multiple start and stop times for each day of the week, varying the daily schedule, and retaining programming for a 10-hour period during loss of power.
3. Occupant detection sensors used to activate the system shall detect entry into the parking garage along both the vehicle and pedestrian pathways.

**404.1.1 System activation devices for enclosed loading docks.** Ventilation systems for enclosed loading docks shall be activated by one of the following:

1. Gas sensors, or
2. Time clock and manual override switch located in the dock area that is accessible to persons in the loading dock area.

**404.1.2 System activation devices for enclosed parking garages.** Ventilation systems for enclosed parking garages shall be activated by gas sensors.

**Exception:** A parking garage having a total design capacity under 8,000 cfm (3.8 $m^3/s$) may use a time clock or occupant sensors.

**404.1.3 Ventilation makeup air.** Ventilation makeup air shall be mechanically supplied to levels of enclosed loading docks and parking garages more than 3 stories above or below the nearest garage or loading dock entrance or exit.

**404.1.4 Exhaust termination point.** The termination point or exhaust outlet for enclosed loading dock and garage exhaust ducts discharging to the atmosphere shall be located using the following minimum distances: 10 feet (3048 mm) from property lines, 10 feet (3048 mm) from operable openings into buildings, and 10 feet (3048 mm) from mechanical air intakes. Exhaust outlets extending to the roof shall extend 3 feet (914 mm) above the roof surface.

**404.2 Minimum ventilation.** Where a time clock is used as the only control device for the automatic operation of the exhaust ventilation system, fans shall be staged to maintain continuous operation of the system. The minimum ventilation rate shall not be reduced below the requirements of Sections 404.2.1 and 404.2.2.

**404.2.1 Enclosed parking garages.** Automatic operation of the exhaust ventilation system for enclosed parking garages shall not reduce the minimum ventilation rate below 0.05 cfm per square foot (0.00025 $m^3/s \cdot m^2$) of the garage floor area and the system shall be capable of producing a ventilation rate of ((~~1.5~~)) 1.0 cfm per square foot ((~~0.0076 m3/s m~~)) (0.00508 $m^3/s \cdot m^2$) of floor area.

**404.2.2 Enclosed loading docks.** Automatic operation of the exhaust ventilation system for enclosed loading docks shall not reduce the minimum ventilation rate below 1.0 cfm per square foot (0.00508 $m^3/s \cdot m^2$) of the loading dock floor area and the system shall be capable of producing a ventilation rate of 1.5 cfm per square foot (0.0076 $m^3/s \cdot m^2$) 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.

**Interpretation:** For purposes of this section, property 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.

**Interpretation:** In certain land use zones, the *Seattle Land Use Code* (Municipal Code Title 23) requires that the venting of odors, vapors, smoke, cinders, dust, gas and fumes shall be at least 10 feet (3048 mm) above finished sidewalk grade, and directed away as much as possible from residential uses within 50 feet (15 240 mm) of the vent. This requirement has been interpreted to apply to garage exhaust system terminations.

## 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. Additional mechanical system control requirements are contained in the *Washington State Energy Code with Seattle Amendments*.

## SECTION 406
## VENTILATION OF UNINHABITED SPACES

**406.1 General.** ((~~Uninhabited spaces, such as~~ e)) 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 $m^3/s \cdot m^2$) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.