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.

401.2 Ventilation required. ~~Every occupied space~~

401.2.1 Group R occupancies. Group R occupancies, regardless of number of stories, shall be ventilated as required by Sections 302 or 303 of the *Washington State Ventilation and Indoor Air Quality Code (WSVIAQ).*

401.2.2 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.

[B] 401.4 Exits. Equipment and ductwork for exit enclosure ventilation shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the exit enclosure by ductwork enclosed in construction as required by the *International Building Code* for shafts.
2. Where such equipment and ductwork is located within the exit enclosure, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required by the *International Building Code* for shafts.
3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required by the *International Building Code* for shafts.

In each case, openings into fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire-resistance-rated devices in accordance with the *International Building Code* for enclosure wall opening protectives.

Exit enclosure ventilation systems shall be independent of other building ventilation systems.

401.5 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.

Exception: Group R ~~3~~.

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

401.5.1 Intake openings. Mechanical and gravity outdoor air intake openings, shall be located a minimum of 10 feet (3048 mm) from any hazardous or noxious contaminant 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) of an intake opening, such opening shall be located a minimum of 2 feet (610 mm) below the contaminant source. Intake openings shall not be located in crawlspaces or less than one foot (305 mm) above a roof, adjacent grade, or other surface directly below the intake.

401.5.2 Exhaust openings. ~~Outdoor exhaust openings shall be located so as not to create a nuisance. Exhaust air shall not be directed onto walkways.~~ The termination point or exhaust outlet for exhaust ducts shall discharge to the outside of the building and shall be located, at a minimum, as follows: 3 feet (914 mm) from the property line; 3 feet (914 mm) from operable openings into the building for all occupancies other than Group U, and 10 feet (3048 mm) from a mechanical air intake. This includes environmental air regulated by Sections 504 and 505, but does not include enclosed parking garage exhaust outlets regulated by Section 404.

Exceptions:

1. The separation between an air intake and exhaust outlet on a single listed package HVAC unit.
2. Exhaust from environmental air systems other than garages may be discharged into an open parking garage.
3. Where ventilation system design circumstances require building HVAC air to be relieved, such as during economizer operation, such air may be relieved into an open or enclosed parking garage within the same building.

[B] 401.5.3 Flood hazard. For structures located in flood hazard areas, outdoor exhaust openings shall be at or above the design flood elevation.

401.6 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 401.6, 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 401.6
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.

401.7 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.

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 required outdoor air shall be determined in accordance with Section 403.3.

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 unit 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.
3. Where mechanical exhaust is required by 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. 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, 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 of the intake to an HVAC unit provided 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.

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	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[b]	—	0.50 cfm/ft^2
Music rooms	50	15
Smoking lounges[b,g]	70	60
Training shops	30	20
Food and beverage service		
Bars, cocktail lounges	100	30
Cafeteria, fast food	100	20
Dining rooms	70	20
Kitchens (cooking)[f,g]	20	15
Hospitals, nursing and convalescent homes		
Autopsy rooms[b]	—	0.50 cfm/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[b,g]	—	35 cfm per room
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]	—	mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous
Public spaces		
Corridors and utilities	—	0.05 cfm/ft^2
Elevators[g]	—	1.00 cfm/ft^2
Locker rooms[b]	—	0.5 cfm/ft^2
Shower room (per shower head) [b,g]		50 cfm intermediate or 20 cfm continuous
Smoking lounges[b,g]	70	60
Toilet rooms[b,g]	—	75 cfm per water closet or urinal
Retail stores, sales floors and Showroom floors		
Basement and street	—	0.30 cfm/ft^2
Dressing rooms	—	0.20 cfm/ft^2
Malls and arcades	—	0.20 cfm/ft^2
Shipping and receiving	—	0.15 cfm/ft^2
Smoking lounges[b]	70	60
Storage rooms	—	0.15 cfm/ft^2
Upper floors	—	0.20 cfm/ft^2
Warehouses	—	0.05 cfm/ft^2
Specialty shops		
Automotive service stations	—	1.5 cfm/ft^2
Barber	25	15
Beauty	25	25
Clothiers, furniture	—	0.30 cfm/ft^2
Florists	8	15
Hardware, drugs, fabrics	8	15
Nail salon[b]	—	25
Pet shops	—	1.00 cfm/ft^2
Reducing salons	20	15
Supermarkets	8	15

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~~,~~	—	1.5 cfm/ft^2
Loading docks	—	1.5 cfm/ft^2
~~e~~Enclosed parking garages[d]	—	1.0 cfm/ft^2
Warehouses	—	0.05 cfm/ft^2
Theaters		
Auditoriums	150	15
Lobbies	150	20
Stages, studios	70	15
Ticket booths	60	20
Transportation		
Platforms	100	15
Vehicles	150	15
Waiting rooms	100	15
Workrooms		
Bank vaults	5	15
Darkrooms	—	0.50 cfm/ft^2
Duplicating, printing	—	0.50 cfm/ft^2
Meat processing[c]	10	15
Pharmacy	20	15
Photo studios	10	15

For SI: 1 cubic foot per minute = 0.0004719 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).

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. A mechanical ventilation system shall not be required in garages having a floor area not exceeding 850 square feet and used for the storage of not more than four vehicles or trucks of 1 ton maximum capacity.

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.

403.3.3 Variable air volume system control. Variable air volume air distribution systems, other than those designed to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow of outdoor air at a rate of

not less than that required by Section 403 over the entire range of supply air operating rates.

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

403.3.5 Ventilation of buildings used for the repair of automobiles. In all buildings used for the repair of automobiles, each repair stall shall be equipped with an exhaust extension duct, extending to the outside of the building, which if over 10 feet in length, shall mechanically exhaust 300 cfm. Connecting offices and waiting rooms shall be supplied with conditioned air under positive pressure.

403.4 Alternate systems. Alternate systems designed in accordance with ASHRAE Standard 62-2001 shall be permitted. Calculations and documentation shall be included with the mechanical permit application.

SECTION 404
ENCLOSED PARKING GARAGES

[E] 404.1 Enclosed parking garages exhaust ventilation systems. ~~Mechanical ventilation systems for enclosed parking garages are not required to operate continuously where the system is arranged to operate automatically upon detection of a concentration of carbon monoxide of 25 parts per million (ppm) by approved automatic detection devices.~~ Enclosed parking garage exhaust ventilation systems with a total design capacity greater than 30,000 cfm shall include the equipment specified in items 1 and 2 below. Smaller exhaust systems shall include the equipment specified in either item 1 or 2.

1. An automatic control that is capable of staging fans or modulating fan speed as required to maintain carbon monoxide (CO) concentration below a level of 50 parts per million (ppm). This provision only applies to garages used predominantly by gasoline-powered vehicles.

2. An automatic control that is capable of shutting off fans or reducing fan speed during periods when the garage is not in use. The system shall be equipped with at least one of the following:

   a. An automatic time clock that can start and stop the system under different schedules for seven different day-types per week, is capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and includes an accessible manual override that allows temporary operation of the system for up to 2 hours.

   b. An occupant sensor.

404.1.1 Ventilation makeup air. Ventilation makeup air shall be mechanically supplied to levels of enclosed parking garages more than 3 stories above or below the nearest garage entrance or exit.

404.2 Minimum ventilation. Unless otherwise allowed by Section 404.1, ~~A~~automatic operation of the exhaust system shall not reduce the ventilation rate below 0.05 cfm per square foot (0.00025 $m^3/s \bullet m^2$) of the garage floor area and the system shall be capable of producing a ventilation rate of 1.0 cfm per square foot (0.00508 $m^3/s \bullet m^2$) of garage floor area, and, where applicable, 1.5 cfm per square foot (0.0076 $m^3/s \bullet m^2$) of loading dock floor area. Where enclosed parking garages and loading docks are combined on the same floor, the 1.5 cfm per square foot (0.0076 $m^3/s \bullet m^2$) of floor area ventilation rate shall apply to both areas of that floor.

Code Alternate CA 404.2: A garage ventilation system shall be designed to exhaust a minimum of 14,000 cfm for each operating vehicle. Such system shall be based on the anticipated instantaneous movement rate of vehicles but not less than 2.5% or one vehicle of the garage capacity.

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.

404.4 Enclosed parking garage exhaust termination point. The termination point or exhaust outlet for garage exhaust ducts discharging to the atmosphere shall be located using the following minimum distances: 10 feet from a property line, 10 feet from operable openings into a building and 10 feet from a mechanical air intake. Exhaust outlets which extend to the roof shall extend 3 feet (914 mm) above the roof.

Interpretation: For purposes of this section, property line shall include any property line separating one lot from another lot, but shall 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 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~~ CRAWL SPACES AND ATTICS

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