3. DEFINITIONS

***acceptable indoor air quality*:** air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.

***air cleaning*:** the use of equipment that removes particulate, microbial, or gaseous contaminants (including odors) from air.

***air, exhaust*:** air discharged from any space to the outside by an exhaust system.

***air, indoor*:** air in an occupiable space.

***air, outdoor*:** air from outside the building taken into a ventilation system or air from outside the building that enters a space through infiltration or natural ventilation openings.

***air, transfer*:** air moved from one occupiable space to another, usually through doorways or grilles.

***air, ventilation*:** outdoor air delivered to a space that is intended to dilute airborne contaminants.

***air change rate*:** airflow in volume units per hour divided by the volume of the space on which the air change rate is based in identical units (normally expressed in air changes per hour [ach]).

***balanced system*:** one or more fans that supply outdoor air and exhaust building air at substantially equal rates.

***bathroom*:** any room containing a bathtub, a shower, a spa, or a similar source of moisture.

***climate, hot, humid*:** climate in which the wet-bulb temperature is 67°F (19°C) or higher for 3500 h or more, or 73°F (23°C) or higher for 1750 h or more, during the warmest six consecutive months of a year that is typical for that geographic area (see Section 8).

***climate, very cold*:** climates that have more than 9000 annual heating degree-days base 65°F-day (5000 annual heating degree-days base 18°C-day) (see Section 8).

***conditioned space*:** the part of a building that is capable of being thermally conditioned for the comfort of occupants.

***contaminant*:** a constituent of air that may reduce acceptability of that air.

***exhaust system*:** one or more fans that remove air from the building, causing outdoor air to enter by ventilation inlets or normal leakage paths through the building envelope.

***exhaust flow, net*:** flow through an exhaust system minus the compensating outdoor airflow through any supply system that is interlocked to the exhaust system.

***habitable space*:** building space intended for continual human occupancy; such space generally includes areas used for living, sleeping, dining, and cooking but does not generally include bathrooms, toilets, hallways, storage areas, closets, or utility rooms.

***heating degree-day*:** the difference in temperature between the outdoor mean temperature over a 24-hour period and a given base temperature of a building space; that is, for heating degree-day base 65°F (18°C), for any one day, when the mean temperature is less than 65°F (18°C), there are as many heating degree-days as degrees Fahrenheit (Celsius) temperature difference between the mean temperature for the day and 65°F (18°C). Annual heating degree-days are the sum of the heating degree-days over a calendar year.

***high-polluting events*:** isolated and occupant-controllable events that release pollutants in excess quantities. Typical cooking, bathing, and laundry activities are not considered high-polluting events.

***infiltration*:** uncontrolled inward leakage of air through cracks and interstices in any building element and around windows and doors of a building.

***kitchen*:** any room containing cooking appliances.

***mechanical cooling*:** reducing the temperature of a fluid by using vapor compression, absorption, desiccant dehumidification combined with evaporative cooling, or other energy-driven thermodynamic means. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

***mechanical ventilation*:** the active process of supplying or removing air to or from an indoor space by powered equipment such as motor-driven fans and blowers but not by devices such as wind-driven turbine ventilators and mechanically operated windows.

***natural ventilation*:** ventilation occurring as a result of only natural forces, such as wind pressure or differences in air density, through intentional openings such as open windows and doors.

***occupiable space*:** any enclosed space inside the pressure boundary and intended for human activities, including, but not limited to, all habitable spaces, toilets, closets, halls, storage and utility areas, and laundry areas.

***pressure boundary*:** primary air enclosure boundary separating indoor and outdoor air. For example, a volume that has more leakage to the outside than to the conditioned space would be considered outside the pressure boundary. Exposed earth in a crawlspace or basement shall not be considered part of the pressure boundary.

***readily accessible*:** capable of being quickly and easily reached for operation, maintenance, and inspection.

***source*:** an indoor object, person, or activity from which indoor air contaminants are released; or a route of entry of contaminants from outdoors or sub-building soil.

***supply system*:** one or more fans that supply outdoor air to the building, causing indoor air to leave by normal leakage paths through the building envelope.

***system*:** equipment and other components that collectively perform a specific function, such as mechanical cooling or ventilation.

***toilet*:** space containing a toilet, water closet, urinal, or similar sanitary service.

***utility*:** laundry, lavatory, or other utility room containing sinks or washing equipment.

ventilation: the process of supplying outdoor air to or removing indoor air from a dwelling by natural or mechanical means. Such air may or may not have been conditioned.

4. WHOLE-BUILDING VENTILATION

4.1 Ventilation Rate. A mechanical exhaust system, supply system, or combination thereof shall be installed for each dwelling unit to provide whole-building ventilation with outdoor air each hour at no less than the rate specified in Tables 4.1a and 4.1b or, equivalently, Equations 4.1a and 4.1b, based on the floor area of the conditioned space and number of bedrooms.

$$Q_{fan} = 0.01A_{floor} + 7.5(N_{br} + 1) \quad (4.1a)$$

where

Q_{fan} = fan flow rate, cfm
A_{floor} = floor area, ft^2
N_{br} = number of bedrooms; not to be less than one

$$Q_{fan} = 0.05A_{floor} + 3.5(N_{br} + 1) \quad (4.1b)$$

where

Q_{fan} = fan flow rate, L/s
A_{floor} = floor area, m^2
N_{br} = number of bedrooms; not to be less than one

TABLE 4.1a (I-P)
Ventilation Air Requirements, cfm

Floor Area (ft^2)	Bedrooms				
	0–1	2–3	4–5	6–7	>7
<1500	30	45	60	75	90
1501–3000	45	60	75	90	105
3001–4500	60	75	90	105	120
4501–6000	75	90	105	120	135
6001–7500	90	105	120	135	150
>7500	105	120	135	150	165

TABLE 4.1b (SI)
Ventilation Air Requirements, L/s

Floor Area (m^2)	Bedrooms				
	0–1	2–3	4–5	6–7	>7
<139	14	21	28	35	42
139.1–279	21	28	35	42	50
279.1–418	28	35	42	50	57
418.1–557	35	42	50	57	64
557.1–697	42	50	57	64	71
>697	50	57	64	71	78

Exceptions: Whole-building mechanical systems are not required provided that at least one of the following conditions is met:

a. the building has no mechanical cooling and is in zone 1 or 2 of the IECC 2004 Climate Zone Map (see Figure 8.2), or
b. the building is thermally conditioned for human occupancy for less than 876 h per year,

and if the authority having jurisdiction determines that window operation is a locally permissible method of providing ventilation.

4.1.1 Different Occupant Density. Tables 4.1a and 4.1b and Equations 4.1a and 4.1b assume two persons in a studio or one-bedroom dwelling unit and an additional person for each additional bedroom. Where higher occupant densities are known, the rate shall be increased by 7.5 cfm (3.5 L/s) for each additional person. When approved by the authority having jurisdiction, lower occupant densities may be used.

4.1.2 Alternative Ventilation. Other methods may be used to provide the required ventilation rates (of Tables 4.1a and 4.1b) when approved by a licensed design professional.

4.1.3 Infiltration Credit. Section 4.1 includes a default credit for ventilation provided by infiltration of 2 cfm per 100 ft^2 (10 L/s per 100 m^2) of occupiable floor space. For buildings built prior to the application of this standard, when excess infiltration has been measured in accordance with *ANSI/ASHRAE Standard 136, A Method of Determining Air Change Rates in Detached Dwellings,*[1] the rates in Section 4.1 may be decreased by half of the excess of the rate calculated from Standard 136 that is above the default rate. No increase to the rate in Section 4.1 is required if measured infiltration in accordance with Standard 136 is lower than the default rate.

4.2 System Type. The whole-house ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls. Local exhaust fans shall be permitted to be part of a mechanical exhaust system. Outdoor air ducts connected to the return side of an air handler shall be permitted as supply ventilation if manufacturers' requirements for return air temperature are met. See Chapter 10 of Guideline 24[2] for guidance on selection of methods.

4.3 Airflow Measurement. The airflow required by this section is the quantity of outdoor ventilation air supplied and/or indoor air exhausted by the ventilation system as installed and shall be measured using a flow hood, flow grid, or other airflow measuring device. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to meet this section.

4.4 Control and Operation. The "fan on" switch on a heating or air-conditioning system shall be permitted as an operational control for systems introducing ventilation air through a duct to the return side of an HVAC system. Readily accessible override control must be provided to the occupant. Local exhaust fan switches and "fan on" switches shall be permitted as override controls. Controls, including the "fan-on" switch of a conditioning system, must be appropriately labeled.

Exception: An intermittently operating, whole-house mechanical ventilation system may be used if the ventilation rate is adjusted, according to the exception to Section 4.5. The system must be designed so that it can operate automatically based on a timer. The intermittent mechanical ventilation system must operate at least once per day and must operate at least 10% of the time.

4.5 Delivered Ventilation. The delivered ventilation rate shall be calculated as the larger of the total supply or total exhaust and shall be no less than specified in Section 4.1 during each hour of operation.

Exception: The effective ventilation rate of an intermittent system is the combination of its delivered capacity, fractional on-time, cycle time, and the ventilation effectiveness from Table 4.2. The fan flow rate required to achieve an effective ventilation rate that is equivalent to the continuous ventilation requirement shall be calculated from the following equation:

$$Q_f = Q_r / (\varepsilon f) \quad (4.2)$$

where

Q_f = fan flow rate during the on-cycle

Q_r = ventilation air requirement (from Table 4.1a or 4.1b)

T_{cyc} = fan cycle time, defined as the total time for one on-cycle and one off-cycle (used in Table 4.2)

ε = ventilation effectiveness (from Table 4.2)

f = fractional on time, defined as the on-time for one cycle divided by the cycle time

TABLE 4.2 Ventilation Effectiveness for Intermittent Fans

Fractional On-Time, f	Cycle Time, T_{cyc} (h)			
	0–4	8	12	24
0.1	1.00	0.79	*	*
0.2	1.00	0.84	0.56	*
0.3	1.00	0.89	0.71	*
0.4	1.00	0.92	0.81	0.20
0.5	1.00	0.94	0.87	0.52
0.6	1.00	0.97	0.92	0.73
0.7	1.00	0.98	0.96	0.86
0.8	1.00	0.99	0.98	0.94
0.9	1.00	1.00	1.00	0.99
1.0	1.00	1.00	1.00	1.00

*Condition not allowed since no amount of intermittent ventilation will provide equivalent ventilation.

See Chapter 10 of Guideline 24[2] for an example of this calculation.

For values not listed, use the next higher value for Cycle Time or the next lower value for Fractional On-Time. Linear interpolation is allowed for intermediate Fractional On-Times. The maximum allowed Cycle Time is 24 h and the minimum allowed Fractional On-Time is 0.1.

4.6 Restrictions on System Type. Use of certain ventilation strategies is restricted in specific climates as follows.

4.6.1 Hot, Humid Climates. In hot, humid climates, whole-house mechanical net exhaust flow shall not exceed 7.5 cfm per 100 ft^2 (35 L/s per 100 m^2). (See Section 8 for a listing of hot, humid U.S. climates.)

4.6.2 Very Cold Climates. Mechanical supply systems exceeding 7.5 cfm per 100 ft^2 (35 L/s per 100 m^2) shall not be used in very cold climates. (See Section 8 for a listing of very cold U.S. climates.)

Exception: These ventilation strategies are not restricted if the authority having jurisdiction approves the envelope design as being moisture resistant.

5. LOCAL EXHAUST

5.1 Local Mechanical Exhaust. A local mechanical exhaust system shall be installed in each kitchen and bathroom. Each local ventilation system shall be either one of the following two:

a. an intermittent mechanical exhaust system meeting the requirements of Section 5.2 or
b. a continuous mechanical exhaust system meeting the requirements of Section 5.3.

Exception: *Alternative Ventilation*. Other design methods may be used to provide the required exhaust rates when approved by a licensed design professional.

5.2 Intermittent Local Exhaust. An intermittently operating, local mechanical exhaust system shall be designed to be operated as needed by the occupant.

5.2.1 Control and Operation. Control devices such as, but not limited to, the following are permissible provided they do not impede occupant control: shut-off timers, occupancy sensors, multiple-speed fans, combined switching, IAQ sensors, etc.

5.2.2 Ventilation Rate. The minimum airflow rating shall be at least the amount indicated in Table 5.1.

5.3 Continuous Mechanical Exhaust. A continuously operating mechanical exhaust system shall be installed to operate without occupant intervention. The system may be part of a balanced mechanical system. See Chapter 10 of Guideline 24[2] for guidance on selection of methods.

5.3.1 Control and Operation. The system shall be designed to operate during all occupiable hours. Readily accessible override control must be provided to the occupant.

5.3.2 Ventilation Rate. The minimum delivered ventilation shall be at least the amount indicated in Table 5.2 during each hour of operation.

5.4 Airflow Measurement. The airflow required by this section is the quantity of indoor air exhausted by the ventilation system as installed and shall be measured using a flow hood, flow grid, or other airflow measuring device.

Exception: The airflow rating, according to Section 7.1, at a pressure of 0.25 in. w.c. (62.5 Pa) may be used, provided the duct sizing meets the prescriptive requirements of Table 5.3 or manufacturer's design criteria.

6. OTHER REQUIREMENTS

6.1 Adjacent Spaces. Measures shall be taken to minimize air movement across envelope components separating dwelling units, and to dwelling units from garages, unconditioned crawl spaces, and unconditioned attics.

Supply and balanced ventilation systems shall be designed and constructed to provide ventilation air directly from the outdoors.

6.1.1 Multifamily Buildings. All doors between dwelling units and common hallways shall be gasketed or made substantially airtight with weather stripping except when the ventilation system design explicitly requires transfer air from corridors into units.

6.2 Instructions and Labeling. Information on the ventilation design and/or ventilation systems installed, instructions on their proper operation to meet the requirements of this standard, and instructions detailing any required maintenance (similar to that provided for HVAC systems) shall be provided to the owner and the occupant of the dwelling unit. Controls shall be labeled as to their function (unless that function is obvious, such as toilet exhaust fan switches). See Chapter 13 of Guideline 24[2] for information on instructions and labeling.

6.3 Clothes Dryers. Clothes dryers shall be exhausted directly to the outdoors.

Exception: Condensing dryers plumbed to a drain.

6.4 Combustion and Solid-Fuel Burning Appliances. Combustion and solid-fuel burning appliances must be provided with adequate combustion and ventilation air and vented in accordance with manufacturers' installation instructions, *NFPA 54/ANSI Z223.1, National Fuel Gas Code,*[3] *NFPA 31, Standard for the Installation of Oil-Burning Equipment,*[4] or *NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances*,[5] or other equivalent code acceptable to the building official. Where atmospherically vented combustion appliances or solid-fuel burning appliances are located inside the pressure boundary, the total net exhaust flow of the two largest exhaust fans (not including a summer cooling fan intended to be operated only when windows or other air inlets are open) shall not exceed 15 cfm/100 ft^2 (75 Lps/100 m^2) of occupiable space when in operation at full capacity. If the designed total net flow exceeds this limit, the net exhaust flow must be reduced by

TABLE 5.1 Intermittent Local Ventilation Exhaust Airflow Rates

Application	Airflow	Notes
Kitchen	100 cfm (50 L/s)	Vented range hood (including appliance-range hood combinations) required if exhaust fan flow rate is less than 5 kitchen air changes per hour.
Bathroom	50 cfm (25 L/s)	

TABLE 5.2 Continuous Local Ventilation Exhaust Airflow Rates

Application	Airflow	Notes
Kitchen	5 ach	Based on kitchen volume.
Bathroom	20 cfm (10 L/s)	

TABLE 5.3 Prescriptive Duct Sizing

Duct Type	Flex Duct				Smooth Duct			
Fan Rating cfm @ 0.25 in. w.g. (L/s @ 62.5 Pa)	50 (25)	80 (40)	100 (50)	125 (65)	50 (25)	80 (40)	100 (50)	125 (65)
Diameter, in. (mm)	**Maximum Length, ft (m)**							
3 (75)	X	X	X	X	5 (2)	X	X	X
4 (100)	70 (21)	3 (1)	X	X	105 (32)	35 (11)	5 (2)	X
5 (125)	NL	70 (21)	35 (11)	20 (7)	NL	135 (42)	85 (26)	55 (17)
6 (150)	NL	NL	135 (42)	95 (29)	NL	NL	NL	145 (45)
7 (175) and above	NL	NL	NL	NL	NL	NL	NL	NL

This table assumes no elbows. Deduct 15 ft (5 m) of allowable duct length for each elbow.
NL = no limit on duct length of this size
X = not allowed, any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop