4.6 Indoor Air Quality and Mechanical Ventilation

§150.0(o) and §150.2(a)

As houses have been tightened up over the last twenty years due to energy cost concerns and the use of large sheet goods and housewrap, what used to be normal infiltration and exfiltration has been significantly reduced. In the meantime, we have introduced thousands of chemicals into our houses through building materials, cleaners, finishes, packaging, furniture, carpets, clothing and other products. The California Standards have always assumed adequate indoor air quality would be provided by a combination of infiltration and natural ventilation and that home occupants would open windows as necessary to make up any shortfall in infiltration. However, Commission sponsored research on houses built under the 2001 Standards has revealed lower than expected overall ventilation rates, higher than expected indoor concentration of chemicals such as formaldehyde and many occupants who do not open windows regularly for ventilation. The 2013 update includes mandatory mechanical ventilation intended to improve indoor air quality in homes with low infiltration and natural ventilation rates.

The Energy Commission adopted the requirements of ASHRAE Standard 62.2-2010, including ASHRAE Addenda b, c, e, g, h, i, j, l, and n [http://www.techstreet.com/ashrae/lists/ashrae_standards.tmpl], except that opening and closing windows (although permitted by ASHRAE) and continuous operation of central forced air system air handlers of a central fan integrated ventilation system are not an acceptable option for providing whole-building ventilation in California.

This section addresses the mandatory requirements for mechanical ventilation. All low-rise residential buildings are required to have a whole-building ventilation system and satisfy other requirements to achieve acceptable indoor air quality (IAQ).

The mechanical ventilation and indoor air quality requirements of ASHRAE Standard 62.2 as referenced from Section 150.0(o) are mandatory measures for newly constructed low-rise residential buildings. The applicable section is §150.0(o) for new construction. The applicable sections are §150.2(a)1C (prescriptive approach) and §150.2(a)2C (performance approach) for additions and alterations.

Ventilation for Indoor Air Quality §150.0(o), §150.2(a)1C, §150.2(a)2C

§150.0(o): ***Ventilation for Indoor Air Quality***. *All dwelling units shall meet the requirements of ASHRAE Standard 62.2 – Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Window operation is not a permissible method of providing the Whole-Building Ventilation airflow required in Section 4 of ASHRAE 62.2. Additionally, all dwelling units shall meet the following requirements:*

4.6.1 Field Verification and Diagnostic Testing –

1. ***Airflow Performance.*** *The Whole-Building Ventilation airflow required by Section 4 of the ASHRAE Standard 62.2 shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.*

2. §150.2(a)1C and§150.2(a)2C: *Additions larger than 1,000 square feet shall meet the ASHRAE Standard 62.2 Section 4 requirement to provide whole-building ventilation airflow. The whole building ventilation airflow rate shall be based on the conditioned floor area for the entire dwelling unit comprised of the existing dwelling conditioned floor area plus the addition conditioned floor area.*

The whole building ventilation airflow requirement in ASHRAE 62.2 is required in new buildings and in buildings with additions greater than 1,000 ft^2. All other mechanical ventilation requirements in §150.0(o), including local exhaust, must be met (as applicable) in all additions and alterations..

Alterations to components of existing buildings which previously met any requirements of ASHRAE 62.2 shall continue to meet its requirements upon completion of the alteration(s).

Refer to Chapter 9.X for more information on ventilation requirements for additions and alterations.

The following summarizes the key requirements for most newly constructed residences.

1. A whole-building mechanical ventilation system shall be provided. The typical solutions are described in the following section. This system shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.
2. Kitchens and bathrooms shall have local exhaust systems vented to the outdoors.
3. Clothes dryers shall be vented to the outdoors.

Miscellaneous indoor air quality design requirements apply, including:

1. Ventilation air shall come from the out of doors and shall not be transferred from adjacent dwelling units, garages or crawlspaces.
2. Ventilation system controls shall be labeled and the home owner shall be provided with instructions on how to operate the system.
3. Combustion appliances shall be properly vented and air systems shall be designed to prevent back drafting.
4. The walls and openings between the house and the garage shall be sealed.
5. Habitable rooms shall have windows with a ventilation area of at least 4 percent of the floor area (see Ventilation Opening Area in Section 4.6.5 below)
6. Mechanical systems including heating and air conditioning systems that supply air to habitable spaces shall have MERV 6 filters or better.
7. Dedicated air inlets (not exhaust) that are part of the ventilation system design shall be located away from known contaminants.
8. A carbon monoxide alarm shall be installed in each dwelling unit in accordance with NFPA 720, *Standard for the installation of Carbon Monoxide (CO) Detection and Warning Equipment*
9. Air moving equipment used to meet the whole-building ventilation requirement and the local ventilation exhaust requirement shall be rated in terms of airflow and sound.
   a. All continuously operating fans shall be rated at a maximum of 1.0 sone.
   b. Intermittently operated whole-building ventilation fans shall be rated at a maximum of 1.0 sone.
   c. Intermittently operated local exhaust fans shall be rated at a maximum of 3.0 sone.
   d. Remotely located air-moving equipment (mounted outside of habitable spaces) need not meet sound requirements if there is at least 4 feet of

ductwork between the fan and the intake grill.

A. Compliance and Enforcement

Compliance with Indoor Air Quality and Mechanical Ventilation requirements is verified by the enforcement agency. HERS verification is required for the whole house ventilation requirement of ASHRAE 62.2.

In addition to HERS verification of the required whole house ventilation rate, if a central heating/cooling system air handler fan is utilized for providing ventilation air to the dwelling (central fan integrated ventilation), the air handler must meet the prescriptive fan Watt draw criteria which requires the installer to perform the diagnostic protocol given in Reference Appendix RA3.3, and a HERS rater must perform a verification of the air handler utilizing the same protocol (see CFI ventilation topic in the Supply Ventilation section below).

Certificate of Compliance reporting requirements:

1. When compliance with the Standards utilizes the performance approach, information that describes the whole-building ventilation system must be given as input to the compliance software, thus a performance Certificate of Compliance (CF1R) will report:
   a. the ventilation airflow rate (calculated value) that must be delivered by the installed system to meet the whole-building ventilation requirement; and
   b. the system type selected to meet the whole-building ventilation requirement; and
   c. the fan power ratio (W/cfm) for the whole-building ventilation system that was selected; and
   d. if applicable, the requirement for HERS verification of fan Watt draw of the central heating/cooling system air handler when CFI ventilation system is the whole-building ventilation system type selected.

The whole-building ventilation system that is installed in the dwelling must conform to the requirements given on the performance CF1R in order to comply. For more information about the performance, see section 4.6.3 Whole-Building Mechanical Ventilation Energy Consumption calculations for whole-building ventilation systems. There are no requirements for providing information on the performance CF1R to describe fans installed for other purposes such as local ventilation exhaust.

1. When compliance with the Standards utilizes the prescriptive approach, information that describes the whole-building ventilation system is not required on the CF1R. Thus, unless otherwise required by the enforcement agency, calculation of the required whole-building ventilation airflow rate and selection of the whole-building ventilation system type can be accomplished at the time of installation. There are no requirements for providing information describing fans installed for other purposes such as local exhaust on the prescriptive CF1R.

The enforcement agency may require additional information/documentation describing the ventilation systems be submitted along with the CF1R at plan check.

B. Installation Certificate reporting requirements:

The builder/installer must complete an Installation Certificate (CF2R-MECH-27) for the dwelling that identifies the installed mechanical ventilation and indoor air quality features for the dwelling.

The Installation Certificate requires that the installer provide:

1. Calculated value for whole-building ventilation airflow rate requirement for continuous and/or intermittent operation per ASHRAE 62.2 equations (see 4.6.2 and 4.6.4)
2. Determination of local ventilation exhaust airflow rate requirements for continuous and/or intermittent operation
3. Whole-building ventilation and local ventilation exhaust system/design type(s)
4. Installed fan equipment make, model, and rated performance used to meet the Standard
5. Installed duct system design information if compliance is being demonstrated by inspection of the prescriptive design criteria or manufacturer's design criteria
6. Measured airflow rate of the installed system if compliance is being demonstrated by the airflow measurement method
7. Confirmation that other requirements given in ASHRAE 62.2 have been met (see section 4.6.5)

The Installation Certificate must be signed by the builder/installing contractor who is responsible for the installed mechanical ventilation and indoor air quality related features, and the completed/signed Installation Certificate must be posted in the field for use by the building inspector at final inspection.

Reducing Pollutant Emissions from Interior Materials, Finishes, and Furnishings

The requirements of ASHRAE Standard 62.2 focus on whole-building mechanical ventilation and local ventilation exhaust at known sources of pollutants or moisture such as kitchens, baths, and laundries. While not a requirement of the Standards, builders and home owners should select materials, finishes and furnishings that have no or low emissions of air pollutants, including formaldehyde and volatile organic compounds (VOCs).

Keeping air pollutants out of the building in the first place is more effective than flushing them out later through ventilation. Most building materials emit some level of VOCs, formaldehyde or other pollutants, and the resultant indoor pollutant exposures can pose a substantial risk for health effects such as cancer, asthma attacks, and irritation of the eyes, nose, and throat. Pollutant emissions are highest immediately after a new product is installed, but emissions may continue for days, weeks, months, or years. Build-up of air pollutants in the home is affected by ventilation, infiltration, and filtration rates which are the subjects of ASHRAE Standard 62.2.

Choosing materials, finishes and furnishings with low pollutant emissions requires some research on the part of the builder or the homeowner. Testing is required to determine the level of pollutant emissions. To this end, the California Department of Public Health (CDPH) has developed a standardized test procedure for interior materials such as paints, adhesives, sealants, sealers, carpets, resilient flooring, furniture, and ceiling panels. Construction assemblies or systems are tested, e.g., resilient floor tile is tested with the required adhesive. Typically, a small sample of the product or material is tested (usually a 6 inch square), but the test procedure may also be applied to larger items such as chairs, desks and other furnishings.

The Collaborative for High Performance Schools (CHPS) maintains a database of materials that have been tested by third-party groups to the CDPH protocol or an equivalent protocol. The list includes materials that are safe to use in classrooms. While not designed for the specific application of residences where ventilation rates are lower than those in schools, the list provides guidance on which products have low emissions. See the following link for more information:

http://www.betterbuildingsbetterstudents.org/dev/Drupal/node/445

In addition, simple measures can be taken during construction to reduce the emissions of pollutants in a building before it is occupied. Such measures include pre-conditioning building materials and furnishings before installation, providing continuous exhaust ventilation once the materials are installed, and controlling dust buildup on interior surfaces and ductwork. CHPS has developed required measures of this type for classrooms, but these measures would also be effective in new homes with mechanical ventilation systems. The California Air Resources Board (ARB) also provides guidance for reducing indoor air pollution in homes. For more information, see:

a ARB Indoor Air Quality Guidelines, http://www.arb.ca.gov/research/indoor/guidelines.htm.

b CHPS 2009 Criteria (Volume III)

Indoor Air Quality and Thermal Comfort section

http://www.chps.net/manual/.

4.6.2 Typical Solutions for Whole-Building Ventilation

There are three generic solutions to meeting the outside air ventilation requirement:

1. Exhaust ventilation,
2. Supply ventilation, or a
3. Combination of supply and exhaust ventilation. If the supply and exhaust flows are within 10 percent of each other this is called a balanced ventilation system.

Whole-building ventilation may be achieved through a single fan or a system of fans that are dedicated to this ventilation only. Or it may be carried out by fans that also provide local exhaust or distribute heating and cooling.

A. Exhaust Ventilation

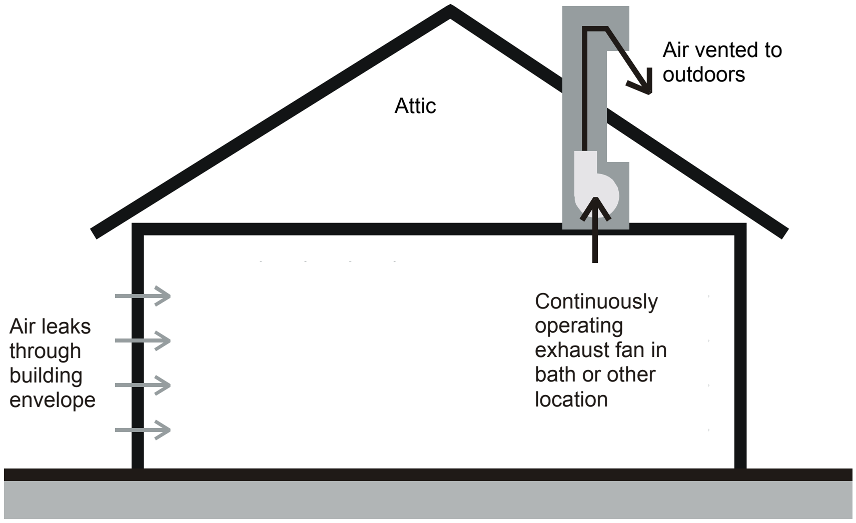

Figure 4-21 – Exhaust Ventilation Example
Source: California Energy Commission

Exhaust Ventilation is probably the most common solution. This is usually achieved by a quiet ceiling-mounted bath fan or remote-mounted inline or exterior-mounted fan. Air is drawn from the house by the exhaust fan and outdoor air enters the house through leaks in the building envelope.

Many high quality bath fans are available in the 30 to 150 cfm size range, and are quiet enough to be used continuously. One or more fans of this size will meet the requirements of most homes. The exhaust fan can be a dedicated IAQ fan or it can be a more typical bath fan that is used for both whole-building ventilation and local ventilation.

Inline fans (either single pickup or multipoint pickup) can be a very effective method of providing quiet exhaust ventilation from one or several bathrooms. As discussed above, inline fans can be located in the garage, attic, basement, or mechanical room. Exterior-mounted fans can be mounted on the exterior wall or on the roof. A sound rating is not required for remote or exterior fans as long as there is at least 4 ft of duct between the closest pickup grille and the fan.

B. Supply Ventilation

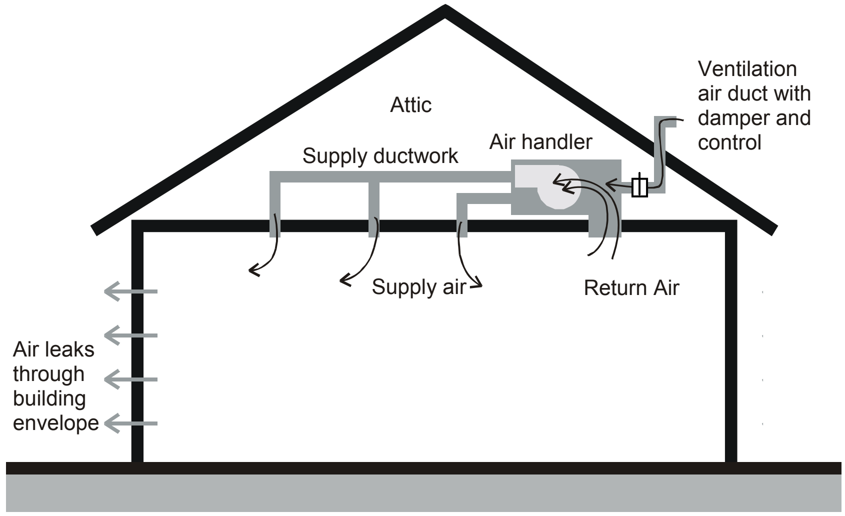

Figure 4-22 – Supply Ventilation Example
Source: California Energy Commission

Supply ventilation works in just the opposite way as exhaust ventilation. Outside air enters the house through a dedicated supply fan or through the central HVAC system air handler and escapes through leaks in the building envelope.

With the supply ventilation approach, the outdoor air inlet should be placed to avoid known areas of contaminants, such as the garage, barbeque areas, and chimneys. If a dedicated fan is used, care must be taken to avoid introducing too much outdoor air into one location and creating uncomfortable conditions. The air handler or supply fans can be located on the exterior of the house or dwelling unit, or in the garage, attic, basement, or mechanical room.

The ventilation air can be distributed by a dedicated ventilation air duct system that is separate from the central forced air distribution duct system.

Alternatively, the central forced air heating/cooling system air handler can be configured to function as a supply ventilation system by installing a dedicated ventilation air duct that connects to the air handler's return plenum at one end, and connects on the other end to the outside of the dwelling to access fresh air from outdoors. This strategy, called Central Fan Integrated (CFI) ventilation, uses the negative pressure in the return plenum to pull the desired amount of outdoor air in through the ventilation air duct and into the return plenum. Then the central system air handler distributes the ventilation air to all rooms in the dwelling. Also, a damper and controls must be installed that ensure the air handler delivers the required ventilation airflow regardless of the size of the heating or cooling load. One type of CFI product operates in ventilation mode by providing 100% outdoor air. This product primarily provides off-peak cooling through mechanical ventilation under favorable outdoor conditions, but can also satisfy fresh air ventilation requirements as long as it is properly controlled to ensure compliance with the minimum intermittent ventilation rate. Refer to section 4.6.2 for more details.

When discussing design and compliance considerations for CFI ventilation systems, it is important to draw the distinction between the central forced air system fan total airflow, and the much smaller airflow that is induced to flow into the return plenum from outdoors (ventilation airflow). Refer to Figure 4-22 and note that the total airflow through the air handler is the sum of the return airflow and the outside air ducted to the return plenum (ventilation airflow).

CFI ventilation systems can use a very significant amount of electricity on an annual basis. Refer to the discussion on energy consumption of central fan integrated ventilation systems in section 4.6.3. Air handlers used in CFI ventilation systems are required to meet the prescriptive fan Watt draw requirements in all climate zones.

ASHRAE Standard 62.2 also requires the installer to measure the ventilation airflow rate induced into the return plenum in a CFI system to ensure that it will meet the whole-building ventilation rate requirements regardless of the heating or cooling load when the dwelling is occupied. Because section 150.0(o) specifically prohibits continuously operated, CFI systems are considered "intermittent" ventilation systems (see section 4.6.2). The results of the airflow measurement of the installed CFI system, and a description of the intermittent ventilation control schedule used for the CFI system must be given on the Installation Certificate for the system. The whole house ventilation rate will also be verified by a HERS rater.

Note: the outside air (OA) ducts for CFI ventilation systems shall not be sealed/taped off during duct leakage testing. However, CFI OA ducts that utilize controlled motorized dampers, that open only when OA ventilation is required to meet ASHRAE Standard 62.2, and close when OA ventilation is not required, may be configured to the closed position during duct leakage testing.

C. Combination Ventilation

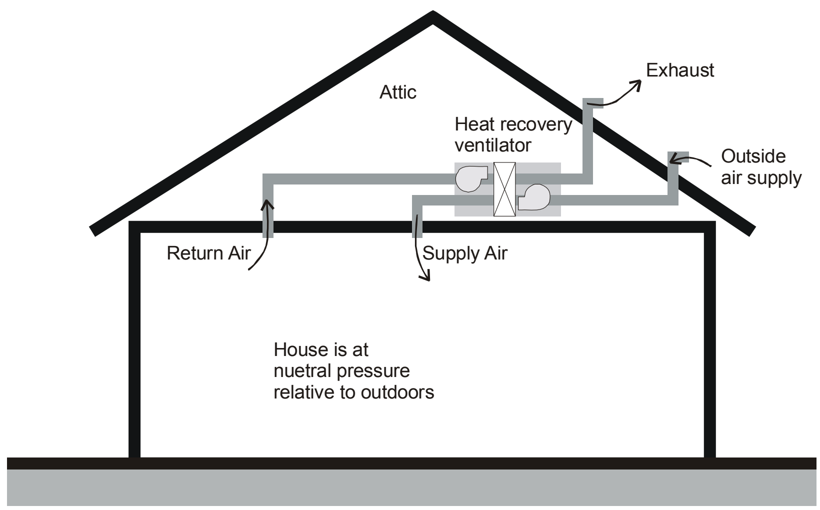

Figure 4-23 – Combination Ventilation Example
Source: California Energy Commission

Combination systems use both exhaust fans and supply fans. If both fans supply the same airflow the system is balanced and the house has a neutral pressure.

Combination systems are often integrated devices, sometimes with a heat exchanger or heat recovery wheel. The supply and exhaust airstreams are typically of equal flow.

Combination systems can also consist of a mixture of supply fans and exhaust fans. It may be as simple as a quiet continuous bathroom exhaust fan matched to an outdoor air connection that introduces air into the return air plenum of a continuously-operating central heating/cooling system air handler. Note: ventilation systems that utilize constant operation of the central heating/cooling system air handler can use a very significant amount of electricity on an annual basis and are not permitted by the standards. Refer to the discussion on energy consumption of central fan integrated ventilation systems in section 4.6.3.

4.6.3 Whole-building Ventilation Flow Rate (Section 4 of ASHRAE 62.2)

The whole-building ventilation system may operate continuously or intermittently. The whole-building ventilation rate is determined for continuous ventilation, and if the system is operated intermittently, an adjustment is made.

A. Continuous Whole-building Ventilation

There are two strategies for determining the continuous whole-building ventilation rate. One, called the Fan Ventilation Rate Method, assumes that all of the required ventilation will be provided mechanically. The other, called Total Ventilation Rate Method, assumes that ventilation will be achieved by some combination of measured natural infiltration and a mechanical means.

Both methods are allowed for newly constructed homes and altered homes. From a design perspective, the Fan Ventilation Rate Method may be advantageous due to not having to predict the homes infiltration rate prior to the home being built, as is required by the Total Ventilation Rate Method.

In either case, a fan system must be designed and installed that meets the whole-building ventilation airflow requirements, however it is determined. Both methods allow for an intermittent ventilation option.

Fan Ventilation Rate Method

The continuous whole-building ventilation rate is 1 cfm for each 100 ft² of conditioned floor area (CFA) plus 7.5 cfm for each occupant. The number of occupants is calculated as the number of bedrooms plus one. For example, a three bedroom house is assumed to have four occupants. The required ventilation rate is given by the following equation.

Equation 4-1

$$Ventilation\ Rate\ (cfm) = \frac{CFA}{100} + \ 7.5\ x\ (Number\ Bedrooms + 1)$$

Instead of using one of the equations given above, Table 4-14 may be used to determine the required ventilation. This table allows the user to find the required ventilation rate directly if they know the floor area and number of bedrooms. Note that Table 4-14 may give somewhat higher targets than Page 4-119.

To comply with ASHRAE 62.2 the delivered airflow of the whole house ventilation fan must be greater than or equal to the required ventilation rate (cfm) from either Table 4-14 or Page 4-119.

Table 4-14 – Continuous Whole-building Ventilation Rate (cfm) (from ASHRAE 62.2, Table 4.1a (I-P))

	Bedrooms				
Conditioned Floor Area (ft²)	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

Example 4-7 – Required Ventilation

Question

What is the required continuous ventilation rate for a 3 bedroom, 1,800 ft² townhouse?

Answer

48 cfm. This is calculated as 1800/100 + (3+1)x7.5 = 48 cfm. Using Table 4–15, the required ventilation rate would be 60 cfm.

Example 4-8

Question

The house I am building has a floor area of 2,240 ft² and 3 bedrooms. My calculations come out to 52.4 cfm. Can I use a 50 cfm fan?

Answer

No, a 50 cfm fan does not meet the standard. You would need to select the next larger size fan, such as a unit rated at 55 cfm or 60 cfm. Note that a fan's nominal rating can be very different than what a fan actually delivers when installed. Actual airflow depends greatly on the length and size of the duct needed to get the air to the outside. Proper fan sizing requires more detailed manufacturer's data, such as airflow vs. static pressure. This is why whole-house ventilation rates must be verified by a HERS rater.

B. Total Ventilation Rate Method

This method for determining a continuous whole-building ventilation rate starts with a calculation of the Total Ventilation Rate that consists of both the natural and mechanical ventilation rates. This number is calculated using a similar equation to the one used in the Fan Ventilation Rate Method, but results in a substantially higher value. Next, the ventilation associated with infiltration is calculated from diagnostically tested values. That value is subtracted from the Total Ventilation Rate, leaving the ventilation rate that must be provided mechanically. This continuous fan ventilation rate can then be used to determine an intermittent value using the same table. (Note that the following equations and factors were taken from ASHRAE 62.2 – 2010, including Addenda b, c, e, g, h, i, j, l, and n)

The equation for calculating the Total Ventilation Rate is:

Equation 4-2 :

$$Q_{total} = 0.03A_{floor} + 7.5(N_{br} + 1)$$

Where:

Q_{total} = total required ventilation rate (cfm)

A_{floor} = floor are of residence (ft^2)

N_{br} = number of bedrooms (not less than one)

Note that the number multiplied times the floor area is three times greater than that used in equation 4-1.

The ventilation rate associate with infiltration is calculated using an ELA value that must be diagnostically verified in the field.

Note that the ELA value used for these equations is in square feet, not square inches as may be the case in other equations.

RA3.8 covers the protocols for blower door testing for the purpose of verifying infiltration for reduced infiltration compliance credit. Unless specifically directed otherwise in this section, RA3.8 shall be met.

Because infiltration can occur by air coming into the home as well as air going out of the home, it is more accurate to measure ELA under depressurization and pressurization, then average the two values using equation 4-3.

Equation 4-3

$$ELA = (L_{press} + L_{depress})/2$$

Where:

ELA = effective leakage area in square feet

L_{press} = leakage area from pressurization in square feet

$L_{depress}$ = leakage area from depressurization in square feet

Note that when designing this system for a house that is not built yet, the ELA values will be estimated numbers. If the actual (measured) number is different, the ventilation system design may need to be modified to comply with the standard.

The leakage is normalized based on the area of the house and the potential for stack effect using equation 4-4.

Equation 4-4:

$$NL = 1{,}000 \cdot \frac{ELA}{A_{floor}} \cdot \left[\frac{H}{H_r}\right]^Z$$

Where:

NL = normalized leakage

Hr = reference height, 8.2 ft (2.5m)

H = vertical distance from lowest above grade floor to highest ceiling, ft (m)

Z = 0.4 for the purpose of calculating Effective Annual infiltration Rate below

A_{floor} = floor area of residence, ft^2

The effective annual infiltration rate is then calculation using Equation 4-5. This is the amount of infiltration that is considered to offset the need for fan powered ventilation.

Equation 4-5:

$$Q_{inf}(cfm) = \frac{NL(wsf)\ A_{floor}}{7.3}$$

Where:

NL = normalized leakage

Wsf = weather and shielding factor from Normative Appendix X, Table X1- US Climates; ANSI/ASHRAE Standard 62.2-2010

A_{floor} = floor area of residence, ft^2

The ventilation rate required by the fan is then calculated by subtracting the infiltration ventilation rate from the total ventilation rate.

Equation 4-6:

$$Q_{fan} = Q_{total} - Q_{inf}$$

Where:

Q_{fan} = required mechanical ventilation rate (cfm)

Q_{total} = total required ventilation rate (cfm)

Q_{inf} = effective annual average infiltration rate (cfm)

Note that for well sealed houses, the fan ventilation rate calculated using the Total Ventilation Rate Method may be higher than that calculated by the Fan Ventilation Rate method, so it is worth checking both.

Ventilation Rate for Combination Systems

When a combination ventilation system is used, meaning that both supply and exhaust fans are installed, the provided ventilation rate is the larger of the total supply airflow or the total exhaust airflow. The airflow rates of the supply and exhaust fans cannot be added together to determine the provided ventilation rate.

Example 4-9

Question

A 2,400 ft² house has exhaust fans running continuously in two bathrooms providing a total exhaust flow rate of 40 cfm, but the requirement is 60 cfm. What are the options for providing the required 60 cfm?

Answer

The required 60 cfm could be provided either by increasing the exhaust flow by 20 cfm or by adding a ventilation system that blows 60 cfm of outdoor air into the building. It cannot be achieved by using a make-up air fan blowing 20 cfm into the house.

C. Intermittent Whole-building Ventilation

In some cases, it may be desirable to design a whole-building ventilation system that operates intermittently. One common example of intermittent ventilation is when outside air is ducted to the return plenum of the central heating/cooling system, and thus the central heating/cooling system fan is used to distribute the ventilation air to the rooms in the building (see CFI system described above in the supply ventilation section).

Intermittent ventilation is permitted as long as the ventilation airflow is increased to respond to the fewer hours of fan operation and the tendency of pollutant concentrations to build up during off cycles.

Equation 4-7

$$Q_{fan} = Q_r/(\varepsilon \times f)$$

Where:

Q_{fan}= fan flow rate

Q_r = ventilation air requirement (continuous)

ε = mechanical ventilation effectiveness (from Table 4-15 below)

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

Table 4-15 also requires the calculation of the required turnover, N, as follows:

Equation 4-8

$$N = 12.8 \times Q_{fan} \cdot T_{cyc}/A_{floor} \text{ (I-P)}$$

Where

Q_{fan} = mechanical ventilation air requirement from Table 4-15, cfm

T_{cyc} = fan cycle time, defined as the total time for one off-cycle and one on-cycle, h.

A_{floor} = floor area, ft^2

Note: the building is thermally conditioned for human occupancy for less than 876 hrs per year,

The values of for turnover (N) and fractional on time (f) are used in Table 4-15, which will yield the fan effectiveness value (e), which is then used in equation 4-8 to calculate the fan flow rate.

Table 4–15 – Mechanical Ventilation Effectiveness for Intermittent Fans

Mechanical Ventilation Effectiveness for Intermittent Fans

Fractional On-Time, *f*	Turnover, *N*														
	0.0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	8.0	12	20	40	100+
0.00	1.00	0.95	0.88	0.78	0.60	0.00									
0.05	1.00	0.96	0.90	0.81	0.67	0.41	0.00								
0.10	1.00	0.96	0.91	0.83	0.72	0.55	0.21	0.00							
0.15	1.00	0.96	0.92	0.85	0.76	0.63	0.44	0.18	0.00						
0.20	1.00	0.97	0.93	0.87	0.79	0.69	0.56	0.40	0.03	0.00					
0.25	1.00	0.97	0.94	0.89	0.82	0.74	0.64	0.53	0.26	0.02	0.00				
0.30	1.00	0.98	0.95	0.90	0.85	0.78	0.71	0.62	0.42	0.24	0.00				
0.35	1.00	0.98	0.95	0.92	0.87	0.82	0.76	0.69	0.54	0.39	0.14	0.00			
0.40	1.00	0.98	0.96	0.93	0.89	0.85	0.80	0.75	0.63	0.52	0.32	0.02	0.00		
0.45	1.00	0.99	0.97	0.94	0.91	0.88	0.84	0.79	0.70	0.61	0.45	0.21	0.00		
0.50	1.00	0.99	0.97	0.95	0.93	0.90	0.87	0.83	0.76	0.69	0.57	0.37	0.13	0.00	0.00
0.60	1.00	0.99	0.98	0.97	0.96	0.94	0.92	0.90	0.86	0.81	0.74	0.61	0.45	0.27	0.14
0.70	1.00	1.00	0.99	0.98	0.98	0.97	0.96	0.94	0.92	0.90	0.85	0.78	0.68	0.55	0.46
0.80	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.94	0.90	0.85	0.77	0.70
0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.97	0.96	0.93	0.88
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: ASHRAE 62.2 – 2010

Intermittent ventilation systems have to be automatically controlled by a timer or other device that assures that they will operate the minimum amount of time needed to meet the ventilation requirement. The scheduling of the automatic controls shall make sure that the fan operates at least 10% of the time and that a single on/off cycle occurs at least once per day.

Example 4-10 – Flowrate for Intermittent Fan

Question

The required ventilation rate is 60 cfm. If the ventilation fan runs 80 percent of the time, what must the airflow rate be?

Answer

Since f is 0.8 (80 percent) and e is 1, then the ventilation effectiveness, Equation 4-7; $Q_{fan}= Q_r/(e \times f)$.
Q_{fan} = 60/(1x 0.8) = 75 cfm. This is a fairly small increase in fan size.

Example 4-11

Question

For the same house, if the fan runs half the day (12 hours per day), what is the required airflow?

Answer

The fractional on-time, f is 0.5 (50 percent), so e is also 0.5 from Table 4-15. The fan size, Q_{fan}= 60/(0.5 x 0.5) = 240 cfm. This is a much larger increase in fan size.

Example 4-12

Question

For an apartment, the flow required is 45 cfm. If the ventilation fan runs 20 minutes on and 10 minutes off, what is the required fan size?

Answer

Fractional on-time is 0.67 (67 percent). [f = on-time/total time = 20/(20 + 10)] Since the fan runs at least once every three hours, e is 1.0. The fan size, Q_{fan} = 45/(0.67 x 1.0) = 67.5 cfm, which rounds to 68 cfm.

Example 4-13

Question

For the same apartment, if the fan runs 8 hours on and 4 hours off, what flow rate is required?

Answer

Fractional on-time is again 0.67 (67 percent, but now e is 0.75. Q_{fan}= 45/(0.67 x 0.75) = 89.6 cfm, rounded to 90 cfm.

Example 4-14

Question

I have an electronic timer system. I would like to have the system run only 2 hours in the morning and 8 hours in the evening (6 a.m. – 8 a.m. and 4 p.m. to midnight). I can set the timer to operate the fan for 1 minute every hour. What flow rate do I need?

Answer

Forget about the 1 minute every hour. ASHRAE has issued an interpretation of the standard that says that operation such as you describe is not sufficient to use a ventilation effectiveness of 1. In this case, the fractional on-time is 0.42 (10 hours/24 hours), so ventilation effectiveness from Table 4-15 is 0.5. Q_{fan}= 60 cfm/(0.42 x 0.5) = 286 cfm.

D. Control and Operation

From ASHRAE 62.2-2010

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 to Section 4.3: An intermittently operating, whole-house mechanical ventilation system may be used if the ventilation rate is adjusted according to the exception to 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 one hour per day and must operate at least 10% of the time.

ASHRAE 62.2 requires that the ventilation system have an override control which is readily accessible to the occupants. The “fan-on” switch on a typical thermostat controlling the HVAC system and the wall switch for an exhaust fan are both allowed as acceptable controls. The control must be “readily accessible”, e.g. it must be capable of being accessed quickly and easily without having to remove panels or doors. It can be as simple as a labeled wall switch by the electrical panel. It may be integrated in a labeled wall-mounted control or in the air moving device that requires the removal of the cover plate, but it cannot be buried in the insulation in the attic or the inside of the fan. The occupant must be able to modify the settings or override the system.

If intermittent fans are used, they must be controlled by a timer, and they must have an increased airflow rate to compensate for the off time.

Time-of-day timers or duty cycle timers can be used to provide intermittent whole-building ventilation. Manual crank timers cannot be used, since the system must operate automatically without intervention by the occupant. Some controls “look back” over a set time interval to see if the air handler has already operated for heating or cooling before it turns on the air handler for ventilation only operation.

Example 4-15 – Control Options

Question

I plan to use a bathroom exhaust fan to provide whole-building ventilation for a house. The fan is designed to be operated by a typical wall switch. Do I need to put a label on the wall plate to comply with the requirement that controls be “appropriately labeled”?

Answer

Yes. If the exhaust fan were serving only the local exhaust requirement for the bathroom, then a label would not be required. Since the fan is providing the required whole-building ventilation, a label is needed to inform the occupant that the fan should be operating whenever the home is occupied.

Example 4-16 – Thermostatic Control

Question

I plan to provide ventilation air by connecting a duct run from the return side of the central air handler to the outdoors. Ventilation will be provided whenever the air handler operates. According to my estimates, the system will run on calls for heating and cooling about 40 percent of the time, averaged over the year. If I provide a safety factor and assume that it only runs 25 percent of the time, and size the airflow accordingly, can I allow the system to run under thermostatic control?

Answer

No. A system under thermostatic control will go through periods with little or no operation when the outdoor temperature is near the indoor setpoint, or if the system is in setback mode. An intermittently operating ventilation system MUST be controlled by a timer in order to assure that adequate ventilation is provided regardless of outdoor conditions.

As mentioned in the text, there are timer based controls available that function to keep track of when (and for how long) the system operates to satisfy heating/cooling requirements in the home. These controls only turn on the central fan to provide additional ventilation air when heating/cooling operation of the central fan has not already operated enough to provide the required ventilation.

4.6.4 Whole-Building Mechanical Ventilation Energy Consumption

For builders using the performance compliance approach the energy use of fans (other than CFI fans) installed to meet the whole-building ventilation requirement is usually not an issue because the standard design W/CFM is set equal to the proposed design W/CFM up to an energy use level sufficient to accommodate most well designed ventilation systems. Also, the standard design whole-building ventilation system airflow rate is set equal to the proposed design whole-building ventilation system airflow rate so there is no energy penalty or credit for most systems. Systems that utilize Heat Recovery or Energy Recovery ventilators (HR/ERV) may need to account for the heat recovery benefit in the performance calculation to make up for their high energy use.

The energy use of the central air handler fan utilized for a CFI ventilation system must conform to the same fan Watt draw (W/CFM) limit as is the prescriptive requirement for cooling systems in all climate zones. CFI systems are the only type of ventilation system that must meet a prescriptive fan Watt draw requirement that must be tested by the builder/installer, and verified by a HERS rater in accordance with the diagnostic test protocols given in RA3.3.

Energy use of fans installed for other purposes such as local exhaust is not regulated in the Standards.

A. Central Fan Integrated Ventilation Systems - Watt Draw

> *§150.1(f)10. Central Fan Integrated Ventilation Systems. Central forced air system fans used in central fan integrated ventilation systems shall demonstrate, in Air Distribution Mode, an air-handling unit fan efficiency less than or equal to 0.58 W/CFM as confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Appendix RA 3.3.*

CFI system automatic controls must operate the central system air handler fan (generally part of every hour of the year) in order to draw in and/or distribute ventilation air around the home even when there is no heating or cooling required. CFI systems generally do not operate continuously, thus do not meet the whole-building ventilation requirement as a “continuous" system. Because the CFI ventilation control increases the central system air handler fan run time significantly, and because typical central system air handler fan and duct systems require a large amount of power, a CFI ventilation system can use a very significant amount of electricity on an annual basis.

The 2008 update includes prescriptive standards for central system air handler fan Watt draw for cooling systems in the hottest California climates. The same prescriptive fan Watt draw requirement also applies to any central system air handler used for a CFI system installed in any California climate zone. Compliance with this requirement involves a post-construction measurement by the installing contractor of the airflow through the air handler, and the simultaneous measurement of the Watt draw of the air handler fan motor. This fan Watt draw measurement must be verified by a HERS rater (see Reference Residential Appendix RA3.3). The central system air handler must be operating in ventilation mode (outdoor air damper is open and ventilation air is flowing into the return plenum from outside the building) and the airflow that must be measured is the total airflow through the air handler (system airflow), which is the sum of the return airflow, and the outside air ducted to the return plenum (ventilation airflow). To pass the test, the watt draw must be less than 0.58 W/CFM.

Builders who utilize CFI systems and comply using the performance approach have the option of accepting the default value for the central system fan Watt draw of 0.8 W/CFM (which does not require a post-construction measurement and HERS verification). Alternatively, the builder can specify a lower W/CFM value for compliance which must be tested and verified by a HERS rater. In either case the compliance software will check the furnace fan heating and cooling operation every hour, and if the air handler has not been operating for at least 20 minutes during that hour, the software will calculate energy use for operation in CFI mode until 20 minutes of fan operating occurs. The standard design ventilation energy consumption for that hour will be calculated as the extra fan run time at a Watt draw of 0.58 W/CFM. The proposed design ventilation energy for that hour will be calculated as the extra fan run time at the Watt draw that was specified for compliance, otherwise at the default Watt draw of 0.8 W/CFM.

B. Other Whole-Building Ventilation Systems – Watt Draw

There are no prescriptive requirements for maximum fan energy (Watt draw) for whole-building ventilation systems other than CFI systems.

Builders who specify other whole-building ventilation systems and comply using the performance approach have the option of accepting the default minimum whole-building ventilation airflow rate and a Watt draw value of 0.25 W/CFM which is typical of simple exhaust fans that meet the 1 Sone requirement. If the builder installs a whole-building ventilation system that has a fan Watt draw specification greater than 1.2 W/CFM of ventilation airflow, then he must input the ventilation airflow (CFM) and Watt draw (W/CFM) corresponding to the system that he proposes to install. The compliance software will simulate whole-building ventilation using the builder’s specified ventilation CFM and W/CFM for the proposed design. For the standard design the builders proposed CFM and 1.2 W/CFM will be used. If the builder specifies a system with heat recovery he inputs the recovery efficiency of his proposed system and the compliance software uses it in the proposed design to calculate the heating and cooling impact of the whole-building ventilation. Ventilation heat recovery is never used in the standard design.

4.6.5 Local Exhaust (Section 5 of ASHRAE 62.2)

Local exhaust (sometimes called spot ventilation) has long been required for bathrooms and kitchens to deal with moisture and odors at the source. Building codes have required an operable window or an exhaust fan in baths for many years and have generally required kitchen exhaust either directly through a fan or indirectly through a ventless range hood and an operable window. The 2008 Standards recognize the limitations of these indirect methods of providing ventilation to reduce moisture and odors and requires that these spaces be mechanically exhausted directly to outdoors even if windows are present. As we build tighter homes with more insulation, the relative humidity in the home has increased and the potential for condensation on cool or cold surfaces has increased as well. The presence of moisture condensation has been a leading cause of mold and mildew in both new and existing construction. The occurrence of asthma has also increased as the interior relative humidity has gotten higher. Therefore, it has become more important to remove the moisture from bathing and cooking right at the source.

The Standards require that each kitchen and bathroom have a local exhaust system installed. Generally this will be accomplished by installing a dedicated exhaust fan in each room that requires local exhaust, although ventilation systems that exhaust air from multiple rooms utilizing a duct system connected to a single ventilation fan are allowed as long as the minimum local ventilation airflow rate requirement is met in all rooms served by the system. The Standards define kitchens as any room containing cooking appliances, and bathrooms are rooms containing a bathtub, shower, spa, or other similar source of moisture. Note that a room containing only a toilet is not required by the Standards to have mechanical exhaust; it assumes that there will be an adjacent bathroom which will have local exhaust.

The Standards allow the designer to choose between intermittent operation or continuous operation for the local exhaust ventilation system. The ventilation rates are different because the ventilation effectiveness of an intermittent operation fan is different than the ventilation effectiveness of a continuous operation fan.

Building codes may require that fans used for kitchen range hood ventilation be safety-rated by UL or some other testing agency for the particular location and/or application. Typically, these requirements address the fire safety issues of fans placed within an area defined by a set of lines at 45° outward and upward from the cook top. Few "bath" fans will have this rating and cannot be used in this area of the kitchen ceiling.

Example 4-17 – Local Exhaust Required for Toilet

Question

I am building a house with 2½ baths. The half bath consists of a room with a toilet and sink. Is local exhaust required for the half bath?

Answer

No. Local exhaust is required only for bathrooms, which are defined by the Standards as rooms with a bathtub, shower, spa or some other similar source of moisture. This does not include a simple sink for occasional hand washing.

Example 4-18

Question

The master bath suite in a house has a bathroom with a shower, spa and sinks. The toilet is in a separate, adjacent room with a full door. Where do I need to install local exhaust fans?

Answer

The Standards only requires local exhaust in the bathroom, not the separate toilet room.

A. Intermittent Local Exhaust

The Standards requires that intermittent local exhaust fans be designed to be operated by the occupant. This usually means that a wall switch or some other type of control is accessible and obvious. There is no requirement to specify where the control or switch needs to be located, but bath fan controls are generally located next to the light switch, and range hood or downdraft fan controls are generally integrated into the range hood or mounted on the wall or counter adjacent to the range hood.

Bathrooms can use a variety of exhaust strategies. They can utilize typical ceiling bath fans or may utilize one or two pickups for remote inline or exterior-mounted fans or heat recovery products. Intermittent local exhaust can be integrated with the whole-building ventilation system to provide both functions. Kitchens can have range hoods, down-draft exhausts, ceiling fans, wall fans, or pickups for remote inline or exterior-mounted fans. Generally, HVR/ERV manufacturers will not allow kitchen pickups to avoid the issue of grease buildup in the heat exchange core. Building codes typically require that the kitchen exhaust must be exhausted through metal ductwork for fire safety.

Example 4-19 – Ducting Kitchen Exhaust to the Outdoors

Question

How do I know what kind of duct I need to use. I've been using recirculating hoods my entire career, now I need to vent to outdoors. How do I do it?

Answer

Kitchen range hood or downdraft duct is generally smooth metal duct that is sized to match the outlet of the ventilation device. It is often six inch or seven inch round duct or the range hood may have a rectangular discharge. If it is rectangular, the fan will typically have a rectangular-to-round adapter included. Always use a terminal device on the roof or wall that is sized to be at least as large as the duct. Try to minimize the number of elbows used.

Example 4-20

Question

How do I know what the requirements are in my area?

Answer

Ask your enforcement agency for that information. Some enforcement agencies will accept metal flex, some will not.

B. Control and Operation for Intermittent Local Exhaust

The choice of control is left to the designer. It can be an automatic control like an occupancy sensor or a manual switch. Some products have multiple speeds and some switches have a delay-off function that continues the exhaust fan flow for a set time after the occupant leaves the bathroom. New control strategies continue to come to the market. The only requirement is that there is a control.

C. Ventilation Rate for Intermittent Local Exhaust

A minimum intermittent ventilation airflow of 100 cfm is required for the kitchen range hood and a minimum intermittent ventilation airflow of 50 cfm is required for the bath fan.

The 100 cfm requirement for the range hood or microwave/hood combination is the minimum to adequately capture the moisture and other products of cooking and/or combustion. The kitchen exhaust requirement can also be met with either a ceiling or wall-mounted exhaust fan or with a ducted fan or ducted ventilation system that provides at least 5 air changes of the kitchen volume per hour. Recirculating range hoods that do not exhaust pollutants to the outside cannot be used to meet the requirements of the ASHRAE Standard 62.2.

Most range hoods provide more than one speed, with the high speed at 150 cfm or more – sometimes much more. Range hoods are available that are rated for 1,000 or 1,500 cfm on high speed and are often specified when large commercial-style stoves are installed. Care must be taken to avoid backdrafting combustion appliances when large range hoods are used. Refer to Table 5.1 in ASHRAE 62.2 for intermittent local ventilation exhaust airflow rates.

Example 4-21 – Is an Intermittent Range Hood Required?

Question

I am building a house with a kitchen that is 12 ft x 14 ft with a 10 ft ceiling. What size ceiling exhaust fan is required?

Answer

The kitchen volume is 12 ft x 14 ft x 10 ft = 1680 ft^3. 5 air changes is a flowrate of 1680 ft^3 x 5/ hr ÷ 60 min/hr = 140 cfm. So this kitchen must have a ceiling or wall exhaust fan of 140 cfm or a 100 cfm vented range hood.

D. Continuous Local Exhaust

The Standards allow the designer to install a local exhaust system that operates without occupant intervention continuously and automatically during all occupiable hours. Continuous local exhaust is generally specified when the local exhaust ventilation system is combined with a continuous whole-building ventilation system. For example, if the whole-building exhaust is provided by a continuously operating exhaust fan located in the bathroom, this fan satisfies the local exhaust requirement for the bathroom. The continuous local exhaust may also be part of the continuous whole-building ventilation system, such as a pickup for a remote fan or HRV/ERV system.

Continuously operating bathroom fans must operate at a minimum of 20 cfm and continuously operating kitchen fans must operate at 5 air changes per hour. Note: these continuous ventilation airflow rates are different than the ventilation airflow rates required for intermittent local exhaust. Refer to Table 5.2 in ASHRAE 62.2 for continuous local ventilation exhaust airflow rates.

The requirement that continuous kitchen exhaust fans must provide 5 air changes per hour is due to the difficulty of a central exhaust to adequately remove contaminants released during cooking from kitchens that may be quite large, have an open-plan design, or have high ceilings. The only way to avoid a vented kitchen hood is to provide more than 5 air changes per hour of constant local exhaust ventilation.

Example 4-22 – Continuous Kitchen Exhaust

Question

The kitchen in an apartment is 5 ft. by 10 ft., with an 8 ft ceiling. If a continuous ceiling-mounted exhaust fan is used, what must the airflow be?

Answer

The kitchen volume is 5 ft x 10 ft x 8 ft = 400 ft^3. 5 air changes equates to 400 ft^3 x 5/hr ÷ 60 min/hr = 34 cfm.

Example 4-23

Question

A new house has an open-design 12 ftx18 ft ranch kitchen with 12 ft cathedral ceilings. What airflow rate will be required for a continuous exhaust fan?

Answer:

The kitchen volume is 12 ft x 18 ft x 12 ft = 2592 ft^3. The airflow required is 2592 ft^3 x 5/hr ÷ 60 min/hr = 216 cfm.

4.6.6 Other Requirements (Section 6 of ASHRAE 62.2)

A. Transfer Air

From ASHRAE 62.2-2010

6.1 Adjacent Spaces

Measures shall be taken to minimize air movement across envelope components to occupiable spaces 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.

ASHRAE Standard 62.2 requires that the air used for ventilation purposes come from the outdoors. Air may not be drawn in as transfer air from other spaces that are outside the occupiable space of the dwelling unit. This is to prevent airborne pollutants originating in those other spaces from contaminating the dwelling unit. For example, drawing ventilation air from the garage could introduce VOCs, or pesticides into the indoor air. Drawing ventilation air from an unconditioned crawlspace could cause elevated allergen concentrations in the dwelling such as mold spores, insects or rodent allergens. Likewise, drawing air from an adjacent dwelling could introduce unwanted contaminants such as cooking products or cigarette smoke.

In addition to designing the ventilation system to draw air from the outdoors, the standard also requires that measures be taken to prevent air movement between adjacent dwelling units and between the dwelling unit and other adjacent spaces, such as garages. The measures can include air sealing of envelope components, pressure management and use of airtight recessed light fixtures. The measures must apply to adjacent units both above and below, as well as side by side.

Air sealing must include pathways in vertical components such as party walls and walls common to the unit and an attached garage; and in horizontal components such as floors and ceilings. Pipe and electrical penetrations are examples of pathways that require sealing.

Section 6.1 of ASHRAE 62.2 does not prohibit whole-building exhaust or local exhaust ventilation systems, and does not require mechanical systems to maintain pressure relationships with adjacent spaces except as required by Section 6.4 of ASHRAE 62.2.

B. Instructions and Labeling

From ASHRAE 62.2-2010

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.

There has been a history of ventilation systems that worked initially but failed due to lack of information for the occupant or lack of maintenance. So ASHRAE Standard

62.2 requires that the installer or builder provide written information on the basic ventilation concept being used and the expected performance of the system. These instructions must include how to operate the system and what maintenance is required.

Because the concept of a designed whole-building ventilation system may be new to a lot of occupants, the standard requires that ventilation system controls be labeled as to their function. No specific wording is mandated, but the wording needs to make clear what the control is for and the importance of operating the system. This may be as simple as "Ventilation Control" or might include wording such as "Operate whenever the house is in use" or "Keep on except when gone over 7 days". If the system is designed to operate with a timer as an intermittent system, the labeling may need to be more complex. One acceptable option is to affix a label to the electrical panel that provides some basic system operation information.

C. Clothes Dryers

From ASHRAE 62.2-2010

6.3 Clothes Dryers

Clothes dryers shall be exhausted directly to the outdoors.

Exception: Condensing dryers plumbed to a drain.

All laundry rooms must be built with a duct to the outdoors, designed to be connected to the dryer. Devices which allow the exhaust air to be diverted into the indoor space to provide extra heating are not permitted. This requirement is consistent with existing clothes dryer installation and design standards.

In multi-family buildings, multiple dryer exhaust ducts can be connected to a common exhaust only when dampers are provided to prevent recirculation of exhaust air from one apartment to another.

Example 4-24 – Clothes Dryer Exhaust Diverter

Question

I am building a home which has been purchased prior to completion. The buyer has asked for an exhaust air diverter to be installed in the dryer exhaust duct. He says that it is wasteful of heating energy to exhaust the warm humid air to the outdoors during the winter when the furnace and humidifier are working. He says that the screen on the diverter will prevent excess dust being released into the space. Can I install the device for him?

Answer

If you do, you will not comply with the Standards. The device is specifically prohibited. Significant amounts of dust are released from such devices, and the moisture in the dryer exhaust can lead to humidity problems as well, particularly in warmer climates.

D. Combustion and Solid-Fuel Burning Appliances

> *From ASHRAE 62.2-2010*
>
> *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 manufacturer's installation instructions, NFPA 54/ANSI Z223.1, National Fuel Gas Code, NFPA 31, Standard for the Installation of Oil-Burning Equipment, or NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances, 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 reducing the exhaust flow or providing compensating outdoor airflow. Atmospherically vented combustion appliances do not include direct-vent appliances.*

ASHRAE Standard 62.2 requires that the vent system for combustion appliances be properly installed, as specified by the instructions from the appliance manufacturer and by the California Building Code. Compliance with the venting requirements will involve determining the type of vent material to be used, the sizing of the vent system, and vent routing requirements.

ASHRAE Standard 62.2 includes a provision intended to prevent backdrafting where one or more large exhaust fans are installed in a home with atmospherically vented or solid fuel appliances. If the two largest exhaust fans have a combined capacity that exceeds 15 cfm/100 ft^2 of floor area, then an electrically interlocked makeup air fan must be installed so that the net exhaust is less than 15 cfm/100 ft^2 with either or both fans operating. This provision applies only when the atmospherically vented appliance is inside the pressure boundary of the house, and does not include a summer cooling fan which is designed to be operated with the windows open. Direct-vent appliances are not considered "atmospherically vented."

The 2 largest exhaust fans are normally the kitchen range hood and the clothes dryer (if located inside the dwelling unit pressure boundary). Many large range hoods, particularly down draft range hoods, have capacities of 1,000 cfm or more.

A problem with this requirement can be solved in one of three ways. First, all atmospherically vented combustion appliances can be moved outside the pressure boundary of the house (to the garage or other similar space). Second, the flowrate of one or more of the fans can be reduced so that the combined flow is less than 15 cfm/100 ft^2. Finally, a supply fan can be installed to balance the flow.

Example 4-25 – Large Exhaust Fan

Question

I am building a 3,600 ft^2 custom home that has 4 bedrooms. The kitchen will have a high end range hood that has three speeds, nominally 1000 cfm, 1400 cfm and 1600 cfm. The house will be heated with a gas furnace located in the basement. If I am using a central exhaust fan for the whole-building ventilation of 90 cfm, and there is a clothes dryer installed, how large does my compensating supply fan need to be?

Answer

You must use the high speed value for the range hood of 1600 cfm. The clothes dryer will have a flow that is assumed to be 150 cfm for sizing purposes. These two flows must be added together for a total exhaust capacity of 1750 cfm. Since the whole-building ventilation fan is not one of the two largest exhaust fans, it does not figure into sizing the supply fan. Using the equation above, the supply fan must be at least 1750 cfm – 15 cfm x 3600 ft² / 100 ft² = 1210 cfm.

Example 4-26

Question

The same custom house will have the furnace located in the garage instead of the basement. Does that change anything?

Answer

The garage and the attic would both normally be considered outside the pressure boundary, so no compensating fan would be required. An exception to this would be if the attic is specially designed to be inside the pressure boundary, then the answer would be the same as for Example 4-23.

Example 4-27

Question

For this house, I need to keep the furnace in the basement. What are my options that would avoid using the compensating supply fan?

Answer

There are several things you could do. First, you could use direct vent appliances which would give higher efficiency and would not require a supply fan. You could use a lower capacity range hood, one that is less than 390 cfm (15 cfm x 3600 ft² / 100 ft² – 150 cfm).Use of supply-only whole-building ventilation would allow the hood capacity to increase to 480 cfm (15 cfm x 3600 ft² / 100 ft² – 150 cfm + 90 cfm). There are also range hoods available in the commercial market that have integrated supply fans (or makeup air).One of these units would be acceptable too.

E. Garages

From ASHRAE 62.2-2010

6.5.1 Garages

When an occupiable space adjoins a garage, the design must prevent migration of contaminants to the adjoining occupiable space. Air seal the walls, ceilings, and floors that separate garages from occupiable space. To be considered air sealed, all joints, seams, penetrations, openings between door assemblies and their respective jambs and framing, and other sources of air leakage through wall and ceiling assemblies separating the garage from the residence and its attic area shall be caulked, gasketed, weather stripped, wrapped, or otherwise sealed to limit air movement. Doors between garages and occupiable spaces shall be gasketed or made substantially airtight with weather stripping.

Garages often contain numerous sources of contaminants. These include gasoline and exhaust from vehicles, pesticides, paints and solvents, etc. The Standards require that when garages are attached to the house, these contaminants be prevented from entering the house. The wall between the unit and garage (or garage ceiling in designs with living space above garages) shall be designed and constructed so that no air migrates through the wall or ceiling. The common doors and any air handlers or ducts located in the garage shall also be sealed, weather-stripped or gasketed. Use of an exterior door system would address this requirement.

If an air handling unit (furnace) is located in the garage, or return ducts are located in the garage (regardless of the air handler location) the entire duct system must meet the sealed and tested ducts criteria.

Example 4-28 – Garages

Question

The building designer located the air handler in the garage. The main return trunk from the dwelling is connected to the air handler. Is this acceptable?

Answer

Yes, provided that the duct system is leak tested at 25 Pa. and sealed, if necessary, to have leakage no greater than 6 percent of the total fan flow.

Example 4-29

Question

The building designer located the air handler in the dwelling unit. A return duct runs through the garage to a bedroom above the garage. The duct has only 4 ft of length in the garage. How do I test that length of the duct?

Answer

This design is allowed but the entire duct system must be leak tested at 25 Pa. and sealed, if necessary, to have leakage no greater than 6 percent of the total fan flow. There is no test available to leak test only the garage portion of the duct system.

F. Ventilation Opening Area

From ASHRAE 62.2-2010

6.6 Ventilation Opening Area

Spaces shall have ventilation openings as listed below. Such openings shall meet the requirements of Section 6.8.

Exception: Spaces that meet the local ventilation requirements set for bathrooms in Section 5.

6.6.1 Habitable Spaces

Each habitable space shall be provided with ventilation openings with an openable area not less than 4% of the floor area, nor less than 5 ft² (0.5 m^2).

6.6.2 Toilets and Utility Rooms

Toilets and utility rooms shall be provided with ventilation openings with an openable area not less than 4% of the room floor area, nor less than 1.5 ft² (0.15 m^2).

Exceptions: (1) Utility rooms with a dryer exhaust duct; (2) toilet compartments in bathrooms.

The whole-building mechanical ventilation is intended to provide adequate ventilation to typical new homes under normal circumstances. On occasion, however, houses experience unusual circumstances where high levels of contaminants are released into the space. When this occurs, some means of providing the significantly higher levels of ventilation required to remove the contaminants is needed. Operable windows are the most likely means of providing the additional ventilation.

This section of ASHRAE Standard 62.2 requires ventilation openings in habitable spaces, toilets and utility rooms. Ventilation openings usually means operable windows, although a dedicated non-window opening for ventilation is acceptable. Spaces that meet the local exhaust requirements are exempted from this requirement.

G. Habitable Spaces

Habitable spaces are required to have ventilation openings with openable area equal to at least 4 percent of the space floor area (but not less than 5 ft^2). Rooms people occupy are considered habitable space. Dining rooms, living rooms, family rooms, bedrooms and kitchens are considered habitable space. Closets, crawl spaces, garages and utility rooms are generally not. If the washer and dryer are located in an open basement that is also the family room, it would be considered habitable space.

The openings do not have to be provided by windows. They can also be provided by operable, insulated, weather-stripped panels.

Ventilation openings, which include windows, skylights, through-the-wall inlets, window air inlets, or similar devices, shall be readily accessible to the occupant. This means that the occupant must be able to operate the opening without having to climb on anything. An operable skylight must have some means of being operated while standing on the floor: a push rod, a long crank handle, or an electric motor.

If a ventilation opening is covered with louvers or otherwise obstructed, the openable area is the unobstructed free area through the opening.

Example 4-30 – Ventilation Openings

Question

I am building a house with a 14 ft. by 12 ft. bedroom. What size window do I need to install?

Answer

It depends on the type of window. The standard requires that the openable area of the window, not the window unit, be 4 percent of the floor area, or 14 ft x 12 ft' x 0.04 = 6.7 ft^2. The fully opened area of the window or windows must be greater than 6.7 ft^2. The requirement for this example can be met using two double hung windows each with a fully opened area of 3.35 ft^2. Any combination of windows whose opened areas add up to at least 6.7 ft^2 will meet the requirement.

Example 4-31 – Ventilation Opening Louvers

Question

There are fixed wooden louvers over a window in a bedroom. The louvers have slats that are 1/8 in thick, and they are spaced 1 inch apart. What is the reduction in openable area?

Answer

Assuming that the 1 inch spacing was measured perpendicular to the slats (the correct way), then the reduction is the slat thickness divided by the spacing, or 1/8 inch. So the credited opening area is the original opening area x (1 inch – 1/8 inch)/1 inch = 7/8 inch of the original opening area.

H. Minimum Filtration

From ASHRAE 62.2-2010

6.7 Minimum Filtration

Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length and through a thermal conditioning component, except evaporative coolers, shall be provided with a filter having a designated minimum efficiency of MERV 6, or better, when tested in accordance with ANSI/ASHRAE Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, or a minimum Particle Size Efficiency of 50% in the 3.0-10 µm range in accordance with AHRI Standard 680, Performance Rating of Residential Air Filter Equipment. The system shall be designed such that all recirculated and mechanically supplied outdoor air is filtered before passing through the thermal conditioning components. The filter shall be located and installed in such a manner as to facilitate access and regular service by the owner.

ASHRAE Standard 62.2 requires that particulate air filtration of no less than MERV 6 efficiency is installed in any HVAC system having more than 10 ft of ductwork. The particulate filter must be installed such that all of the air circulated through the furnace or air handler is filtered prior to passing through the thermal conditioning portion of the system. In addition, the standard requires that the filter be located and installed for easy access and service by the homeowner. Lastly, the standard requires that the filter cartridge be sized to operate at no greater than 0.1 inch water column when clean, or that the air handler be selected to handle greater pressure loss without undue restriction on airflow.

Many residential units have factory installed filter cartridges that comply with this minimum filtration requirement. These are normally 1-inch thick with a pleated media configuration to attain the proper efficiency and airflow performance. If the filter bank is to be field installed, the sizing selection is critical to HVAC system performance.

The filter retainer section must be easily accessible by the homeowner to assure continued monitoring and replacement. The filter bank may be located in the air handler/furnace (1); in the return air plenum near the air handler (2a); in the return air plenum with a deep pleat cartridge (2b); angled across the return air plenum to enhance cross-section (3); or situated in a wall return grille (4). See Figure 4-24.

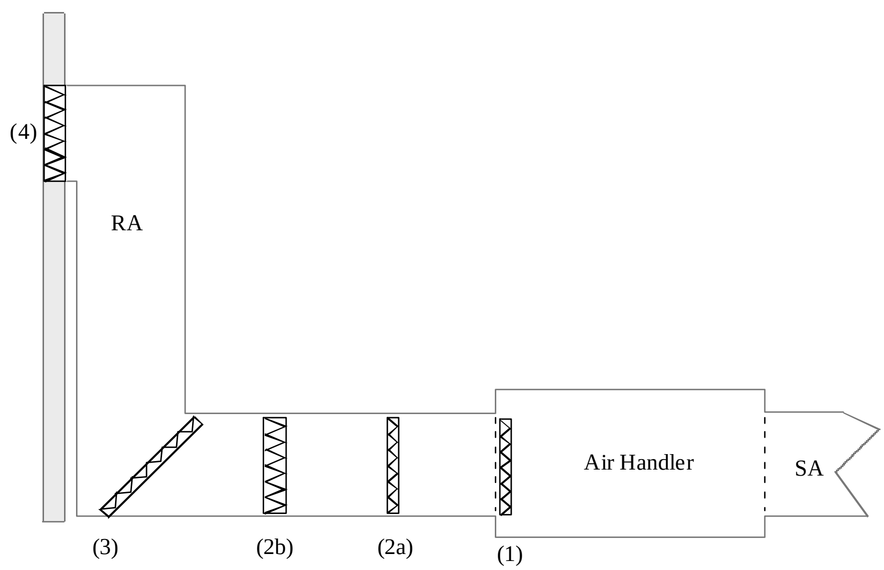

Figure 4-24 – Filter Location Options
Source: California Energy Commission

The MERV 6 pleated filter provides enhanced particulate arrestance, but also provides longer service life than the conventional low efficiency panel filter. Typically, the pleated type filter will last 3 months or longer, depending upon operating conditions, as compared to the typical 1 month life cycle of disposable fiberglass filters. The deeper pleated versions will typically provide even longer life cycles, up to 1 year or more.

Example 4-32– Filter Sizing

Question

I am installing a 1200 cfm furnace in a new house. It has a 20 inches x 20 inches filter furnished and installed in the unit. Is this in compliance?

Answer

Yes, you may assume that the equipment manufacturer has selected a compliant filter efficiency and pressure drop to match the features of their air handler.

Example 4-33

Question

What if the above unit has no filter installed but recommends a 20 inches x 20 inches filter size? What filter do I select?

Answer

A number of manufacturers produce a 1-inch deep MERV 6 for use in slide-in tracks and return air grills. If the pressure drop information is not furnished with the filter to assist with the selection, oversize the filter by at least one size multiple beyond the normal recommendation of the manufacturer. In this case, a filter selection of 20 inches" x 25 inches to over-size the filter would reduce the face velocity by 25 percent, which in turn reduces the initial pressure drop by almost 50 percent.

Example 4-34

Question

For the same 1200 cfm furnace, what other options do I have?

Answer

For any filter, the pressure drop, efficiency, and life cycle can all be affected by velocity control. By enlarging the filter cartridge size, the approach velocity is decreased along with the pressure drop. If the depth of the filter is increased, likewise the air velocity through the media is decreased, and that, in turn, substantially reduces the actual pressure drop. Doubling the pleat depth will halve the velocity through the media and decrease pressure drop by up to 75 percent.

Example 4-35

Question

I am installing an HVAC system with the filter to be installed at the return air grill. What should I do to accommodate a 1 inch pleated MERV 6 filter?

Answer

You can reduce the face velocity and related pressure drop by employing multiple return air grilles. By doubling or tripling the return air filter surface area, the pressure drop is reduced by 75 percent or greater. Alternatively, you can increase the size of the return air grill similar to what was discussed in Example 4-31, above, or increase the depth of the filter as discussed in Example 4-32

Example 4-36

Question

I am installing a ductless split system in a space that is being added on to the house. Must I use the designated MERV 6 filter?

Answer

No, the requirement does not apply since there is no ductwork attached to the unit.

Example 4-37

Question

My builder supply house has only MERV 8 or greater efficiency filters. Is this in compliance?

Answer

Yes, this is a better efficiency. However, higher MERV filters usually have higher pressure drop. Make sure that the pressure drop does not exceed the MERV 6 specified performance level and adjust the size and related air velocity accordingly.

I. Air Inlets

From ASHRAE 62.2-2010

Section 6.8 Air Inlets

Air inlets that are part of the ventilation design shall be located a minimum of 10 ft (3 m) from known sources of contamination such as a stack, vent, exhaust hood, or vehicle exhaust. The intake shall be placed so that entering air is not obstructed by snow, plantings, or other material. Forced air inlets shall be provided with rodent/insect screens (mesh not larger than 1/2 inch).

Exceptions:

a Ventilation openings in the wall may be as close as a stretched-string distance of 3 ft (1 m) from sources of contamination exiting through the roof or dryer exhausts.

b No minimum separation distance shall be required between windows and local exhaust outlets in kitchens and bathrooms.

c Vent terminations covered by and meeting the requirements of the National Fuel Gas Code (NFPA 54/ANSI Z223.1, National Fuel Gas Code) or equivalent.

When the ventilation system is designed with air inlets, the inlets must be located away from locations that can be expected to be sources of contamination. The minimum separation is 10 ft. Inlets include not only inlets to ducts, but windows which are needed to the opening area.

The Standards list some likely sources of contaminants. For typical residential applications, the sources will include:

- Vents from combustion appliances
- Chimneys
- Exhaust fan outlets
- Barbeque grills
- Locations where vehicles may be idling for any significant length of time
- Any other locations where contaminants will be generated

The Standards also require that air intakes be placed so that they will not become obstructed by snow, plants, or other material. Forced air inlets must also be equipped with insect/rodent screens, where the mesh is no larger than 1/2 inch.

There are three exceptions to the separation requirements.

1. Windows or ventilation openings in the wall can be as close as three feet to sources of contamination which exit through the roof or to dryer exhausts.
2. There is no minimum distance between windows and the outlet of a local exhaust outlet from kitchens or bathrooms.
3. Vent terminations which meet the requirements of the National Fuel Gas Code, which has its own separation and location requirements, do not need to meet the requirements.

4.6.7 Air Moving Equipment (Section 7 of ASHRAE 62.2)

From ASHRAE 62.2-2010

Section 7.1 Selection and Installation

Ventilation devices and equipment shall be tested in accordance with ANSI/ASHRAE Standard 51/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating, and ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans, and rated in accordance with the airflow and sound rating procedures of the Home Ventilating Institute (HVI 915, Procedure for Loudness Rating of Residential Fan Products, HVI 916, Air Flow Test Procedure, and HVI 920, Product Performance Certification Procedure Including Verification and Challenge). Installations of systems or equipment shall be carried out in accordance with manufacturers' design requirements and installation instructions.

Equipment used to meet the whole-building ventilation requirements or the local ventilation exhaust requirements shall be rated to deliver the required airflow, and shall have sound ratings that meet the requirements of this section.

A. Selection and Installation

ASHRAE Standard 62.2 requires that equipment used to comply with the standard be selected based on tested and certified ratings of performance for airflow and sound. When selecting fans for use in meeting the requirements of the standard, you must check the Home Ventilating Institute (HVI) certified products directory to confirm that the equipment you select has been tested, and the rated performance meets the requirements. The HVI-Certified Products Directory can be viewed at the following link:

www.hvi.org/resourcelibrary/proddirectory.html

In addition, the Standard requires that the fans be installed in accordance with the manufacturer's instructions. You must review the installation instructions and other literature shipped with the fan, and make sure that the installation complies with those instructions.

B. Sound Ratings for Fans

From ASHRAE 62.2-2010

Section 7.2 Sound Ratings for Fans)

Ventilation fans shall be rated for sound at no less than the minimum airflow rate required by this standard, as noted below. These sound ratings shall be at minimum of 0.1 in. w.c. (25 Pa) static pressure in accordance with the HVI procedures referenced in Section 7.1.

Section 7.2.1 Whole-Building or Continuous Ventilation Fans.

These fans shall be rated for sound at a maximum of 1.0 sone. Section 7.2.2 Intermittent Local exhaust Fans.

Fans used to comply with Section 5.2 shall be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm (200 L/s).

Exception: HVAC air handlers and remote-mounted fans need not meet sound requirements. To be considered for this exception, a remote-mounted fan must be mounted outside the habitable spaces, bathrooms, toilets, and hallways, and there must be at least 4 ft (1 m) of ductwork between the fan and the intake grille.

One common reason for not using ventilation equipment, particularly local exhaust fans, is the noise they create. To address this, ASHRAE Standard 62.2 requires that certain fans be rated for sound, and that installed fans shall have ratings below specified limits. The sound rating must be done at an airflow that is no less than the airflow that the fan must provide to meet the ventilation airflow requirement.

Because of the variables in length and type of duct and grille, there is no clearly repeatable way to specify a sound level for ventilation devices that are not mounted in the ceiling or wall surface. Consequently, air handlers, HRV/ERVs, inline fans and remote fans are exempted from the sound rating requirements that apply to surface-mounted fans. However, to reduce the amount of fan and/or motor noise that could come down the duct to the grille, the Standards sets a minimum of 4 ft of ductwork between the grille and the ventilation device. This may still produce an undesirable amount of noise for the occupant, especially if hard metal duct is used. Flexible insulated duct or a sound attenuator to will reduce the transmitted sound into the space.

Continuous Ventilation Fans (surface mounted fans)

Continuously operated fans shall be rated at 1.0 sone or less. This 1.0 sone requirement applies to continuous whole-building ventilation fans, and also to continuous local ventilation exhaust fans.

Intermittent Fans (surface mounted fans)

Intermittently operated whole-building ventilation fans shall be rated at a maximum of 1.0 sone. Intermittently operated local exhaust fans shall be rated at a maximum of 3.0 sone, unless the maximum rated airflow is greater than 400 cfm.

Thus, ASHRAE Standard 62.2 extends the requirement for quiet fans to include range hoods and regular bath fans, not just whole-building ventilation system fans. The whole-building fan or other combined systems that operate continuously to provide whole-building ventilation must be rated at 1.0 sone or less, but intermittent local ventilation exhaust fans, including intermittently operated bath fans, must be rated at a maximum of 3.0 sones. Range hoods must also be rated at 3.0 sones or less, but this is at their required “working speed” of 100 cfm. Most range hoods have maximum speeds of much more than 100 cfm, but 100 cfm is the minimum airflow that is required by the Standards.

C. Airflow Rating

From ASHRAE 62.2-2010

Section 4.3 Airflow Measurement

The airflows 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.

Section 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 to Section 5.4

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

Compliance with the ventilation airflow requirements for a ventilation system can be demonstrated in one of two ways:

1. The ventilation system can be tested using an airflow measuring device after completion of the installation to confirm that the delivered ventilation airflow meets the requirement. The builder/installer must also list the result of the airflow measurement(s) for the ventilation fan(s) on the Installation Certificate (CF2R-MCH-27) for the building. The ventilation airflow must be measured and reported for any/all ventilation system types installed in the building, except for those described in item 2 below.
2. Simple exhaust systems can comply by performing and documenting an inspection of the installation to verify conformance to a prescriptive requirement that the fan has a certified airflow rating that meets or exceeds the required ventilation airflow, and the ducts for the ventilation system meet either the fan manufacturers published duct design specifications, or the prescriptive duct design requirements given in Table 4-167 below (Table 7.1 of ASHRAE 62.2). The builder/installer must also list the description of the installed fan equipment and duct design criteria for the ventilation fan(s) on the Installation Certificate (CF2R-MCH-27) for the building.

The fan's certified airflow rating must be based on tested performance at the 0.25 inch w.c. operating point. The certified airflow rating of a ventilation device is generally available from the manufacturer, and is also available for hundreds of products in the Home Ventilating Institute (HVI) Certified Products Directory at the HVI website (www.hvi.org). Manufacturers can choose whether to provide the certified data for posting at the HVI website, but all of them should have available the rated data at 0.25 inches of water column static pressure.

If the manufacturer's duct system design specifications are utilized for compliance, the enforcement agency may require that the manufacturer's published system design documentation be provided for use in inspection of the installation(s).

The prescriptive duct design criteria given in Table 4-16 provide maximum duct lengths based on various duct diameters and duct type. As can be seen, the higher the flow, the larger in diameter or shorter in length the duct has to be. Also note that smooth duct can be used to manage longer duct runs. Interpolation and extrapolation of Table 4-16 (Table 7.1 of ASHRAE 62.2) is not allowed. For airflow values not listed, use the next higher value. The table is not applicable for systems with airflow greater than 125 cfm at 62 Pa (0.25 inches of water column) static pressure.

Table 4-16 – Prescriptive Duct Sizing for Single Fan Exhaust Systems (from 62.2, Table 7.1)

Duct Type	Flex Duct				Smooth Duct			
Fan Rating 62 Pa (cfm@ 0.25 in. w.c.)	50	80	100	125	50	80	100	125
Diameter inch	Maximum Length ft.							
3	X	X	X	X	5	X	X	X
4	70	3	X	X	105	35	5	X
5	NL	70	35	20	NL	135	85	55
6	NL	NL	125	95	NL	NL	NL	145
7 and above	NL	NL	NL	NL	NL	NL	NL	NL

This table assumes no elbows. Deduct 15 feet 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.

Example 4-38 – Prescriptive Duct Sizing

Question

I need to provide 75 cfm of continuous ventilation, which I plan to do using a central exhaust fan. I plan to connect the fan to a roof vent termination using flex duct. The duct will be about 8 ft long, with no real elbows, but some slight bends in the duct. What size duct do I need to use?

Answer

From Table 4-16, using the 80 cfm, flex duct column, we find that the maximum length with 4 inch duct is 3 ft, so you cannot use 4 inches duct. With 5 inch duct the maximum length is 70 ft, so that will clearly be adequate. Even if the bend in the duct is treated as an elbow, the allowable length only drops to 55 ft, more than adequate for the 8 ft required.

Example 4-39

Question

For the situation in example 4-36, again providing 75 cfm, what size duct would I need if smooth metal duct were used? In this case the total length would increase to about 10 ft, and there would be 2 elbows.

Answer

Using the 80 cfm, smooth duct column of Table 4-16, we find that the maximum length of 4 inches duct is 35 ft. Subtracting 15 ft for each of the 2 elbows leaves us with 5 ft, which is not long enough. With 5 inch duct the maximum length is 135 ft. Subtracting 15 ft for each of the 2 elbows leaves us with 105 ft, so that will clearly be adequate.

Example 4-40

Question

I will need a 100 cfm range hood. I have two possible duct routings. One is 15 ft long and will require 3 elbows. The other is 35 ft long but only requires one elbow. What size flex duct do I need to use?

Answer

First, let's take the 2 routings and add in the correction for the elbows. Elbow corrections can be either added to the desired length or subtracted from the allowable length. In this case, we know the desired length, so we'll add the elbows. We get 15 ft plus 3 times 15 ft for a total of 60 ft, or 35 ft plus 15 ft equals 50 ft.

Looking at Table 4-16, in the 100 cfm, flex duct column, we find that the maximum length with 5 inches duct is 35 ft, which is less than the adjusted length for either routing. With 6 inches duct, the maximum length is 125 ft, longer than either adjusted length. 6 inch duct would need to be used for either routing. *Note:* The building code may not allow flex duct to be used for the range hood, in which case smooth duct would be required. For smooth duct, 5 inches would be acceptable.

D. Multi-Branch Exhaust Ducting

From ASHRAE 62.2-2010

Section 7.3 Multi-Branch Exhaust Ducting (62.2 text)

If more than one of the exhaust fans in a dwelling unit shares a common exhaust duct, each fan shall be equipped with a back-draft damper to prevent the recirculation of exhaust air from one room to another through the exhaust ducting system. Exhaust fans in separate dwelling units shall not share a common exhaust duct.

ASHRAE Standard 62.2 contains restrictions on several situations where multiple exhausts are connected through a combined duct system. These restrictions are intended to prevent air from moving between spaces through the exhaust ducts.

The first restriction is that if more than one exhaust fan in a dwelling shares a common duct, then each fan must be equipped with a backdraft damper so that air exhausted from one bathroom or unit is not allowed to go into another space. Exhaust fans in multiple dwelling units may not share a common duct.

The other restriction applies to remote fans serving more than one dwelling unit. Sometimes a single remote fan or HRV/ERV will exhaust from several units in a multifamily building. This section does not preclude the use of that type of system, but it does require that either the shared exhaust fan operate continuously or that each unit be equipped with a backdraft damper so that air cannot flow from unit to unit when the fan is off.

In multifamily buildings, fire codes may impose additional restrictions.

4.6.8 Multifamily Buildings (Section 8 of ASHRAE 62.2)

A. Whole-Building Mechanical Ventilation

From ASHRAE 62.2-2010

Section 8.2 Multifamily Buildings – Ventilation Rate (62.2 text)

For multifamily buildings, the term "building" in Section 4 refers to a single dwelling unit.

The required dwelling unit mechanical ventilation rate, Q_{fan}, shall be the rate in Section 4.1.1 plus 0.02 cfm per ft^2 (10 L/s per 100 m^2) of floor area or, equivalently, the rate from Tables 8.2.1a and 8.2.1b. The required mechanical ventilation rate shall not be reduced as described in Section 4.1.2.

Corridors and other common areas within the conditioned space shall be provided with ventilation at a rate of 0.06 cfm per ft^2 (30 L/s per 100 m^2) of floor area.

Nonresidential spaces in mixed-use buildings shall meet the requirements of ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality.

The strategy for determining the continuous whole-building ventilation rate for multifamily buildings is called the Fan Ventilation Rate Method, which assumes that all of the required ventilation will be provided mechanically. From a design perspective, the Fan Ventilation Rate Method may be advantageous due to not having to predict the homes infiltration rate prior to the home being built, as is required by the Total Ventilation Rate Method. The fan system must be designed and installed to meets the whole-building ventilation airflow requirements and may use an intermittent ventilation option.

Fan Ventilation Rate Method

The continuous whole-building ventilation rate is 3 cfm for each 100 ft² of conditioned floor area (CFA) plus 7.5 cfm for each occupant. The number of occupants is calculated as the number of bedrooms plus one. For example, a three bedroom house is assumed to have four occupants. The required ventilation rate is given by the following equation.

Equation 4-9

$$Ventilation\ Rate\ (cfm) = 0.03 * CFA + 7.5\ x\ (Number\ Bedrooms + 1)$$

Instead of using the equations given above, Table 4-147 may be used to determine the required ventilation. This table allows the user to find the required ventilation rate directly if they know the floor area and number of bedrooms.

Table 4-17 Dwelling Unit Ventilation Air Requirements, cfm

Floor Area (ft^2)	Bedrooms				
	1	2	3	4	≥5
<500	30	40	45	55	60
500-1000	45	55	60	70	75
1001-1500	60	70	75	85	90
1501-2000	75	85	90	100	105
2001-2500	90	100	105	115	120
2501-3000	105	115	120	130	135

3001-3500	120	130	135	145	150
>3501	135	145	150	160	165

B. Other Requirements

> *From ASHRAE 62.2-2010*
>
> *Section 8.4.1- Transfer air and 8.4.2 - Compliance*
>
> *Measures shall be taken to minimize air movement across envelope components separating dwelling units, including sealing penetrations in the common walls, ceilings, and floors of each unit and by sealing vertical chases adjacent to the units. All doors between dwelling units and common hallways shall be gasketed or made substantially airtight.*
>
> *One method for demonstrating compliance with 8.4.1 shall be to verify a leakage rate below a maximum of 0.2 cfm per ft^2 of the dwelling unit envelope area (i.e., the sum of the area of the walls between dwelling units, exterior walls, ceiling and floor) at a test pressure of 50 Pa by a blower door test conducted in accordance with either ANSI/ASTM E779-10, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization, or ANSI/ASTM E1827, Standard Test Method for Determining Airtightness of Buildings Using an Orifice Blower Door. The test shall be conducted with the dwelling unit as if it were exposed to outdoor air on all sides, top, and bottom by opening doors and windows of adjacent dwelling units.*

ASHRAE Standard 62.2 requires that the air used for ventilation purposes come from the outdoors. Air may not be drawn in as transfer air from other spaces that are outside the occupiable space of the dwelling unit. This is to prevent airborne pollutants originating in those other spaces from contaminating the dwelling unit. For example, drawing air from an adjacent dwelling could introduce unwanted contaminants such as cooking products or cigarette smoke.

In addition to designing the ventilation system to draw air from the outdoors, the standard also requires that measures be taken to prevent air movement between adjacent dwelling units and between the dwelling unit and other adjacent spaces, such as common corridors. The measures can include air sealing of envelope components, pressure management and use of airtight recessed light fixtures. The measures must apply to adjacent units both above and below, as well as side by side.

Air sealing must include pathways in vertical components such as party walls and walls common to the unit; and in horizontal components such as floors and ceilings. Pipe and electrical penetrations are examples of pathways that require sealing.

In order to verify that all the accessible penetrations have been sealed a blower door test must be conducted following the procedures of RA3.8.

C. Air-Moving Equipment

> *From ASHRAE 62.2-2010*
>
> *Section 8.5.1 - Exhaust Ducts and 8.5.2 – Supply Ducts*
>
> *Exhaust fans in separate dwelling units shall not share a common exhaust duct. Exhaust inlets from more than one dwelling unit may be served by a single exhaust fan downstream of all the exhaust inlets if the fan is designated and intended to run continuously or if each inlet is equipped with a back-draft damper to prevent cross-contamination when the fan is not running.*
>
> *Supply outlets to more than one dwelling unit may be served by a single fan upstream of all the supply outlets if the fan is designated and intended to run continuously or if each supply outlet is equipped with a back-draft damper to prevent cross-contamination when the fan is not running.*

The source of supply air must be located away from locations that can be expected to be sources of contamination at a minimum separation of 10 ft.

The Standards list some likely sources of contaminants. For typical residential applications, the sources will include:

- Vents from combustion appliances
- Chimneys
- Exhaust fan outlets
- Barbeque grills
- Locations where vehicles may be idling for any significant length of time
- Any other locations where contaminants will be generated

The Standards also require that air intakes be placed so that they will not become obstructed by snow, plants, or other material. Forced air inlets must also be equipped with insect/rodent screens, where the mesh is no larger than 1/2 inch.

4.7 Alternative Systems

4.7.1 Hydronic Heating Systems

Hydronic heating is the use of hot water to distribute heat. Hydronic heating is discussed in this compliance manual as an “Alternative System” because it is much less common in California than in other parts of the United States.

A hydronic heating system consists of a heat source, which is either a boiler or water heater, and a distribution system. There are three main types of hydronic distribution systems, and they may be used individually or in combination: baseboard convectors or radiators, hot water air handlers, and radiant panel heating systems. These three options are illustrated in Figure 4-25.

Baseboard convectors or radiators are most effective when mounted near the floor. Cool air rises by gravity over heated panels or finned tubes and warms the air in the room. These devices also increase the mean radiant temperature of the space, improving comfort. Baseboard convectors or radiators do not require ducting.

Air handlers consist of a blower and finned tube coil enclosed in a sheet metal box (similar to a typical residential furnace), and may be ducted or non-ducted. Air handlers may also include refrigerant coils for air conditioning. Some air handlers are compact and can fit under cabinets.

Radiant panels may be mounted on or integrated with floors, walls, and ceilings. Radiant floor panels are most typical. See the separate section below for additional requirements specific to radiant floor designs.

4.7.2 Mandatory Requirements

For hydronic heating systems without ducts, the mandatory measures cover only pipe insulation, tank insulation, and boiler efficiency. Otherwise, for fan coils with ducted air distribution, the mandatory air distribution measures also apply as described in Section 4.4. And for combined hydronic systems, as described below, mandatory water heating requirements also apply to the water heating portion of the system.