1. For demand-controlled exhaust, the NYS WAP ASHRAE calculator will specify a minimum of 100 CFM for the kitchen and 50 CFM for each bathroom. An operable window reduces either room's ventilation requirement by 20 CFM.
2. For continuous exhaust specify a minimum of 20 CFM for each bathroom, and 5 ACH for the kitchen (based on volume).

### Local Exhaust Deficit

If the existing kitchen or bathroom ventilation doesn't meet the requirements stated here, the NYS WAP ASHRAE calculator will adjust the whole-dwelling ventilation rate required (QFAN Required Mechanical Ventilation) to compensate for the local airflow deficits.

Follow these steps, and enter the data into the NYS WAP ASHRAE tool. The tool will calculate the local-ventilation deficit in CFM that will then be added to the whole-dwelling ventilation rate.

1. Fill out the top half of the NYS ASHRAE calculator with agency and building information, including nearest weather station, # of units, sq. ft. of occupied area in the total building, ceiling height, number of stories, number of bedrooms and number of occupants.
2. Measure the delivered airflow of existing kitchen or bathroom exhaust fans using flow hood, flow grid, or other airflow measuring device, and enter results into the ASHRAE calculator.
3. Subtract 20 CFM for each kitchen or bathroom that has an operable window.

The ASHRAE calculator will display the total local exhaust ventilation deficit in CFM. The calculator will automatically add $^1/_4$ of this deficit to the required whole-dwelling ventilation rate after you enter your blower door airflow result in CFM50.

Use of the NYS WAP ASHRAE calculator is required to justify your ventilation strategy in the project file. Any questions on how to use the NYS WAP ASHRAE calculator, please contact the NYS WAP T&TA Unit for guidance.

**Measuring fan airflow:** Use an exhaust-fan flow meter or a flow hood to verify the airflows through local exhaust fans and whole-building ventilation fans.

### 9.2.4 Infiltration Credit

ASHRAE 62.2–2016 allows for infiltration to contribute to the dwelling's ventilation airflow. Infiltration can supply the entire whole-dwelling ventilation requirement for very leaky buildings. For moderately leaky buildings, infiltration may supply some of the building's ventilation.

**Single-family and only multifamily buildings that are horizontally attached (i.e. row houses sharing a common wall) are eligible for the infiltration credit.**

You can determine the amount of the infiltration credit with a blower-door test and weather data based on the building's location. Calculating the infiltration credit without software is complicated.

To simplify all ASHRAE 62.2-2016 calculations, always use the required NYS WAP tool.

## 9.3 Fan and Duct Specifications

This section covers fan and duct specifications for both local ventilation and whole-dwelling ventilation. Duct sizing, materi-

als, and installation determine whether airflow meets the design airflow rate (CFM). Most existing exhaust fans and ventilation systems don't achieve their design airflow because of installation flaws.

## 9.3.1 Fan Specifications

*SWS Detail: 6.0201.1 Surface Mounted; 6.0201.2 Kitchen Range Hoods; 6.0201.3 Inline and Multiport Fans; 6.0302.1 Individual Exhaust Fan Serving Entire Dwelling; 6.0302.2 Multiport Exhaust Fan Serving Multiple Dwellings;*

We highly recommend continuous ventilation. Continuous ventilation simplifies design and control. Continuous ventilation also minimizes depressurization by allowing selection of the minimum-sized fan.

### General Fan and Ventilator Specifications

Exhaust fans, installed as part of weatherization work, must vent to outdoors and should include these features.

- ✓ Rated for continuous operation if the fan operates continuously.
- ✓ A weatherproof termination fitting, equipped with a screen, louver, or grille material over exterior termination with an opening size of no less than $^1/_4$-inch and no greater than $^1/_2$-inch.
- ✓ Unless the fan operates continuously, the fan housing or termination fitting should have a backdraft damper that opens in the direction of flow and closes when the fan is off.
- ✓ Noise rating must be no more than 2 sones.
- ✓ Ventilation efficacy must be more than or equal to 4 cfm/watt.

✓ The fan must move at least 50 cfm after installation, ducting, and termination are complete.

**Table 9-1: Fan Noise Limits ASHRAE 62.2–2016**

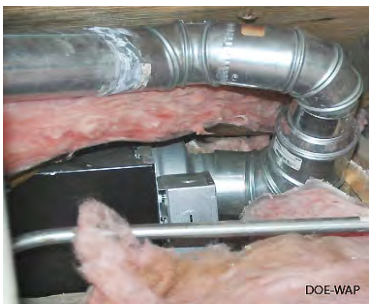
| Fan | Noise Rating (sones) |
|---|---|
| Whole-dwelling fans | 1 sone or less |
| Continuous Local Exhaust Fan | 1 sone or less |
| Intermittent local ventilation | 3 sones or less |

## Fan Installation

Observe these procedures when installing ventilation fans.

✓ Install the fan or ventilator as close as possible to its termination.

✓ Orient the fan or ventilator housing so that the exit fittings face toward their duct termination fittings, using the shortest duct possible.




**Wrong-way fan orientation:** Turning the air stream 180 degrees substantially reduces airflow.


**Right-way fan orientation:** Air stream turns 90 degrees which is acceptable.

✓ Mount fan using mechanical fasteners so that fan housing doesn't shake, rattle, or vibrate when operating.

✓ Seal gap around fan housing and intake grills with a durable and compatible sealant, appropriate for indoor use.

✓ Remove an integral backdraft damper if the fan operates continuously.

- ✓ Don't inhibit back-draft-damper operation by installing screws that interfere with the damper's movement or by damaging the damper housing.
- ✓ Repair or replace the backdraft damper on an existing fan, if the damper doesn't open and close freely.
- ✓ If fan housing is in unconditioned space, enclose fan housing and insulate it to a minimum of R-8.
- ✓ Ensure fan and service disconnect switch are accessible for maintenance.
- ✓ Install in-line fans and multi-port ventilators in remote areas such as attics and crawl spaces and connect the fans to intake grilles in rooms.
- ✓ Isolate in-line fans and multi-port ventilators from framing to minimize noise.
- ✓ Measure the fan airflow to verify compliance with ASHRAE 62.2–2016.
- ✓ Install a MERV 6 filter in all ducted supply ventilation systems. *See "Evaluating Duct Air Leakage" on page 360.*

### Kitchen Range Hoods

- ✓ Select a fan that is rated a maximum of 3 sones at one or more airflow settings greater than or equal to 100 cfm.
- ✓ The fan must have a minimum efficacy of 2.8 cfm/watt.
- ✓ The fan must move at least 100 cfm intermittently or 5 kitchen air changes per hour (ACH) continuously after installation, ducting, and termination are complete.
- ✓ See *"Fan Installation" on page 420* for additional requirements.

### Inline and Multi-port Fans

- ✓ Select a fan that: has an electrically commutated motor (ECM) and an efficacy of 3.8 cfm/watt or more.

- ✓ Seal gaps around intake register boots with compatible sealant.
- ✓ See *"Fan Installation" on page 420* for additional requirements.


**Two- or variable-speed fan:** An occupancy sensor toggles between speeds. A 6-inch outlet provides airflow for whole-building ventilation.


**Advanced 4-speed range fan:** Lower speeds for continuous ventilation and higher ones for spot ventilation.

**In-line fan in attic:** A Y exhausts airflow from two bathrooms for both local exhaust and whole-building ventilation.


**Outdoor-mounted kitchen fan:** Provides adequate power with less noise.

## 9.3.2 Intake and Exhaust Fittings

*SWS Detail: 6.0101.3 Exterior Intakes; 6.0101.2 Exhaust Terminations*

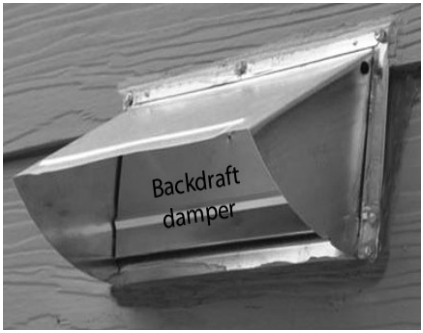
Termination fittings for intake and exhaust ducts must exclude pests and water. Termination fittings must comply with these specifications.

- ✓ Termination fittings must terminate outdoors and never in an attic, crawl space, garage, or within 10 feet of an intake fitting.
- ✓ The hole for termination fitting must leave no more than a $^1/_4$-inch gap around the fitting assembly.
- ✓ Termination fitting must direct water away from its opening.
- ✓ Flash or weather-seal termination fittings.
- ✓ Termination fittings must have insect screens over the openings. Insect screen openings must be between $^1/_4$ and $^1/_2$-inch in size.
- ✓ The termination-fitting collar must be the same diameter as the exhaust or intake fitting on the fan.

**PVC elbow:** This screened PVC elbow is an intake fitting for an HRV.

- ✓ If the fan has no backdraft damper and the fan operates intermittently, install a termination fitting with a backdraft damper, to operate in the direction of airflow.

✓ Don't inhibit the backdraft damper operation if included in termination fitting — with fasteners, for example,




**Termination fitting:** If the fan operates intermittently, the termination fitting or the fan must have a backdraft damper.


**Backdraft damper in the kitchen-fan housing:** Many kitchen fans have integral backdraft dampers.

### Locating Termination Fittings

Locate termination fittings using these specifications.

- ✓ At least 6 inches above grade.
- ✓ At least 10 feet from another fan termination.
- ✓ Above local snow or flood line.
- ✓ At least18 inches above a sloped asphalt based roof.
- ✓ Comply with local building authority requirements.
- ✓ Exhaust terminations must be at least 3 feet away from an operable window, an exterior door, or the property line.

## 9.3.3 Duct Sizing

Fans often fail to deliver their rated airflow capacity. Bends, unstraight flex duct, dirty grills, and backdraft dampers can reduce design airflow by 50% or more.

If you follow the sizing in this table, you may achieve the fan's rated airflow for short duct runs with a maximum of two elbows.

For more detailed duct-sizing recommendations, see *"ASHRAE 62.2 Duct Sizing" on page 570*.

**Table 9-2: Round Duct Diameters (inches) for Desired Airflows**

| Desired CFM | 25 | 50 | 75 | 100 | 150 | 200 |
|---|---|---|---|---|---|---|
| **Rigid** | 4 | 5 | 6 | 7 | 8 | 9 |
| **Flex duct** | 5 | 6 | 7 | 8 | 9 | 10 |
| Friction rate = 0.05; maximum equivalent length =100 feet | | | | | | |

## 9.3.4 Duct Materials and Installation

*SWS Detail: 6.0101.1 Ventilation Ducts; 6.0101.2; Exhaust Terminations; 6.0101.3 Exterior Intakes*

This sections covers SWS requirements and best practices for installing ventilation ducts connected to exhaust fans, ventilators, and air handlers.

*See also "Sealing Duct Leaks" on page 369.*

### Rigid Duct Installation

Observe these best practices for installing rigid ventilation ducts.

- ✓ Prefer rigid smooth metal pipe (30 gauge or thicker) or plastic pipe (Schedule 30 or thicker) for ventilation duct.
- ✓ Limit elbows to a maximum of two per duct run.
- ✓ Use three equally spaced sheet-metal screws to fasten sections of round metal duct together.
- ✓ Join rigid duct sections so the edge of male end of a duct section isn't opposing airflow.
- ✓ Follow manufacturer's instructions to join other types of rigid ducts together.

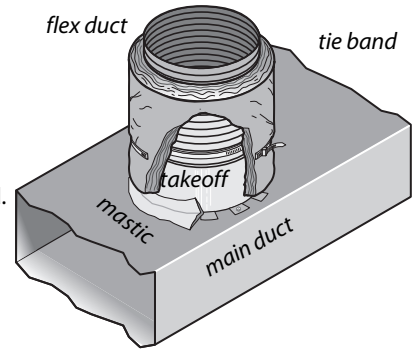
- ✓ Seal all rigid-duct joints and seams with mastic, mastic and webbing, or metal tape, labeled UL181B or UL181B-M. *See "Sealing Duct Leaks" on page 369.*
- ✓ Support metal ducts with at least $^{1}/_{2}$-inch, 18 gauge strapping or at least 12-gauge galvanized wire, not more than 10 feet apart.
- ✓ To prevent condensation, insulate all ducts to R-8 if they travel through unconditioned spaces. *See "Duct Insulation" on page 375.*
- ✓ Fasten PVC exhaust ducts together with approved PVC cement.

### Flexible Duct Installation

Observe these best practices for installing flexible ducts.

- ✓ Stretch flex duct and support it every 4 feet with a 1.5-inch duct support.
- ✓ Use tool-tensioned plastic tie bands to join both the inner liner and the outer liner of the flex duct to the rigid duct or a fitting on the fan or termination fitting.
- ✓ Install a screw to secure the flex duct and tie band to the metal duct between the tie band and the end of the metal duct.
- ✓ Flexible air duct material must meet UL 181, NFPA 90A/90B, International Mechanical Code, or the Uniform Mechanical Code.

**Flex duct joint to metal:** Seal the metal takeoff to the main duct. Seal the inner liner of the flex duct to the takeoff with a tool-tensioned tie band.




## 9.4 Commissioning Ventilation Systems

Commission new, retrofitted and serviced whole-dwelling ventilation systems to verify that the systems function according to design and the ASHRAE 62.2 standard.

- ✓ Verify that all the required ventilation-system components are present and connected correctly.
- ✓ Use airflow and pressure manometers that are appropriate for the operating range and that render accuracy of ± 10%.
- ✓ Measure total airflow, room airflows, and total static pressure to verify that these measurements are within design specifications.
- ✓ Adjust fan speed, dampers, and registers as necessary to bring airflow into conformance with design specifications.
- ✓ Verify that all sensors and controls function correctly. Check intermittent or continuous operation, verify sensor operation, record control settings, and observe the sequence of operation.

## 9.5 Whole-Dwelling Ventilation Systems

This section discusses three options for design of whole-building ventilation systems.

- ✓ Exhaust ventilation
- ✓ Supply ventilation
- ✓ Balanced ventilation

*See "Fan and Duct Specifications" on page 418.*

We begin by discussing ducts for all types of ventilation systems.

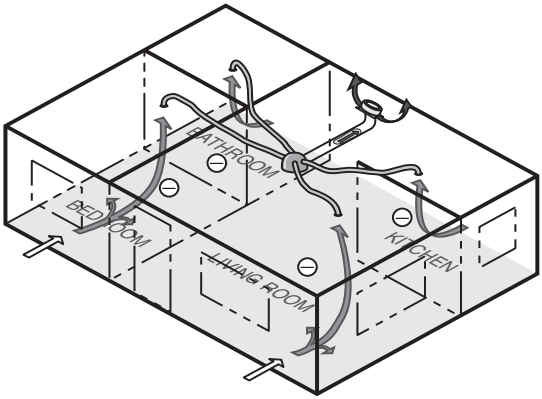
### 9.5.1 Exhaust Ventilation

*SWS Detail: 6.0302 Exhaust Ventilation*

Exhaust ventilation systems employ an exhaust fan to remove indoor air, which infiltrating outdoor air then replaces.

Installing a two-speed bathroom fan is a common ventilation strategy. The new fan runs continuously on low speed for whole-building ventilation. A built-in occupancy sensor switches the fan automatically to a high speed to remove moisture and odors from the bathroom quickly.

A remote fan that exhausts air from several rooms through ducts (4-to-6 inch diameter) may provide better ventilation for larger more complex dwellings, compared to a single-point exhaust fan.




**Multi-port exhaust ventilation:** A multi-port ventilator creates better fresh-air distribution than a single central exhaust fan.

**Passive intake vent:** Exhaust ventilation systems often use passive vents to supply make-up air. This vent is close-able for very cold weather

Exhaust ventilation systems create a negative house pressure, drawing outdoor air in through leaks in the envelope. This keeps moist indoor air from traveling through building cavities, which would occur with a positive building pressure. The negative building pressure reduces the likelihood of moisture accumulation in building cavities during the winter months in cold climates.

In hot and humid climates, however, this depressurization can draw moist outdoor air into the home through building cavities. Therefore we recommend supply ventilation for warm humid climates rather than exhaust ventilation.

## Single-Family Exhaust-Ventilation-System Specifications

- ✓ Fans must conform to *"Fan Specifications" on page 419*.
- ✓ Ducts must conform to *"Duct Materials and Installation" on page 426*.

- ✓ Termination fittings must conform to *"Intake and Exhaust Fittings" on page 424*.
- ✓ Use passive intake vents only if you can air seal the building to 1 $ACH_{50}$ or less. Otherwise the ventilation fans may draw their makeup air from air leaks rather than the passive vents.

### Multi-room Exhaust-Ventilation-System Specifications

- ✓ Evaluate the seal between the roof-mounted ventilator and the its ducts and the roof.
- ✓ Evaluate ventilation-duct chases for air leakage.
- ✓ Install backdraft dampers on intermittently operating systems.
- ✓ Measure airflow through registers to ensure a correct airflow rate. Adjust register size if necessary to decrease or increase ventilation airflow.
- ✓ Adjust ventilator airflow if building ventilation airflow is either excessive or insufficient.
- ✓ Insulate ducts outside the thermal boundary to R-8.
- ✓ Fire dampers must be accessible for inspection and testing.
- ✓ Educate occupants or building manager on maintenance procedures.

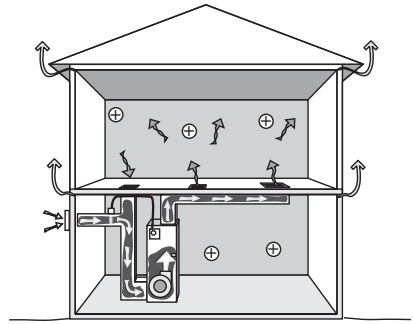
## 9.5.2 Supply Ventilation

*SWS Detail: 6.0301 Supply Ventilation; 6.0301.1 Fresh Air Intake In Forced Air System; 6.0301.2 Dedicated Air Handler for Multiple Dwellings*

Supply ventilation, using the home's air handler, is never operated continuously as with exhaust ventilation because the furnace or heat-pump blower is too large and would over-ventilate the home and waste electrical energy. Supply ventilation may

not be appropriate for tight dwellings in very cold climates because supply ventilation can push moist indoor air through exterior walls, where moisture can condense on cold surfaces.

**Supply ventilation:** A furnace or heat pump with an outside air duct intake is used for ventilation with a control that ensures sufficient ventilation.



## Motorized Outdoor-Air Damper

A motorized damper that opens when the air-handler blower operates must control outdoor-air supply. The furnace/air conditioner heats or cools the outdoor air as necessary before delivering it to the living spaces.

The damper control estimates how much ventilation air is needed. The damper closes after the required amount of ventilation air has entered during heating or cooling. The control also activates the damper and the blower for additional ventilation air as needed without heating or cooling the air during mild weather.

## Supply-Ventilation System Requirements

Supply ventilation and sometimes balanced ventilation typically use the furnace or heat pump to move ventilating air. Comply with these specifications.

- ✓ The existing duct system must leak less than 10% of the air handler flow when measured at 25 pascals WRT outside.
- ✓ Install intake to pull air from the outdoors, not including unconditioned spaces such as attics, crawl spaces, and garages.

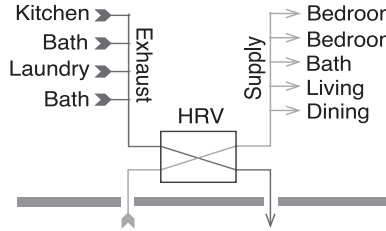
- ✓ Install intake above local snow or flood line and a minimum of 10 feet from contaminant sources or exhaust outlets.
- ✓ Install intake a minimum of 18 inches above an asphalt based roof.
- ✓ Install intake a minimum of 6 inches from grade.
- ✓ The outdoor air must flow through a MERV 8 or better air filter before flowing through heating and cooling equipment.
- ✓ Ducts must conform to *"Duct Materials and Installation" on page 426*.
- ✓ Termination fittings must comply with *"Intake and Exhaust Fittings" on page 424*.
- ✓ *See also "Fan Installation" on page 420.*

### 9.5.3 Balanced Ventilation

*SWS Detail: 6.0303 Balanced Ventilation*

Balanced ventilation systems exhaust stale air and provide fresh air through a ducted distribution system. Of the three ventilation systems discussed here, balanced systems do the best job of controlling pollutants in a building. However weatherization contractors seldom install them because of their high cost and high-maintenance demands.

Balanced systems move equal amounts of air into and out of the home. Most balanced systems incorporate heat-recovery ventilators or energy-recovery ventilators that reclaim heat and moisture from the exhaust air stream.




**Centralized balanced ventilation:** Air is exhausted from areas most likely to contain pollutants and fresh air is supplied to living areas.

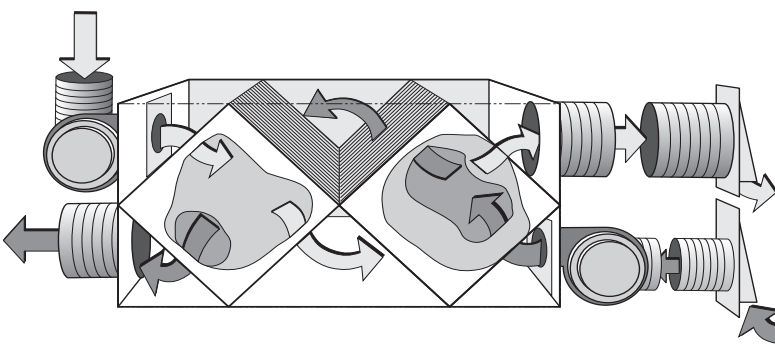
Balanced ventilation systems can improve the air quality and comfort of a building, but they require a high standard of care. Testing and commissioning are vital during both the initial installation and periodic service calls.

*See also "Supply-Ventilation System Requirements" on page 432.*

## Heat-Recovery and Energy-Recovery Ventilators

The difference between heat-recovery ventilators (HRVs) and energy-recovery ventilators (ERVs) is that HRVs transfer heat only, while ERVs transfer both sensible heat and latent heat (moisture) between air streams.

HRVs are often installed as balanced whole-building ventilation systems. The HRV core is an air-to-air heat exchanger in which the supply and exhaust air streams pass one another and exchange heat without mixing.



**Heat-recovery ventilator:** Heat from the exhaust air heats a plastic or aluminum heat exchanger, which in turn heats the fresh intake air. Two matched fans provide balanced ventilation.

### 9.5.4 Rooftop-Unit (RTUs) Economizer Ventilation

*SWS Detail: 6.0301.1 Fresh Air Intake In Forced Air System; 6.0301.2 Dedicated Air Handler for Multiple Dwellings*

Many buildings, particularly those with RTUs use economizers as their ventilation system. The delivered ventilation air is part outdoor air and part indoor air. The outdoor air dilutes pollutants and the indoor air provides mixing and moderation. Economizers don't normally have heat recovery or energy recovery function, so economizer ventilation has an energy penalty compared to a heat recovery ventilators.

Mild climates are ideal for ventilating with an economizer. When buildings use an economizer for ventilation, its dampers are open a small amount while the HVAC system is heating, cooling, or operating on the fan-only option. The fan-only control setting functions when you need ventilation, but not heating or cooling.

To run efficiently, the economizer requires a programmable thermostat that tracks the amount of ventilation air delivered during the free cooling mode and during the ventilation mode.

*See also "Supply-Ventilation System Requirements" on page 432.*

## 9.6 Garage Exhaust Ventilation

*SWS Detail: 6.0201.4 Garage Exhaust Fans*

Attached garages, particularly garages beneath living areas, may require exhaust ventilation to prevent indoor CO contamination. Only consider garage exhaust ventilation when all attempts to air seal the garage from the house were insufficient.

- ✓ Use pressure diagnostics to assist in determining the level of connection from the garage to the house and in making the determination for the need to add garage ventilation.

- ✓ For single family homes, install 100-CFM-capacity exhaust fans with an efficacy of 3.8 cfm/watt or more on the exterior wall or surface mounted inside the garage.
- ✓ Make sure the fan doesn't cause an unacceptable depressurization in a nearby CAZ. Provide pressure-relief if necessary.
- ✓ If the fan doesn't contain an integrated damper, install a damper that opens in the direction of the desired flow and closes when the system is off
- ✓ For larger multifamily garages, do thorough air sealing and then provide exhaust ventilation necessary to reduce indoor CO to a negligible level.
- ✓ Operate the fan using an occupancy sensor with a 15-minute runtime or continuous for larger garages as necessary.

*See also "Garages Underneath Living Areas" on page 209.*

## 9.7 Multifamily Ventilation

*SWS Detail: 6.0301.1 Fresh Air Intake In Forced Air System; 6.0301.2 Dedicated Air Handler for Multiple Dwellings; 6.0304.1 Multi-Story Passive System; 6.0302.2 Multiport Exhaust Fan Serving Multiple Dwellings*

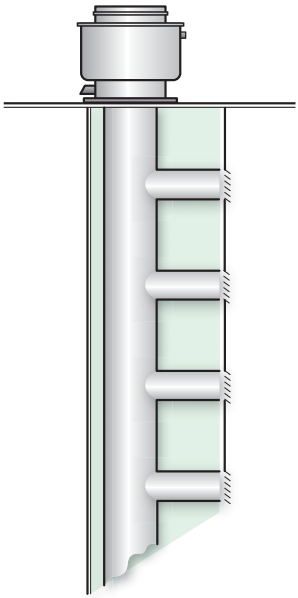
Exhaust-only ventilation is the most common ventilation strategy for multifamily buildings. Vertical chases surround the ventilation ducts and installers cut holes in the chase for the ventilation registers/grills.

Forced-air HVAC systems also provide ventilation to multifamily buildings. The HVAC system delivers a portion of heated and cooled air as outdoor ventilation air.

See the following sections for more information on multifamily ventilation.


- *"General Fan and Ventilator Specifications" on page 419*

*Roof-mounted ventilator*



**Multifamily exhaust ventilation system:** Many multifamily buildings have vertically ducted exhaust ventilation systems with registers opening to kitchens and bathrooms on each floor.


- *"Fan Installation" on page 420*
- *"Whole-Dwelling Ventilation Systems" on page 428*
- *"Air Filtration for Indoor Air Quality" on page 438*
- *"Rooftop-Unit (RTUs) Economizer Ventilation" on page 435*


## 9.7.1 Adaptive Ventilation

The dwelling's residents can maintain good indoor air quality by using spot ventilation together with opening windows and doors. Depending on climate and season, residents can control natural ventilation to provide clean air, comfort, and energy efficiency.

✓ Choose windows and screen doors in strategic locations to ventilate using prevailing winds.

✓ Make sure that windows and screen doors, chosen for ventilation, open and close and have effective insect screens.