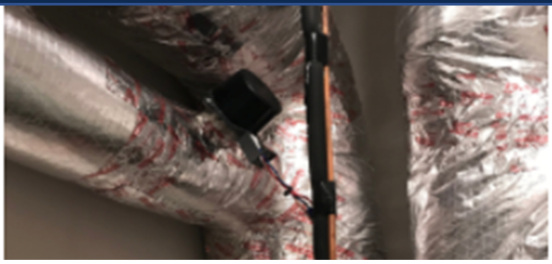
Whole-House Ventilation

2018 VRC/VECC Inspection Guide


2018 Whole-House Ventilation Code Requirements (section 403.6):

Summary: Virginia's Residential Energy Conservation Code has required mechanical ventilation in new homes since the 2012 version. Whole-house mechanical ventilation operates continuously or intermittently. Controls enable operation for not less than 25 percent (25%) of each four (4) hour segment. The intent of these systems is to provide ongoing delivery of controlled (ideally filtered) fresh air to the living space, expel stale air, dilute potential contaminants, and generally improve indoor environmental quality.

Why: Whole-house ventilation is fundamentally concerned with the health and well-being of the occupants. Estimates show that Americans spend up to 90% of their time indoors. To maintain healthy indoor environments, homes need a controlled means of bringing in fresh air and removing stale air on a regular schedule to ensure some dilution of contaminants and dissipation of odors.[1] There are three basic strategies used to bring in whole-house ventilation: supply, exhaust, and energy recovery ventilation. Depending on the strategy and equipment utilized, fresh air systems consist of air intake (**2018 VRC Sections: M1602.1, M1602.2**) and outlet vents, filters, ducts, controls, and fans (**2018 VECC Section: R403.6.1**). The strategy and equipment should take into account exterior temperature variations, desired indoor and prevalent outdoor humidity conditions, house configuration, and design objectives for the quantity and quality of air delivered.[2] Each system has its advantages and disadvantages, as listed in the table below.

Ventilation System	Pros	Cons
Exhaust	• Relatively inexpensive and simple to install • Works fine in cold climates	• Can draw pollutants into living space • Not appropriate for hot humid climates • Relies in part on random air leakage • Can increase heating and cooling costs • May require mixing of outdoor and indoor air to avoid drafts in cold weather • Can cause backdrafting in combustion appliances

[1] https://basc.pnnl.gov/building-science-measures/dilution-whole-house-ventilation
[2] https://basc.pnnl.gov/building-science-measures/properly-installed-whole-house-ventilation

Supply	• Relatively inexpensive and simple to install • Allows better control than exhaust systems • Minimize pollutants from outside living space • Prevent backdrafting of combustion gases from fireplaces and appliances • Allows filtering of pollen and dust in outdoor air • Allows dehumidification of outdoor air • Works well in hot or mixed climates	• Can cause moisture problems in cold climates • Will not always temper or remove moisture from incoming air • Can increase heating and cooling costs • May require mixing of outdoor and indoor air to avoid drafts in cold weather
Energy & Heat Recovery Ventilators	• Reduce heating and cooling costs • Available as both small wall- or window-mounted models or central ventilation systems • Allows filtering of outdoor air • Cost-effective in climates with extreme winters or summers and high fuel costs	• Can cost more to install than other ventilation systems • May not be cost-effective in mild climates • May be difficult to find contractors with experience and expertise to install these systems • Require freeze and frost protection in cold climates • Require more maintenance than other ventilation systems

Table 1: Pros and Cons of Various Mechanical Ventilation Systems[3]

Indoor air quality and ventilation needs vary greatly from home to home. Consider the following factors when choosing a specific design and equipment:

* **Occupancy:** A house or apartment with one occupant has very different ventilation needs compared to a household of five or more.
* **Occupant sensitivity:** Some people are more sensitive than others to contaminants. Pollutant levels that cause an asthma attack in one person may cause no problems for someone else.
* **Building characteristics:** The size, shape, design, and materials used in a building affect air leakage rates and pollutant sources.
* **Pollutant load:** Each house and apartment have different sources and levels of indoor pollutants
* **Weather:** Temperature, wind, and humidity vary throughout the year in any single location and in different climate zones. Each of these weather factors affects indoor air quality

Notes:

* *Providing fresh air by mechanical means uses energy – to operate fans and to heat/cool the incoming air. Optimize systems to avoid increasing relative humidity within the living space. Design for efficient operation and commission the fresh air system to ensure operation as designed.*
* *Best Practice: Select positive pressure or balanced ventilation systems in Virginia's mixed-humid climate. Avoid negative pressure/exhaust-only systems). See* ***www.buildingscience.com/documents/insights/bsi069-unintended-consequences-suck***

[3] https://www.energy.gov/energysaver/weatherize/ventilation/whole-house-ventilation

Whole-house Ventilation Equipment Examples:

Image 1 (above): Exhaust Ventilation Strategy – requires controls to ensure run times are met.

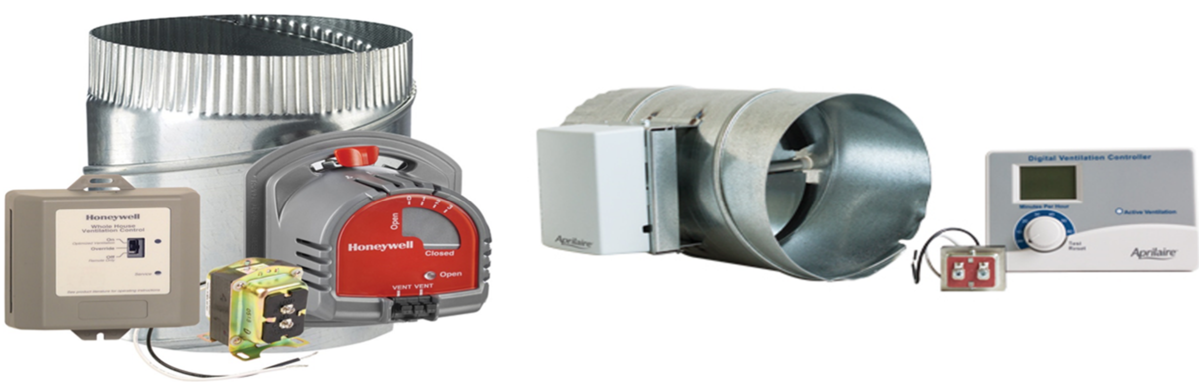


Image 2 (above): Common Supply Ventilation Systems – duct run from exterior to return plenum, automated damper, and controls

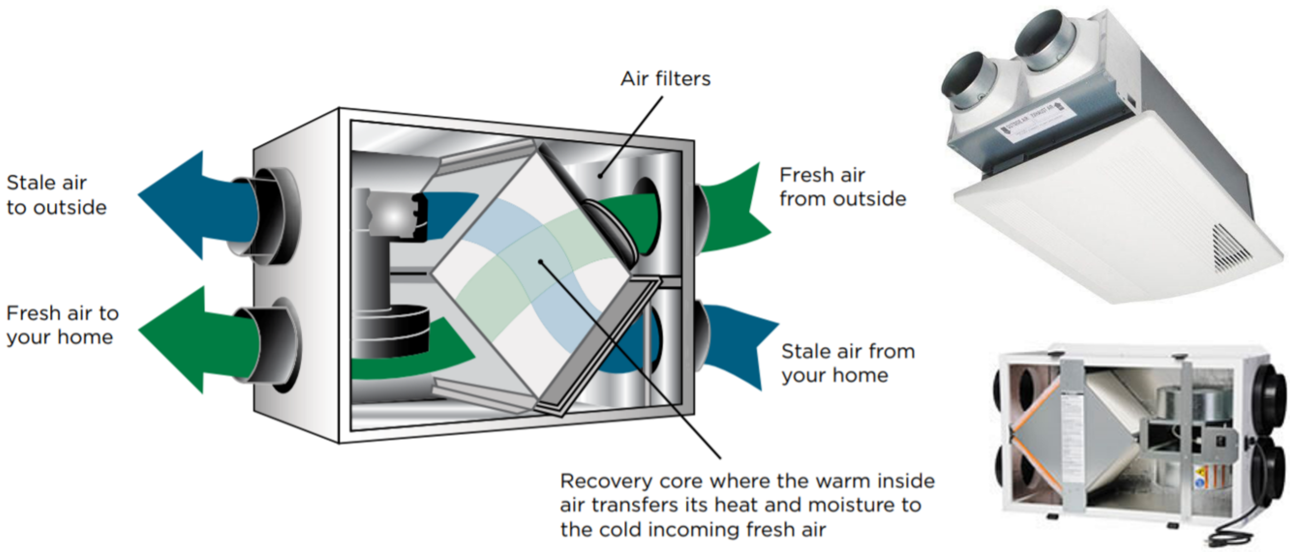


Image 1 (above): Balanced Ventilation Strategy utilizing heat or enthalpy recovery

Whole-House Ventilation Code Reference:

2018 VRC Section M1505.1 Mechanical Ventilation. General. Where local exhaust or whole-house mechanical ventilation is provided, the equipment shall be designed in accordance with this section.

2018 VRC Section M1505.4 Whole-house mechanical ventilation system. Whole-house mechanical ventilation systems shall be designed in accordance with Sections M1505.4.1 through M1505.4.4.

M1505.4.1 System Design. The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. Local exhaust or supply fans are permitted to serve as such a system. Outdoor air ducts connected to the return side of an air handler shall be considered as providing supply ventilation.

M1505.4.2 System Controls. The whole-house mechanical system shall be provided with controls that enable manual override.

M1505.4.3 Mechanical ventilation rate**.** The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate as determined in accordance with Table M1505.4.3(1) or Equation 15-1.

Equation 15-1: Ventilation rate in cubic feet per minute = (0.01 x total square foot area of house) + [7.5 x (number of bedrooms + 1)]

Exception: *The whole-house mechanical ventilation system is permitted to operate intermittently where the system has controls that enable operation for not less than 25 percent of each 4-hour segment and the ventilation rate prescribed in Table M1505.4.3(1) is multiplied by the factor determined in accordance with Table M1505.4.3(2).*

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 – 1	2 – 3	4 – 5	6 – 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 – 3,000	45	60	75	90	105
3,001 – 4,500	60	75	90	105	120
4,501 – 6,000	75	90	105	120	135
6,001 – 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

(above) Table 1505.4.3(1) Continuous whole-house ventilation system airflow rate requirements

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor[a]	4	3	2	1.5	1.3	1.0

a. For ventilation system run time values between those given, the factors are permitted to be determined by interpolation.

b. Extrapolation beyond the table is prohibited.

(above) Table 1505.4.3(2) Intermittent whole-house mechanical ventilation rate factors.

2018 VECC Section R403.6.1 Whole-house mechanical ventilation system fan efficacy. Fans used to provide whole-house mechanical ventilation shall meet the efficacy requirements of Table R403.6.1.

> ***Exception:*** Where an air handler that is integral to tested and listed HVAC equipment is used to provide whole-house mechanical ventilation, the air handler shall be powered by an electronically commutated motor.

FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
Range hoods	Any	2.8 cfm/watt	Any
In-line fan	Any	2.8 cfm/watt	Any
Bathroom, utility room	10	1.4 cfm/watt	< 90
Bathroom, utility room	90	2.8 cfm/watt	Any

(above) Table R403.6.1 Whole-house mechanical ventilation system fan efficacy

Fresh Air Inlet Location Requirements Code Reference:

2018 VRC Section R303.5 Opening location. Outdoor intake and exhaust openings shall be located in accordance with sections R303.5.1 and R303.5.2.

R303.5.1 Intake openings. Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks.

For the purpose of this section, the exhaust from dwelling unit toilet rooms, bathrooms and kitchens shall not be considered as hazardous or noxious.

Exceptions:

1. The 10-foot separation is not required where the intake opening is located 3 feet or greater below the contaminant source.
2. Vents and chimneys serving fuel-burning appliances shall be terminated in accordance with the applicable provisions of Chapters 18 and 24.
3. Clothes dryer exhaust ducts shall be terminated in accordance with Section M1502.3

Section R303.5.2 Exhaust openings. Exhaust air shall not be directed onto walkways.

***R303.6 Outside opening protections*.** Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles having an opening size of not less than ¼ inch (6 mm) and a maximum opening size of ½ inch (13 mm), in any dimension. Openings shall be protected against local weather conditions. Outdoor air exhaust and intake openings shall meet the provision for *exterior wall* opening protectives in accordance with this code.

Definitions:

Above-Grade Wall: A wall more than 50% above grade and enclosing conditioned space; this includes between-floor spandrels, peripheral edges of floors, roof and basement knee-walls, dormer walls, gable end walls, walls enclosing mansard roof, and skylight shafts

Air Barrier: One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies

Building Thermal Envelope: The basement walls, exterior walls, floor, roof, and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space

Conditioned Space: An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Infiltration: The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both

R-Value: Thermal resistance. The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ($h \bullet ft^2 \bullet °F/Btu$) [($m^2 \bullet K$)/W]. **Note: In more general terms, resistance to heat flow of a single material, expressed as a whole number. Higher numbers denote higher resistance to heat flow*

U-Factor (U-Value): Thermal transmittance. The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films ($Btu/h \bullet ft^2 \bullet °F$) [W/($m^2 \bullet K$)]. **Note: In more general terms, resistance to heat flow of multiple materials expressed as a decimal point. Lower numbers denote higher resistance to heat flow*