18. Mechanical Ventilation

Residential Mechanical Ventilation

Good ventilation in homes is important because it helps protect both occupant health and the house itself. We have introduced thousands of chemicals into our houses through building materials, finishes, packaging, furniture, carpets, clothing and other products. This is in addition to the allergens and occupant-generated air borne chemicals. Natural ventilation using windows and other operable openings can provide ventilation if they are used, but at a significant energy penalty. In a cold climate, use of windows for ventilation is not a common practice during the heating season. There are many reasons why occupants may not choose to open the windows including security, outdoor air quality, dust, or noise. Building science has taught us that we can't rely on natural forces to provide ventilation at all times of the year.

Why is Mechanical Ventilation Important?

Good ventilation protects home occupants from unpleasant odors, irritating pollutants, and potentially dangerous gases like carbon monoxide and radon. Well-planned ventilation also prevents the growth of mold and mildew, which can cause or aggravate allergic reactions and lung problems such as asthma. As we build tighter homes with more insulation, the relative humidity in the homes increases and the potential for condensation on cool or cold surfaces increases as well. The presence of condensation has been a leading cause of mold and mildew in both new and existing construction. Asthma has also increased as interior relative humidity has gotten higher. Therefore, it has become more important to remove the moisture from bathing and cooking right at the source.

Too much moisture rots window sills and attic eaves, peels paint, and invites insect infestation. Damp insulation in walls and ceilings means lost heat, higher fuel bills, and destructive and harmful mold growth. Carpeting, wallpaper, electronic equipment, and furniture all can be damaged by excess moisture. One example is how condensation occurs on the interior surface of a window based on the temperature of the glass and the relative humidity in the space.

The mantra of building science experts has become "Build Tight and Ventilate Right." Energy codes now require tight construction. All new houses in Montana must be tested to no more than 4 air changes per hour at 50 Pascals pressure. New homes also must comply with the Air Barrier and Insulation Installation Table in the Energy Code. Building and testing a tight envelope is fairly straightforward. In fact, if properly ventilated, a house building envelope can't be built too tight. Getting ventilation right is by far the more difficult challenge. While building science experts agree that mechanical whole house ventilation is important, those same experts differ on exactly how much ventilation air is required and how to design an effective ventilation system.

Both the 2012 International Energy Conservation Code (IECC) and the 2012 International Residential Code (IRC) require whole-house mechanical ventilation systems in the Montana climate zone. The IRC (R303.4) requires a whole-house mechanical ventilation system that complies with either Chapter 15 of the IRC or the International

TABLE R403.5.1 MECHANICAL VENTILATION SYSTEM FAN EFFICACY			
FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
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

Mechanical Code. The requirements of both are similar, but IRC Chapter 15 is much more user-friendly. In this discussion, only Chapter 15 of the IRC will be addressed.

As a result of the new ventilation requirements, fans designated for whole-house ventilation will have many more operating hours than bathroom or kitchen exhaust fans that are temporarily operated to remove local humidity and odors. Homes and dwelling units under the new ventilation requirements will expend significantly more energy on fan use; consequently, improved fan efficiency for those fans is cost effective. The energy code calls for the use of energy-efficient fans that provide whole-house mechanical ventilation. The table above specifies the efficiency of the fans that provide the required whole-house mechanical ventilation.

Code Requirements: Whole-House Ventilation

IRC Table M1507.3.3 (1) shown to the right, specifies the minimum required whole-house ventilation air flow based on floor area and number of bedrooms. The code assumes that one bedroom will be occupied by two persons and each additional bedroom will be occupied by a single person. The code states that the ventilation may be either exhaust or supply. Please note that a supply-only ventilation system is inappropriate for the Montana climate because it drives moisture into building cavities during the heating season. The whole-house mechanical ventilation system must be provided with controls that allow manual override.

IRC TABLE M1507.3.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

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

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

As you can see from the table on the previous page, a house of 2,500 ft^2 conditioned floor area with three bedrooms would require 60 cfm of continuous ventilation.

Intermittent Operation. If the home uses intermittent ventilation instead of continuous ventilation, then the capacity of the ventilation system must be greater. Refer to IRC Table M1507.3.3 (2) shown below. For example, if the whole-house mechanical ventilation system will operate only 50% of the time, the capacity of the system must be increased by a factor of two as specified in the table. If the system operates intermittently then it must have controls that enable operation for not less than 25% of each four-hour period.

Code Requirements: Local Exhaust

Local Exhaust. In addition to a whole-house ventilation system, the code also requires minimum local (also called "spot" or "point source") exhaust capability in kitchens and bathrooms. Kitchens must have a 100-cfm, intermittent exhaust, or a 25-cfm continuous exhaust. The fans must exhaust to the outside. Recirculation fans do not comply. Bathrooms must have either 50-cfm intermittent exhaust or 20-cfm continuous exhaust. If continuous exhaust is used to comply with the local exhaust requirement, it may also be counted toward the whole-house mechanical ventilation.

TABLE M1507.3.3(2)

Intermittent Whole-House Mechancial Ventilation Rate Factors

Run-Time Percent in Each 4-Hour Segment	25%	33%	50%	66%	75%	100%
Factor	4	3	2	1.5	1.3	1.0

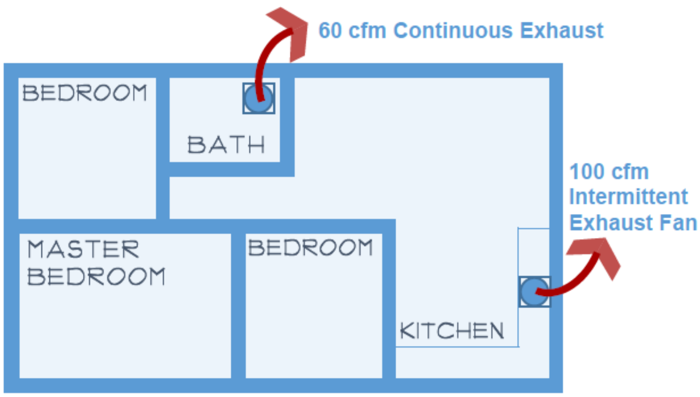
Minimum Required Local Exhaust Rates for One- and Two-Family Dwellings

Area to Be Exhausted	Exhaust Rates
Kitchens	100 cfm intermittent or 25 cfm continuous
Bathrooms-Toilet Rooms	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous

Code Requirements Examples

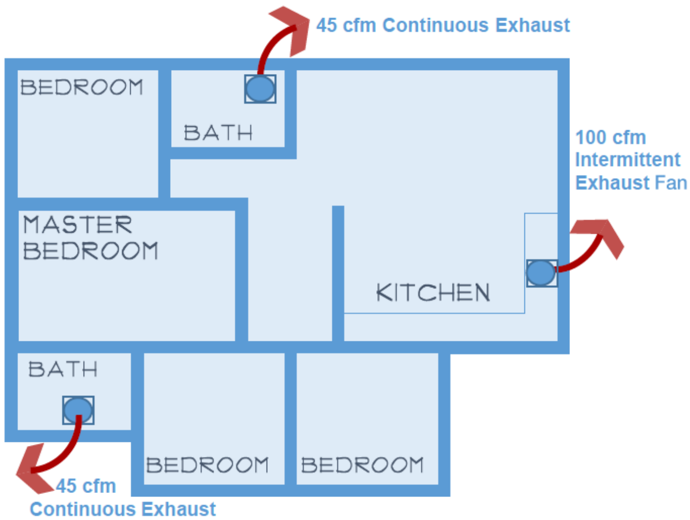
Example #1 is a 2,000 ft^2 single-story, three-bedroom house. This house requires 60 cfm of continuous ventilation. The house could comply with code with a continuous 60 cfm exhaust in the bathroom and a 100-cfm intermittent exhaust fan in the kitchen.

Example #1: 2,000 ft^2 House, 3 bedroom, 1 Bath

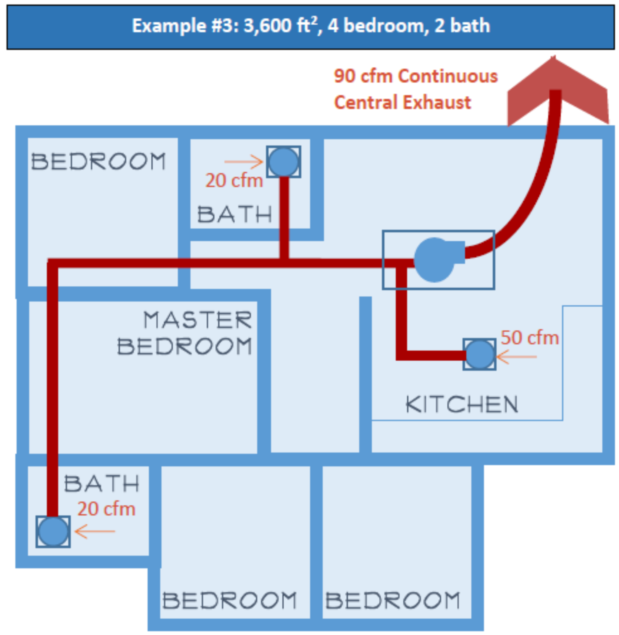


In **Example #2** a four-bedroom 3,600 ft^2, one-story home would require 90 cfm of continuous ventilation air-flow according to Chapter 15 of the IRC. One way to accomplish this is to have a continuous 45 cfm exhaust fan in each of the two bathrooms and a 100 cfm manually controlled exhaust fan in the kitchen.

Example #2: 3,600 ft^2, 4 bedroom, 2 bath



In **Example #3** another code compliant ventilation solution is shown for the same four-bedroom, 3,600 ft² one-story home. A central exhaust system would continuously exhaust 20 cfm from each of the two bathrooms and 50 cfm from the kitchen. This satisfies both the whole-house air flow requirement and the local exhaust requirement. A central exhaust system could feature heat recovery.



Plan Review

1. Identify that the fans that are part of the whole house mechanical ventilation system provide the required airflow rate (cfm).

2. Verify that all fans included in the whole-house mechanical ventilation system meet the efficacy requirements, and if integral with a central air handler, the air handler fan is powered by an electronically commutated motor.

3. Check that required local exhaust fans in kitchens and bathrooms, either continuous or intermittent, have been identified and sized per the code.

Inspection

1. Verify that all fans included in the whole-house mechanical ventilation system match the efficacy of specified units or the submittals provided and assessed during plan review. Verify that all exhaust is to the outside. Recirculation fans do not comply.

2. Verify that an occupant override has been installed as required for the whole-house mechanical ventilation system.

3. Verify that all local exhaust fans match the efficacy of specified units or the submittals provided and assessed during plan review. Verify that all exhaust s to the outside. Recirculation fans do not comply.

Code References

Resources

2012 International Energy Conservation Code, Copyright August 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 IECC Code and Commentary, Copyright August 2012 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 International Mechanical Code, Copyright August 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.