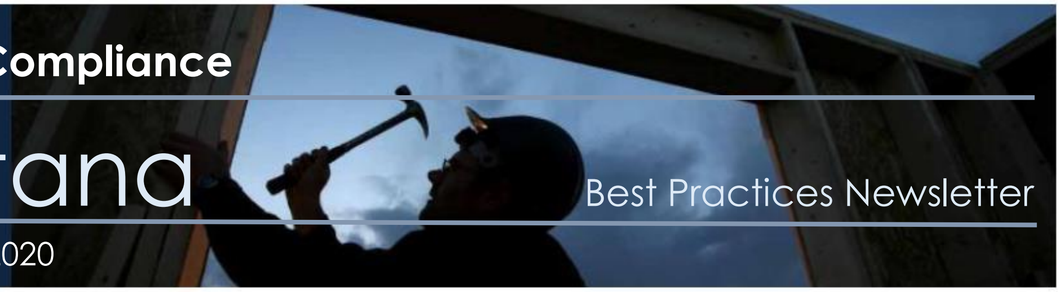
Energy Code Compliance

Montana

Best Practices Newsletter

Spring 2020



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Some old-fashioned things like fresh air and sunshine are hard to beat.

- Laura Ingalls Wilder

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What is *whole-house mechanical ventilation*? Chapter 2 of the 2012 International Energy Conservation Code (IECC) defines whole-house mechanical ventilation as:

> An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole-house ventilation rates.

Prior to the 2012 IRC, mechanical ventilation in homes was limited to localized exhaust fans — in kitchens and bathrooms, for example — e.g., to control moisture and odors. Typical residential building envelopes were generally leaky enough that whole-house systems were considered unnecessary.

Since its introduction in the 2012 International Residential Code (IRC) and 2012 IECC, whole-house mechanical ventilation is now required for Montana residential buildings. The current applicable Montana codes are the 2018 IRC and the 2012 IECC. These current codes are assumed for this discussion. Montana is in the process of updating the 2012 IECC to the 2018 IECC. The state is expected to adopt the 2018 IECC before the end of the year.

Before discussing best practice for design of a whole-house mechanical ventilation system, let's review the benefits of mechanical ventilation and the types of systems available for today's tighter homes.

Benefits of Mechanical Ventilation Systems

1. Provides a consistent supply of outdoor air that improves indoor air quality and occupant comfort.
2. Dilutes indoor air contaminates, such as volatile organic compounds, odors, allergens, and airborne bacteria and viruses.

> Note: *The New England Journal of Medicine* recently reported that Covid-19 and other viruses could be detected and viable in the air for up to three hours. Therefore, the Center for Disease Control (CDC) recommends good ventilation to provide fresh air to occupied spaces. When outdoor temperatures

allow, open windows also help provide fresh air to occupied spaces and helps dilute indoor air contaminates.

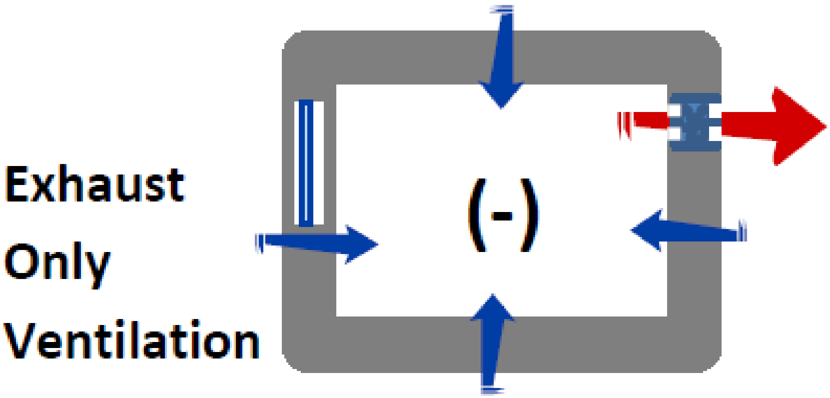
3. In Montana's relatively dry climate it helps reduce indoor moisture accumulation.

4. Allows better control over the source and amount of outdoor air introduced into the home.

Types of Mechanical Ventilation Systems

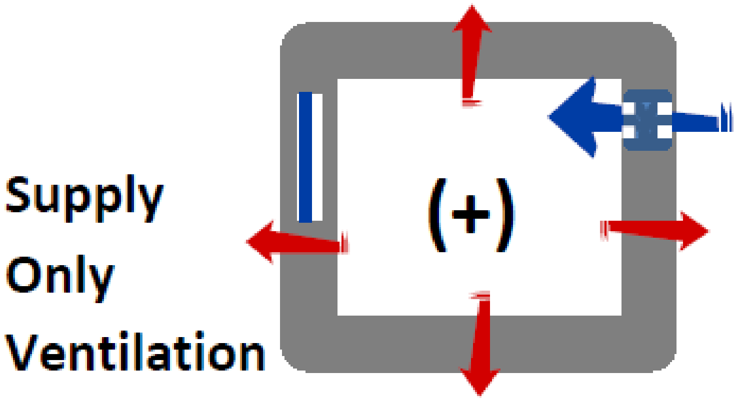
Before describing the three basic types of mechanical ventilation, let's review an important building science principle related to ventilation, which states that the volume of air that is exhausted from a building is equal to the volume of air that enters the building. The inverse is also true: the volume of air supplied to the building will equal the volume of air exhausted from the building. This basic principle of physics holds true for all types of ventilation systems. It is this principle that allows blower door building tightness testing to estimate building envelope leakage.

Exhaust-Only Systems:



In an exhaust-only system, one or more fan(s) exhaust indoor air to the outside. Outdoor makeup air is drawn into the building through leaks in the building envelope. An exhaust-only system tends to depressurize the house and can draw contaminants into the house from the attic, garage, crawlspace, and wall cavities. In hot humid climates, it also has the potential to draw moist outdoor air into wall cavities that could condense in the cooling season causing moisture problems. This is not typically a problem in Montana. Another problem associated with exhaust-only systems is that, in a tight house, the negative indoor air pressure relative to outside, can lead to backdrafting of combustion appliances, allowing carbon monoxide to enter the home.

Supply-Only Systems:



In a supply-only system, a fan draws outdoor air into the house and indoor air escapes through the building enclosure and exhaust fan ducts due to the positive pressure created. A supply-only system may be used in a central fan integrated (CFI) system where outdoor air is ducted to the return plenum of the air handler. A supply-only system tends to pressurize the house and, as a result, has the potential to drive moist indoor air into wall cavities that could condense during the heating season in Montana's cold climate. Therefore, supply-only systems are not recommended for the Montana climate.

Balanced System – Best practice in most cases

A balanced system provides equal amounts of supply and exhaust air. The simplest balanced system includes one or more exhaust fans along with designed makeup air vents. A more energy efficient and effective approach includes a *heat recovery ventilator* (HRV) or, in humid climates, an *energy-recovery ventilator* (not recommended for Montana's dry climate). HRVs transfer heat between the exhaust air and supply air through a *heat exchanger*. The HRV may be ducted independently or integrated with a HVAC system. Typically, an HRV will transfer 60% to 90% of the heat in the stale air being exhausted from the home to the fresh air entering the home. HRVs have the potential to provide energy savings and effective ventilation, but only if they are designed and installed properly.

For small energy-efficient homes, HRVs may not be cost-effective. If integrated with a central air handler, the potential for an HRV to provide cost-effective savings is reduced. An HRV collects air from spaces in the home that are most likely to produce moisture or pollutants and is then exhausted at a central point. Outside air is supplied by the central ventilation system to one or more spaces. When an air handler is present, the fresh air supply from the HRV can be connected to the return side of the air handler and the low-speed air handler fan is interconnected with the operation of the HRV. While it is possible to integrate an HRV with a central air handler, it is difficult to balance the HRV in this configuration because of the ducting and operating conditions of the central air-distribution system. For best results, most building science experts recommend that HRVs be independent systems. This approach it may result in higher initial costs.

Heat Recovery Ventilator

Best Practice Checklist

While the codes set important minimum whole-house mechanical ventilation requirements, the code provisions alone do not ensure that the installed system will provide effective and energy-efficient ventilation to occupants of new homes. To the contrary, it takes thoughtful design, proper installation, and appropriate occupant behavior to provide healthy, comfortable, and energy-efficient ventilation. Following are some design and operational considerations that improve the effectiveness and energy efficiency of whole-house mechanical ventilation systems.

- ✓ *A whole-house mechanical ventilation system must be used in order to be effective.* Factors that discourage use and cause occupants to disable the systems include noise, cool air blowing on occupants, complex controls, lack of understanding of system operation by occupants, and controls not being labeled.

- ✓ *Simplify and label controls.* Although not mandated by the code, the mechanical ventilation system manual control should be clearly and permanently labeled, especially the required override switch.

- ✓ *Exhaust air from source locations.* Air should be exhausted from the rooms where most pollutants, odors, and moisture are generated, such as bathrooms, laundry rooms, and kitchens.

- ✓ *Supply air to occupied rooms.* Supply and returns to each bedroom will assure that each is well ventilated, even when doors are closed.

- ✓ *Distribute fresh air directly to occupied rooms.* Good distribution means that fresh air is supplied to the rooms where occupants spend most of their time, such as the living room and bedrooms.

- ✓ *Exhaust kitchen range hoods to exterior.* Kitchen range hoods should exhaust outside to remove moisture, odors, and pollutants.
    - Recirculation hoods allow grease vapors and odors to remain in the house and should be avoided.

- ✓ *Install quiet fans*. Fan noise can be a major factor in whether occupants use the ventilation system provided. If fans are rated over one sone, there is a good chance the system will be deactivated by the occupants.
    - Exhaust fans are rated for noise. A sone is a measure of loudness. The higher the sone rating, the louder the sound. Exhaust fans with a sone rating of one or less will be quiet and much less likely to be disabled by the occupant.

- ✓ *Beware of backdrafting.* Backdrafting is the spillage of combustion gases, including carbon monoxide, from a combustion appliance such as a fireplace, woodstove, atmospherically vented gas furnace, or atmospherically vented gas water heater.
    - Installing sealed-combustion, power-vented, direct-vented, and induced-draft appliances will significantly reduce the chance of backdrafting. These system types usually are more expensive.
    - *Gas ovens and gas stovetops are also sources of combustion gases and should only be used with an exhaust hood directly vented to the exterior.* Unvented gas fireplaces or gas heaters should never be installed.

- ✓ *Test exhaust and supply flow.* Flow hoods and other testing equipment are available to test the air flow of ventilation devices. The test is usually quick and easy. Actual fan flow depends not only on the fan capacity, but also on the length and character of the duct. If the duct to the exterior is long, compressed, or has sharp bends, then air flow will be significantly reduced.

- ✓ *Beware of radon.* Radon enters a home through cracks in concrete, joints in construction below grade, and poorly sealed crawlspace construction. Because you can’t test for radon before construction, the U.S. EPA recommends that all homes built in Zone 1, which includes most of Montana, have radon-mitigation systems installed at time of construction.

Code Requirements (2012 IECC R403.5, 2018 IRC M1505)

The 2018 IRC and the 2012 IECC require whole-house mechanical ventilation, as well as local ventilation. In some cases, exhaust fans or a heat recovery ventilator may serve both purposes. Montana allows either Section 1505 of the IRC or IMC Section 403 to be used in complying with the mechanical ventilation code requirements. The requirements of both are similar, but IRC Section 1505 is more user-friendly.

Fan Efficacy. Since the fans associated with a whole-house mechanical ventilation system will be operating continuously or for a significant number of hours, the code requires the use of efficient fans. The IECC table below specifies the efficacy of the fans that provide the required whole-house mechanical ventilation. Efficacy is given in units CFM/Watt.

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

Minimum Ventilation Air. 2018 IRC Table M1505.4.3(1) specifies the minimum required whole-house continuous ventilation air flow based on floor area and number of bedrooms in the house. The code states that the ventilation may be either exhaust or supply, but a supply-only ventilation system is inappropriate for the Montana climate. Exhaust air may not discharge into the attic, crawlspace, or other spaces inside the building. Whole-house mechanical ventilation systems must be provided with manual override controls.

For example, a house with conditioned floor area of 2,500 ft^2 that has three bedrooms would require 60 CFM of continuous ventilation based on the table below. The minimum ventilation table values did not change in the 2018 IRC, but a formula was added to allow a more precise calculation option.

Continuous Whole-House Mechanical Ventilation System Airflow Requirements (IRC Table M1505.4.3(1))

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

Ventilation Rate (CFM) = (0.01 x Floor Area in ft2 + [7.5 x (Number of Bedrooms + 1)]

Using the above formula instead of the table, the 2,500 ft^2, three-bedrooom house would require 55 CFM of whole-house mechanical ventilation.

Intermittent Whole-House Ventilation. If the home uses intermittent whole-house mechanical ventilation, then the capacity of the ventilation system must be increased. For example, if the ventilation system will operate only 50% of the time, the capacity of the system must be increased by a factor of 2 per the following table. The ventilation must operate at least 25% if each four-hour period.

Intermittent Whole-House Mechanical Ventilation Rate Factors (IRC Table M1505.4.3(2))

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

Local Exhaust Ventilation. In addition to the whole-house mechanical ventilation, the code also requires local exhaust in kitchens and bathrooms. Kitchens must have either a 100-CFM intermittent exhaust fan or a 25-CFM continuous exhaust fan. Each bathroom must have either a 50-CFM intermittent exhaust fan or a 20-CFM continuous exhaust fan. If continuous exhaust is used to also comply with the local exhaust requirement, it may also be counted toward whole-house mechanical ventilation. Local exhaust fans may be controlled manually by an on-off switch, a crank timer, or other controls, such as a dehumidistat.

Minimum Required Local Exhaust Rates (Table M1505.4.4)

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

DEQ Montana Department of Environmental Quality

For questions, suggestions, or to be removed from the newsletter distribution list, email: carll@ncat.org

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Energize Montana Energy Code Website:
http://deq.mt.gov/Energy/EnergizeMT/EnergyCode