CODE NOTES

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

2012 IECC

Residential Fan Efficiency

Over the past several code cycles, mechanical ventilation requirements have been added to ensure adequate outside air is provided for ventilation whenever residences are occupied. These ventilation requirements can be found in the International Residential Code for homes and the International Mechanical Code for dwelling units in multifamily buildings.

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 or odors. Earlier ventilation practices relied on infiltration or operable windows as the primary source of ventilation air. 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 and is now required by the 2012 International Energy Conservation Code (IECC). In this code note, the new fan efficacy requirements are explained, along with how to determine which fans are affected by the new fan requirements.

DEFINITIONS

cfm: Cubic feet per minute, a standard measurement of fan airflow.

Efficacy: Useful work divided by power input. For ventilation fans the efficacy is measured in cfm per watt (cfm/W). Like the miles per gallon rating, higher is better.

HVAC: Heating, ventilating, and air conditioning.

Mechanical ventilation: The active process of supplying air to or removing air from an indoor space by using powered equipment.

Watts: Electrical power input to a fan or other equipment.

Whole-house mechanical ventilation system: The fans, controls, dampers and ducts included in the system that supplies and exhausts or relieves ventilation air for the residence. An important distinction is that a "whole-house fan" intended to flush air out of a house on summer nights is not typically part of the whole-house mechanical ventilation system; the airflow of a whole-house fan is much higher than that for continuous ventilation. A small whole-house fan may be used to provide the needed ventilation.

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The whole-house mechanical ventilation system can be designed in one of several ways:

- Air is exhausted when the home or dwelling unit is occupied to meet the ventilation requirements, and outside air is drawn in by negative pressure through window vents or through-the-wall vents.
- Air is exhausted when the home or dwelling unit is occupied to meet the ventilation requirements, and fresh makeup air is provided to replace exhausted air via ventilation ductwork that is independent or connected to the heating or cooling unit return duct.
- Outside ventilation air is supplied with a dedicated fan, and relief vents allow air to escape from the home or dwelling unit when the supply air pressurizes the home.
- A combination of supply and exhaust fans operate, often in conjunction with a heat recovery unit, to both supply the required ventilation air through ductwork and exhaust stale air.

Figure 1 shows a whole-house exhaust fan ventilation approach. In this arrangement, only the whole-house fan needs to meet the efficacy requirements as long as it provides the full ventilation airflow (cfm) required. If there were no whole-house fan, and bathroom fans were controlled to meet the ventilation requirement, then fans totaling the required ventilation rate in cfm must meet the efficacy requirement.

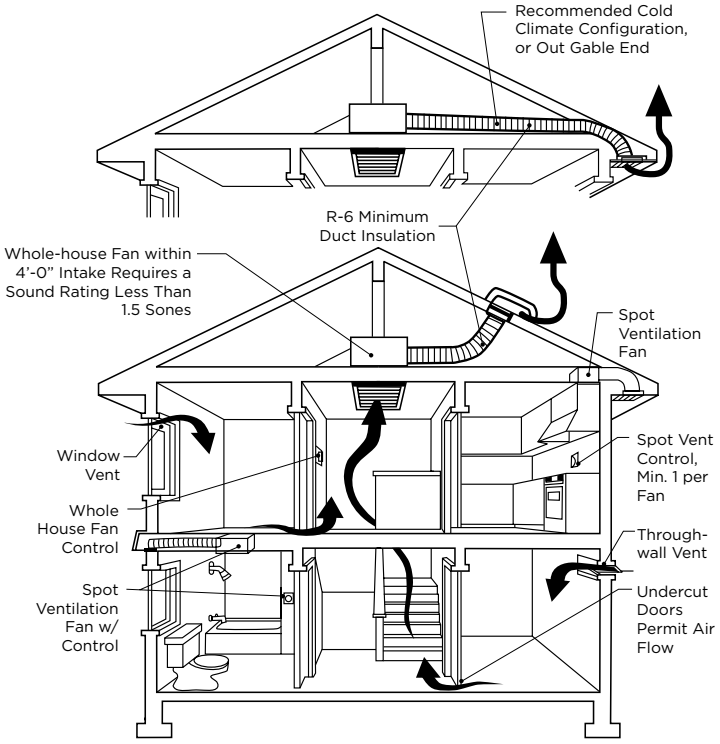

Figure 1. Whole-house ventilation diagram[1]

1 Adapted from BECP – U.S. Department of Energy, Building Energy Codes Program. 2011. "Whole-House Mechanical Ventilation – Code Notes," Building Energy Codes Resource Center, Article 1707. U.S. Department of Energy, Washington, D.C.

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Older style or "economy" bathroom, kitchen, or whole-house exhaust fans are not likely to meet the new fan efficacy requirements, but can be used if they are not part of the whole-house ventilation system. Therefore, the efficacy of such fans will not be indirectly enforced in the marketplace due to manufacturing requirements for minimum efficacy.

The efficacy of the fans included in the whole-house ventilation system must be verified. One challenge in verifying compliance with fan efficacy is determining which fans are subject to the requirement. **Supply or exhaust fans that are part of the system needed to provide the required whole-house ventilation must meet the efficacy requirements.** If the controlled system uses one or two bathroom exhaust fans to meet the occupied ventilation requirement, and outside air is introduced through ducts connected to the home's furnace or air conditioner, then the furnace or air conditioner supply fan may not be required to meet the ventilation requirement, and may only run intermittently to meet heating or cooling loads. In this case, the bathroom exhaust fan(s) needs to meet the efficacy requirement, but the supply fan does not. Other fans that are not part of the system needed to meet the whole-house ventilation requirement (e.g., kitchen exhaust, other bathroom exhaust, garage exhaust) are also exempt from the efficacy requirements.

An example of ventilation requirements can be found at Table 4.1a of ANSI/ ASHRAE Standard 62.2-2010, or at Table M1507.3.3(1) of the 2012 International Residential Code. For more information and background on residential ventilation, see the companion code note, "Whole-House Mechanical Ventilation."[2]

Plan Review

1. Identify the exhaust or supply fans that are part of the mechanical ventilation system that provides the appropriate ventilation rate (cfm).
2. Review specification information on the included fans and, where necessary, calculate the efficacy for each fan in terms of cfm/W. Determining fan efficacy is discussed in more detail in the following sections.
3. Verify that all fans included in the whole-house mechanical ventilation system meet the efficacy requirements, or if integral to tested and listed HVAC equipment, are powered by an electronically commutated motor.

Field Inspection

Confirm 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.

How to Determine Fan Efficacy

Verifying the fan efficacy depends on the information available. The cfm/W may be listed on the specification sheet for the fan (see Example A, a typical

2 U.S. Department of Energy, Building Energy Codes Program. 2011. "Whole-House Mechanical Ventilation – Code Notes," Building Energy Codes Resource Center, Article 1707. U.S. Department of Energy, Washington, D.C. Available online at: www.energycodes.gov/help/notes.stm

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fan data table from a fan specification sheet). If multiple values are listed, choose the airflow (cfm) shown on the mechanical plans and 0.1 in. of static pressure.[3] If efficacy is not listed, it can be calculated from published watts and specified airflow (cfm) as is shown in Example B, or an estimate can be made from fan electrical information. Note that if the specified wattage is not supplied, it is necessary to secure the fan voltage and amperage to calculate watts, as shown in Example C. The results of all three examples and steps required are illustrated inTable 1. A blank column is provided so Table 1 can be copied and re-used for actual calculations for during plan review.

Example Technical Specifications

Use static pressure of 0.1 in.

Scheduled airflow (cfm)

Static Pressure in inches w.g.	0.1	0.25	0.1	0.25	0.1	0.25
Air Volume (CFM)	130	135	110	111	90	93
Noise (sones)	<0.3	0.7	<0.3	0.6	<0.3	0.6
Power Consumption (watts)	11.9	21.5	9.0	15.6	6.2	12.5
Energy Efficiency (CFM/watt)	11.2	6.4	12.5	7.3	15.2	7.8
Speed (RPM)	662	917	643	912	580	900
Current (amps)	0.01	0.12	0.03	0.09	0.02	0.07

Fan efficacy is cfm/W

Example A. Sample technical specification. In this example, the efficacy is directly listed on the specification, so one must only verify that the listed efficacy is greater than or equal to the required efficacy.

Item	Bathroom Fan
Type	Deluxe
CFM @ 0.100-in. SP	80
Sones @ 0.100-in. SP @ 5 ft	2.5
Duct Dia. (In.)	4
Discharge	Horizontal
Voltage	120
Hz	60
Phase	1
Amps	0.50
Watts	48
Nominal RPM	1280
Grille Length (In.)	10-5/8
Grille Width (In.)	11-1/8
Housing Height (In.)	5-3/4
Housing Length (In.)	8-1/4
Housing Width (In.)	8
Housing Material	Galvanised Steel
Grille MaterialMatte	White Polymeric
Mounting Location	Ceiling
Agency Compliance	UL Listed, HVI Certified

Example B. Sample technical specification. In this example, the efficacy must be calculated from the stated watts and airflow.

Item	Bathroom Fan
Type	Economy
CFM @ 0.100-in. SP	50
Sones @ 0.100-in. SP @ 5 ft	4.0
Duct Dia. (In.)	3
Discharge	Horizontal
Voltage	120
Hz	60
Phase	1
Amps	0.90
Grille Length (In.)	9-1/4
Grille Width (In.)	9
Housing Height (In.)	3-5/8
Housing Length (In.)	7-1/2
Housing Width (In.)	7-1/4
Housing Material	Galvanised Steel
Grille Material	White Polymeric
Mounting Location	Ceiling or Wall
Agency Compliance	UL Listed, HVI Certified

Example C. Sample technical specification. In this example, the estimated watts must first be calculated from voltage and amperage before calculating efficacy.

3 The Home Ventilating Institute (HVI) specified test point for residential fans is 0.1 in. w.g.

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In Table 1, specifications for three fans are evaluated to determine efficacy and compliance with the 2012 IECC. Remember, the efficacy requirements apply only to fans included in a whole-house mechanical ventilation system. The fan specified in Example C would be allowed if that fan was not part of the required whole-house mechanical ventilation system.

Table 1. Examples of fan efficacy verification

Verify Fan Efficacy	Your Case	Example A	Example B	Example C
Fan electrical voltage				120 V
Fan motor nameplate amps (do not include lamp if provided)				0.9 A
Estimated power factor[a]	0.75 PF			0.75 PF
Calculated watts = V × A × PF (use only if watts not specified)				120V × 0.9A × 0.75PF = 81 W
Specified watts			48 W	
Rated airflow, cfm @ 0.1 in. w.g.		110 cfm	80 cfm	50 cfm
Fan efficacy cfm/W		12.5 cfm/W	1.67 cfm/W	0.62 cfm/W
Required minimum fan efficacy		2.8 cfm/W	1.4 cfm/W	1.4 cfm/W
Meets requirement?		Yes	Yes	No

[a] Power factor is estimated for typical fan motors as it is generally not listed in the fan motor specifications. Whenever watts or efficacy are available, use the published information and do not estimate watts.

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Recovery Ventilators

Recovery ventilators may be called heat recovery ventilators (HRV) or energy recovery ventilators (ERV). These units increase energy savings by recovering energy from the exhaust air and preheating or precooling the fresh outside air. As a listed unit, they are exempt from the efficacy requirement as long as they are equipped with an electronically commutated motor (ECM). The motor type should be noted on the specification sheet. Note that units with permanent split capacitor motors do not meet this requirement even though they are much more efficient than shaded pole motors, which also do not meet the ECM requirement. ECMs may also be called brushless DC motors. Often qualifying units will have "ECM" as part of their model number. Figure 2 shows how exhaust air (stale air) is used to precondition the outside air (ventilation or fresh air) in a recovery ventilator.

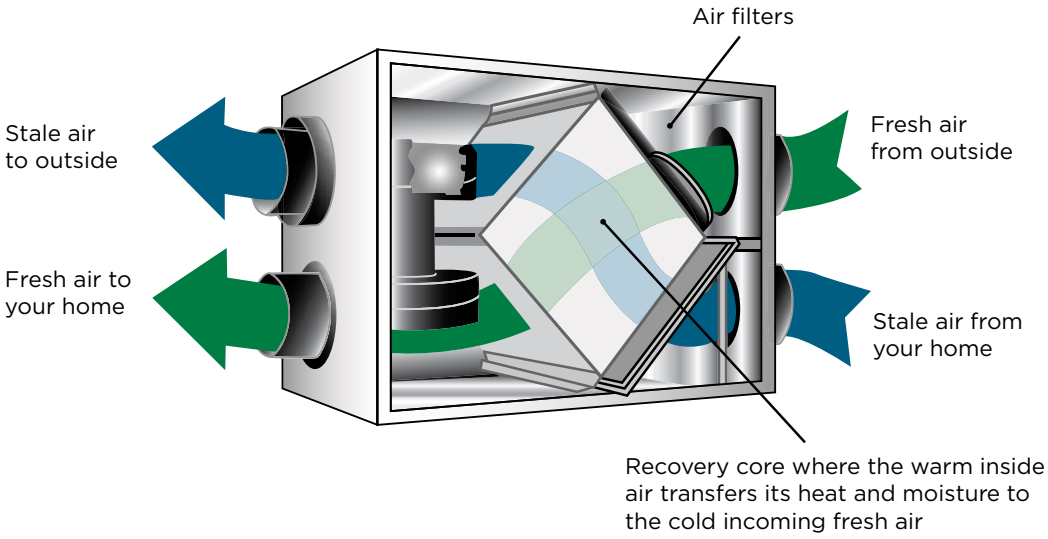

Figure 2. Recovery ventilator

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Code Citations*

IECC 2012, Section R403.5 Mechanical Ventilation (Mandatory)
The building shall be provided with ventilation that meets the requirements of the International Residential Code or International Mechanical Code, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

IECC 2012, Section R403.5.1 Whole-House Mechanical Ventilation System Fan Efficacy
Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.5.1.

Exception: Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor.

Table R403.5.1: Mechanical Ventilation System Fan Efficacy

Fan Location	Airflow Rate Minimum (cfm)	Minimum Efficacy (cfm/W)	Airflow Rate Maximum (cfm)
Range hoods	Any	2.8	Any
In-line fan	Any	2.8	Any
Bathroom, utility room	10	1.4	<90
Bathroom, utility room	90	2.8	Any

For SI: 1 cfm = 28.3 L/min.

References

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EERE Information Center
1-877-EERE-INFO (1-877-337-3463)
eere.energy.gov/informationcenter

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