The Weatherization Training Center

Ventilation Strategies in Weatherization

Technical Update

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Some homes that are tight or even moderately leaky after weatherization measures have been installed may still need some type of spot source or whole house ventilation to help mitigate a moisture or indoor air quality problem. The need to install mechanical ventilation in weatherized homes will be the exception rather than the rule. A decision to ventilate or not will be driven by a number of factors including house tightness, high occupancy, and the level of existing or potential moisture problems. This is an often difficult thing to judge based on a one-time visit by an auditor. An auditor needs to be observant about existing conditions in the home and be knowledgeable enough to ask the right kinds of questions.

The purpose of this article is to introduce weatherization practitioners to various types of ventilation and control systems and offer some basic selection criteria and recommended installation practices. It is beyond the scope of this article to offer a strategy that covers every scenario since all houses are unique and each will have different issues.

It is important to note that mechanical ventilation *alone* should *not* be considered as a remedy to solve bulk moisture loads or other IAQ problems. Adding exhaust fans or over-ventilating a building may create or make an existing problem worse. Excessive mechanical ventilation in conjunction with a tight house may have the undesirable effect of backdrafting combustion equipment, introduce hot humid air into the building during the summer months, or bring soil gas and other contaminates into the living area from outdoors, basements, and crawl spaces.

Spot Source Ventilation

A spot source fan removes moisture or pollution at its source from areas like kitchens and bathrooms. They are the most commonly observed fan type in stick built homes constructed after 1965 or mobile homes built after 1976. The equipment is generally small in size (between 50 and 70 cubic feet per minute [cfm] of airflow) and controlled by a standard wall switch or timer. The advantages of spot source fans are that they remove the pollutants from a localized area quickly and therefore require short operating times. They are also less likely to back-draft combustion equipment. In homes with more than one bathroom, multiple spot source fans may need to be installed.

Whole House Exhaust Ventilation

These systems are designed to dilute the pollutants from the whole house by removing indoor air and replacing it with outdoor air through the building envelope. These exhaust fans have a larger capacity to enable them to move a larger amount of air. They may be installed in the same fashion as a spot source fan and placed in a central location such as a hallway or in a bathroom. Since this is a centralized system concept, transfer grills will likely be needed so that the fan can communicate with all areas of the house. Because these fans have a higher capacity, care

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must be taken that they do not create pressure differentials or excessive drafts.

Another type of continuous whole house exhaust fan is a central fan system with multiple inlets commonly known as “Octopus” systems. These systems are typically placed in a remote area such as an attic and have several duct runs serving different rooms that may require ventilation. They feature quiet operation, effective distribution, and reduce the possibility of pressure imbalances in the home. On the other hand, they are expensive, require balancing, and are labor intensive to install. Therefore, they are generally impractical for weatherization retrofit applications in all but extremely specialized situations.

Central exhaust system with multiple duct runs

Equipment Selection and Sizing

Ventilation fans, whether designed for spot source or whole house ventilation, should be of good quality and rated for “continuous” operation. The equipment should be energy efficient and feature quiet operation to discourage occupants from shutting them off. Above all, fans need to be properly sized. The following guidelines for sizing exhaust fans adhere to recommendations set forth by the Home Ventilation Institute (HVI) and the American Society of Heating and Air Conditioner Engineers (ASHRAE).

For spot source ventilation, HVI recommends the following air changes per hour (ACH):

- Bathrooms – 8 ACH
- Kitchens – 15 ACH
- Other Rooms – 6 ACH

Sizing a Spot Source Fan

To size an exhaust fan for a 672 cubic foot bathroom using HVI standards of 8 ACH for spot ventilation, use the following formula:

$$\frac{\text{Volume (cu.ft.) X ACH}}{60} = \text{Fan Size}$$

Bathroom: 12 ft x 7 ft. x 8 ft. = 672 cu.ft.
672 cu.ft. x 8 ach = 5376 cu.ft./hr
5376 cu.ft./hr ÷ 60 min. = 89.6 cfm

In this case, select a 90 cfm fan

Sizing a Whole House Fan

To size a whole house ventilation fan in an 8,000cu.ft. home, employ ASHRAE standard 62 to achieve .35 ACH and use the following formula:

$$\frac{\text{Volume (cu.ft.) X .35 ACH}}{60} = \text{Fan Size}$$

House: 25 ft. x 40 ft x 8 ft.
25 ft. x 40 ft. x 8 ft. = 8000cu.ft.
8000cu.ft. ÷ 60 min./hr = 133 cfm
133 CFM x .35 ACH = 46.5 cfm

In this case, select a 50 cfm fan. A larger commercially available fan may be used in conjunction with a speed control to achieve the desired ventilation rate.

Note: A successful whole house ventilation approach will require the system to operate constantly but does not take periods of elevated moisture levels into account. Also, the spot source or whole house fan sizing methodologies described do not factor in the impact of static losses on actual performance.

Static Pressure and Duct Runs

Question**:** *"Why, after following all of the sizing methods, does my fan not exhaust properly or my 90 CFM fan only exhausts 30 cfm of air?"* The answer could very well be related to static duct losses.

To achieve its stated airflow rating, a fan must overcome the resistance of the inlet grill, duct material, length of the duct run, elbows, and outside termination. This resistance is called static pressure. If faced with an unusual installation such as a long duct runs or excessive elbows, the fan needs must have sufficient capacity to overcome this static loss. You may want to use what is called the Equivalent Duct Length (EDL) method to size the fan. Every manufacturer has performance curves for each fan they offer. The manufacturer's EDL chart will help size a fan to overcome static losses.

EDL Sizing Method

In the following example, an 84 square foot (672 cu.ft.) bathroom requiring a net 90 cfm of airflow will employ a Panasonic EDL chart to recalculate a recommended fan size to account for static losses. The assumption is that 12 feet of 4 inch aluminum flexible duct, one 90° elbow, and one outdoor terminal device will be used.

1. Multiply the duct length of 12 ft. times the manufacturer value of 1.25 (15 ft.)
2. One elbow at 15 ft.
3. One terminal device at 30 ft.
4. Total the distances in 1-3 to determine the total EDL (60 ft.)
5. Using the sample chart for bathrooms, find the floor area that closely matches the footprint of the bathroom (90 sq.ft.)
6. Find the fan size and model that the EDL and bathroom floor area intersect

Bathroom Ventilation (to achieve 8 ACH as per HVI)

EQUIVALENT DUCT LENGTH

Sq. Ft.	**20 Feet**	**40 feet**	**60 feet**	**80 feet**
50	FV-05VQ2	FV-05VQ2	FV-05VQ2	FV-05VQ2
60	FV-05VQ2	FV-05VQ2	FV-07VQ2 or FV-07VQL3	FV-08VQ2 or FV-08VQL3
70	FV-07VQ2 or FV-07VQL3	FV-08VQ2 or FV-08VQL3	FV-11VQ2 or FV-11VQL3 or FV-11VH1 or FV-11VHL1	FV-15VQ3
80	FV-08VQ2 or FV-08VQL3	FV-08VQ2 or FV-08VQL3	FV-11VQ2 or FV-11VQL3 or FV-11VH1 or FV-11VHL1	FV-15VQ3
90	FV-08VQ2 or FV-08VQL3	FV-11VQ2 or FV-11VQL3 or FV-11VH1 or FV-11VHL1	FV-15VQ3	FV-15VQ3
100	FV-11VQ2 or FV-11VQL3 or FV-11VH1 or FV-11VHL1	FV-15VQ3	FV-15VQ3	FV-20VQ3

Equivalent Duct Length (EDL) chart from Panasonic Catalog

In this case a Panasonic model FV-15VQ3, 150 cfm fan is required to overcome the static losses produced by duct length, elbow, and terminal fitting for a bathroom that would have otherwise required a net 90 cfm of exhaust air flow. Always follow the manufacturer's data for the fan type when calculating the EDL.

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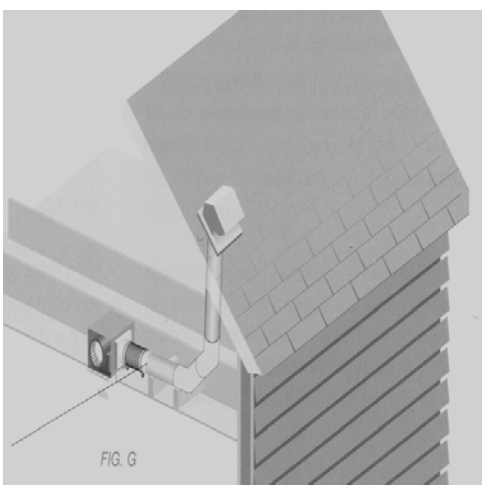
Duct Basics

Actual performance of a mechanical exhaust system often falls short of performance expectations. This is primarily due to poor duct design or suspect installation practices. What follows are some essential guidelines for duct design and installation:

- Exhaust airflow must terminate to the outside and not to attics.
- Ducts should be short and as straight as possible with few elbows to prevent static duct looses.
- Add two to three feet of straight pipe before installing an elbow as shown in the illustration below.
- Use long radius elbows.
- Use smooth, rigid ducting, not plastic dryer vent material.
- Ducts running through unheated spaces should be insulated to at least R-5 to prevent condensation.
- Exhaust terminations must prevent birds or animals from entering.
- Follow manufacturer specs and/or installation instructions.



Typical ductwork schematic showing three foot straight section at fan breech

Example of poor duct installation practice; an uninsulated dryer vent is twisted into a 180^o elbow and will restrict airflow that leads to a likelihood of condensation in the line.

Exhaust Equipment Controls

Besides the fan itself, the control may be the most important component of the ventilation system. The selection of the control should be based on the occupants needs, be user friendly, and cost effective. The design of the total control system should offer the client or contractor some degree of flexibility. Many methods exist to control a ventilation system ranging from simple and inexpensive to complex and expensive controls. Fan controls are either manual or automatic but each will do the following:

- Turn the fan on or off
- Vary the on/off times
- Vary the speed if needed

The decision to operate the ventilation system continuously or intermittently is dependent on a number of factors including occupant levels, tightness of the house, and pollution or moisture levels.

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Simple Manual Controls

Simple controls for fan operation include standard single pole wall switches that turn the fan on and off. Crank timers are simple rotary dials which are set by occupant to evacuate moisture or odors but should probably be avoided since they usually have a short life span.

A step up is The Grasslin 24-hour timer switch, which resembles the timer of a low voltage landscape lighting system. This switch has 72 pins representing 20 minutes each and represents the operating time that may be set for different periods throughout a day.

Lutron Manufacturing Co. makes a three-speed wall switch which looks and installs in the same fashion as a regular single pole switch. This switch could be useful if the fan is needed to operate at lower speeds. National Controls Corp. makes a single pole switch or fan delay time switch, which is designed for bathroom fan/light combos. This switch is designed to shut the light off when thrown and allows the fan to run for different time settings ranging from 1 to 60 minutes. The drawback is that a three conductor wire needs to be installed between the switch and the fan/light combo which electrically separates the light from the fan. Time or fan delay switches are ideal to clear the bathroom area of moisture during high use periods.

Electronic Timers

There are several types of electronic "smart" timers available. One type of multi-button control available through EFI, Inc. operates a fan at specific intervals between 10 and 60 minutes including one button to cancel or shut the fan off. A 24-hour programmable control, also available through EFI, Inc., permits on/off scheduling in 30 minute intervals throughout the day and features a large display that indicates the time and day. The Intermatic Digital Timer features a programmable timer with a digital clock and LED read-out. It has four separate programming options for days of the week and up to 42 settings. As is usually the case with many so-called smart controls, the big drawback is the degree of interaction required by the occupant to program them and resulting call backs to the agency. Therefore, they may not be an advisable option for weatherization clients.

Variable Speed controls

There are many different types of speed controls available to fine tune a ventilation system. Speed control has the advantage of derating a large fan to meet a specific flow requirement or boost its capacity to deal with periodic higher moisture loads. However, a word of caution is needed. Not all speed controls are compatible with all fans and manufacturers. If you desire speed control, check with the fan manufacturer or supplier to identify which speed controls are compatible. Failure to follow manufacturer guidelines on speed controllers may result in failure of the fan motor or shorten the life span of the control itself. Never install a standard light dimmer to control a fan motor.

Tamarack Technologies, Inc. offers two microprocessor-based time and speed controls, called the Airetrak and Airetrak-CD. These controls offer up to 16 selectable fan speeds, which adjust the fan capacity from 40 to 100% and can operate the fan in five minute increments during a 12 or 24-hour period. These switches are often used to control a bathroom fan when used as a whole house ventilation system. Tamarack maintains that their Airetrak is the only variable speed fan that is compatible with the Panasonic Whisperfit or Whisper Ceiling fan lines. We have found that these controls are very simple to set and operate but are on the expensive side with an MSRP of $141.

Summary

Weatherization practitioners are faced with many day-to-day challenges to provide increased safety, comfort, and energy efficiency for their clients. Indoor air quality and moisture are just some of the many issues that are supplementary to the primary program goal of energy efficiency.

Although a fairly rare occurrence, there are situations when a combination of house tightness, high occupancy, and high moisture load may require that an agency provide mechanical ventilation where none exists. Equipment and labor costs are a primary consideration in the choice of a system. Assuming that there is no dedicated electric circuit, roof penetration, or existing ductwork, a complete system can cost between $300 and $600. At the very least, weatherization providers should assure that:

- Existing exhaust fans, dryers, and combustion equipment are working properly and are vented to the outside.
- Moisture sources are removed to the greatest extent possible.
- Field technicians are careful about air sealing homes with existing moisture problems.
- Clients are aware of the impact of moisture producing devices in their homes.
- Clients understand how to use their home ventilation system correctly.

To be successful in incorporating mechanical ventilation into a home, a properly sized fan and control and good ductwork design are important to success.

Equipment Suppliers

ENERGY FEDERATION, INC. (EFI)
40 Washington Street, Suite 3000
Westborough, MA 01581-1013
(800) 76-0660
www.efi.org/wholesale

TAMARACK TECHNOLOGIES, INC.
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PANASONIC HOME & COMMERCIAL PRODUCTS CO.
One Panasonic Way 4A-4
Secaucus, NJ 07094
(201) 348-7231
www.panasonic.com

Publications

MOISTURE CONTROL HANDBOOK
Lstiburek, J .W. and Carmody, J
www.buildingscience.com

UNDERSTANDING VENTILATION SYSTEMS
Bower, J.
The Healthy House Institute
www.buildingscience.com