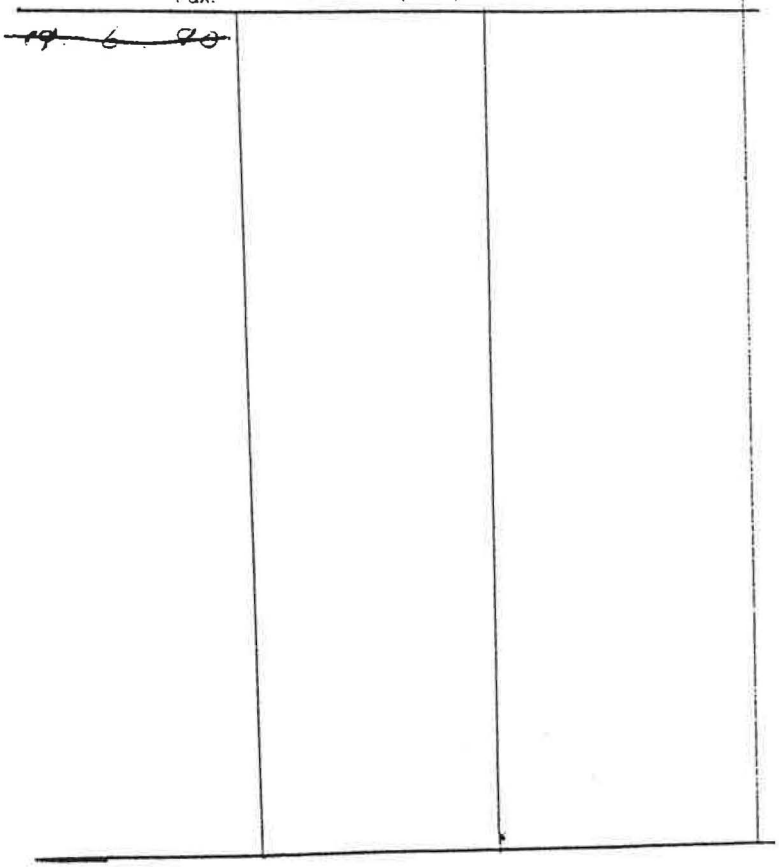
Guide to Residential Exhaust Systems

Air Infiltration and Ventilation Centre
University of Warwick Science Park
Barclays Venture Centre
Sir William Lyons Road
Coventry CV4 7EZ
Great Britain
Telephone: (0203) 692050
Telex: 312401
Fax: (0203) 410156



Cette publication est aussi disponible en français sous le titre *Guide de la ventilation d'extraction dans les habitations* (LNH 6115)

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Contents

Builders Take Note

The effectiveness of residential mechanical exhaust equipment has become of growing importance to Canadian builders. Changes in building code requirements and in house construction, as well as growing concern about indoor air quality and structural damage from excess humidity require greater knowledge of exhaust systems on the part of builders. They must understand the basic requirements of a good exhaust system configuration so that it will work as intended, and make sure that the subtrades use and install exhaust system components that will meet the basic requirements of good practice.

What Is an Exhaust System?

An exhaust system is designed to convey air from inside a house to the outdoors. It consists of a fan, interconnecting ductwork, and a termination device.

The purpose of exhaust systems is:

- to remove air contaminants at their source
- to control humidity.

This guide provides builders with basic but important information on how to select and install effective residential exhaust systems for kitchen range hoods and bathrooms that will ensure that contaminants are removed from the air, humidity is controlled, and all applicable codes and regulations are met.

The information is based on the results of recent field tests of residential exhaust fans and systems across Canada, and laboratory tests of exhaust system components. These tests were made to determine installation practices, and component and system performance, and to compare these to manufacturers' catalogue information.

The field survey, conducted by Heating, Refrigeration and Air Conditioning Institute (HRAI) contractors in 1988, looked at the fan systems installed by 20 different builders across the country. The research report based on the field survey, *Residential Exhaust Equipment,* is available from:

Canadian Housing Information Centre,
Canada Mortgage and Housing Corporation
682 Montreal Road
Ottawa, Ontario
K1A 0P7

How to Install Exhaust Systems Properly

Exhaust System Requirements

The exhaust fan for a typical bathroom should exhaust 20–25 L/s (40–50 cfm).

The exhaust fan for a typical range hood should exhaust 75–100 L/s (150–200 cfm).

To obtain these airflows, builders must:

- use an exhaust fan that has an adequate capacity, certified by an appropriate testing agency
- use proper ducting components
- ensure proper installation.

System Design

Builders must consider the following points when asking the installing subcontractor to design an appropriate exhaust system :

- the quantity of air to be exhausted by the fan (one factor in the sizing of the exhaust duct)
- the location of the exhaust fan, and the location at which air is to be discharged outside the house (the second factor in the sizing of the exhaust duct)
- the quality of fan desired — the noise level and appearance, for example (see Noise Level)
- any special control requirements (see Controls)
- the type of termination device or hood to be used (see Terminations).

When installing systems with flow rates greater than 75 L/s in houses with tight construction and naturally aspirated heating appliances, builders should confer with the heating contractor to make sure that the venting of the heating appliance will not be affected.

How Exhaust Systems Are Now Being Installed

Field Survey Results

The field study found that many subtrades are involved in the installation of residential exhaust systems. For instance, the fan or range hood is often installed by an electrician; the duct to the outside by either a sheet metal mechanic or an electrician; the insulation of the duct, where it passes through unheated spaces, by the insulating contractor; and the termination device by a roofer or bricklayer.

Even a properly designed exhaust system may not work unless the builder carefully coordinates all these trades. An alternative is to make one subtrade responsible for the installation of the entire system.

The field study found that only one range hood installation out of the 20 tested exhausted the amount of air for which the fan was rated. Most operated in the range of 15-50 percent of rated flow. None of the 26 bathroom exhaust systems tested exhausted at their manufacturer's rated flow, and most operated at 20-60 percent of their rated flow.

Why didn't they work?

- Ducts were too small and too long.
- Fans lacked sufficient capacity.
- Too many elbows were installed.
- Flexible ducts with too many bends were used.
- Inappropriate termination devices were used.
- There was little or no system design.
- Manufacturers' installation instructions were not followed.

Selecting Equipment

Fans

Two types of fans are commonly used in kitchen range hoods and bathroom exhaust fans: the axial flow (or propeller) type and the centrifugal (or squirrel cage) type (fig. 1). Squirrel cage fan designs are more expensive, because of their more complicated blower wheel, but they are more efficient, that is, they deliver more airflow against a higher pressure.

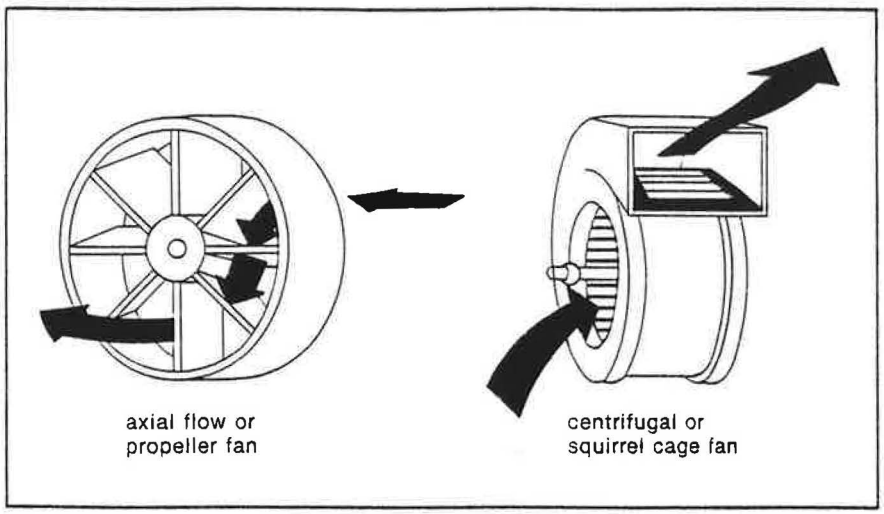

Fig. 1 Fan types.

As a duct system becomes more restricted because of increased length, the use of several elbows, the use of flexible duct, or all of the above, the air delivered by the propeller fan falls off drastically.

Though propeller fans cost less, they often require larger ducts to deliver the same amount of air. In many cases, the cost of the larger duct system may offset the extra cost of a squirrel cage fan.

In general, low-cost fans may perform poorly unless the designer of the exhaust system recognizes the limitations of the fan, and designs the duct system accordingly.

Higher-quality fans, especially of the squirrel cage design, are more tolerant of poor system design.

Laboratory tests found that higher-quality fans generally deliver their rated air flow capacity.

Noise

Exhaust fans will remove indoor air contaminants only if the homeowner turns them on. If fans are too noisy, homeowners will not use them. Wherever possible, quiet operating fans should be selected.

Many exhaust fans have sound ratings certified by the Home Ventilating Institute (HVI). In the near future, all fans sold in Canada will have to have sound ratings certified by CSA.

The HVI certified ratings are in a unit of measurement called the sone. Better-quality bathroom fans are rated at 1-3 sones, and range hoods at 4-6 sones.

Range Hoods

Multiple fan speeds
Range hoods with two-speed fans, or variable speed fans, allow the user to select a speed that will exhaust an adequate quantity of air for various purposes. Light cooking, for example, would require the lower level and would consequently generate less noise.

Hood height above range
Do not locate range hoods more than 750 mm (30 inches) above the range surface. A recent study found that 450 mm (18 inches) is the best height at which the range hood captures cooking vapours, without interfering with the view of the range top.

Range hood depth
Research has also shown that range hoods 600 mm (24 inches) deep will capture cooking vapours more effectively than shallower hoods (fig. 2).

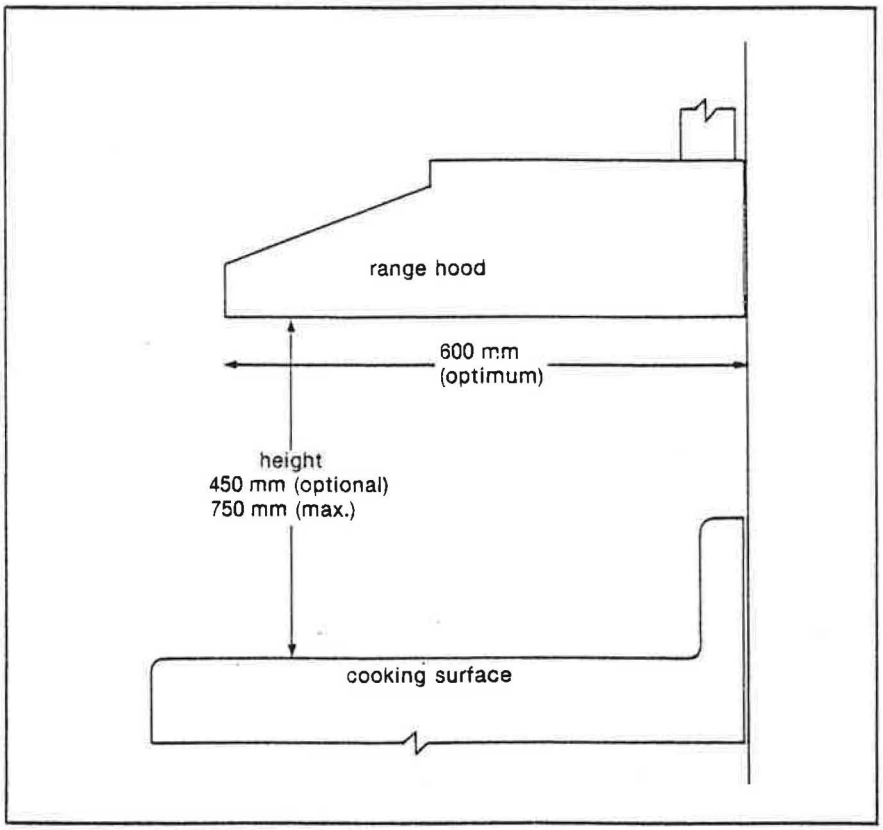

Fig. 2 Optimum dimensions for range hoods.

Don't use flexible ducts
Do not connect range hoods to plastic flexible ducts. Grease accumulates in the duct, and this, together with the flammability of the duct material, creates a dangerous situation.

Terminations

Wall termination devices
The three most common wall termination devices are: 1) hoods with a single blade gravity-operated backdraft damper, 2) hoods with a single spring-assisted damper, and 3) a multi-blade gravity-operated damper. See fig. 3 for various types. Laboratory tests of devices that terminate through the wall show that, at typical flow rates for bathroom exhaust fans and for appropriate sizes of terminations, the performance of all three types was approximately the same. Kitchen fans with higher flow rates need the manufacturer's specified termination.

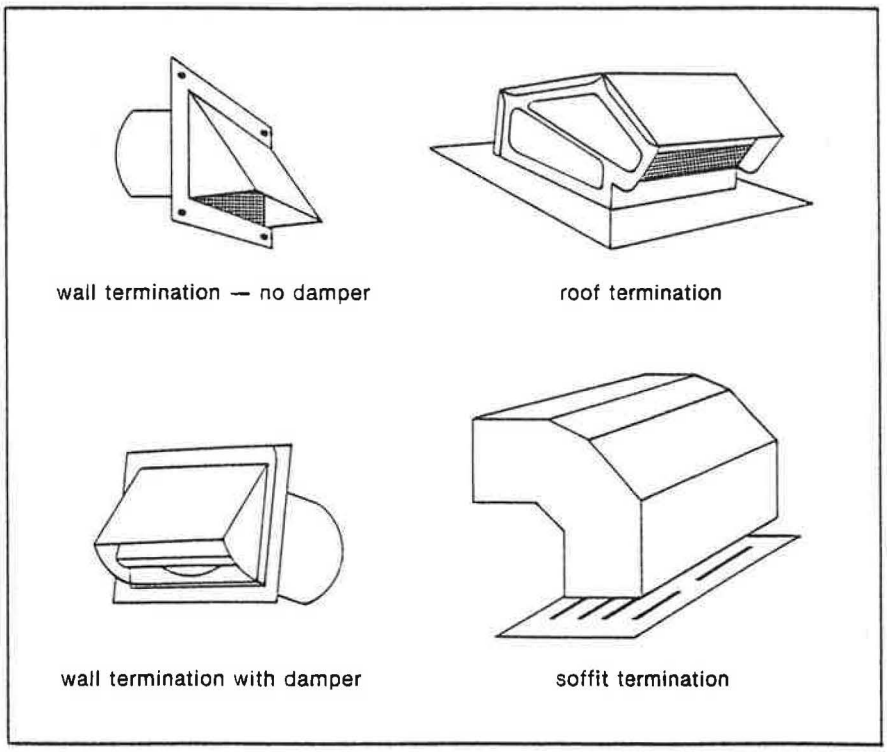

Fig. 3 Various types of exhaust terminations.

Roof termination devices
Devices that terminate through the roof are designed to prevent the entry of rain and snow, and to provide a weathertight seal on the roof.

Soffit termination
Devices that terminate through the soffit are common in some parts of the country. This may not be suitable in colder climates because of the potential problem of ice build-up in the form of icicles.

Often the termination of an exhaust duct at the soffit is not done with a proper soffit fitting, but is terminated over or near a soffit vent opening. This contravenes the National Building Code, which requires that exhaust systems discharge directly to the outdoors.

Controls

Bathroom

There are four common control configurations used with bathroom exhaust fans (combinations of these basic four may also be used):

1. The most common control has a separate manual switch. This gives occupants independent control of the fan, which means they can reduce humidity levels after a bath or shower simply by turning on the fan as needed.
2. A variation of the manual switch that adds considerable convenience is the manual timer switch. This allows the fan to operate, then automatically shut-off after moisture and odours have been removed.
3. A bathroom fan can also be connected to the bathroom light switch, which means the fan operates when the light goes on. However, if the light is left on, the fan will continue to operate.
4. A humidistat may also be used to control a bathroom fan. This control is useful in houses where excess moisture may be a problem.

Ducting and Installation

Ductwork

Install range hoods in accordance with the manufacturer's instructions. These instructions generally require the use of an 85 × 250 mm (3.25 × 10 in) rectangular duct, a 175 mm (7 in) round rigid metal duct, or a 200 mm (8 in) flexible duct. Range hoods should never be installed with smaller ducts. See fig. 4 for a comparison of rigid and flexible ducts.

Always install bathroom fans with ducts of 100 mm (4 in) diameter or larger. If there are more than two elbows and 1500 mm (5 ft) of straight duct, use a 125 mm (5 in) metal duct.

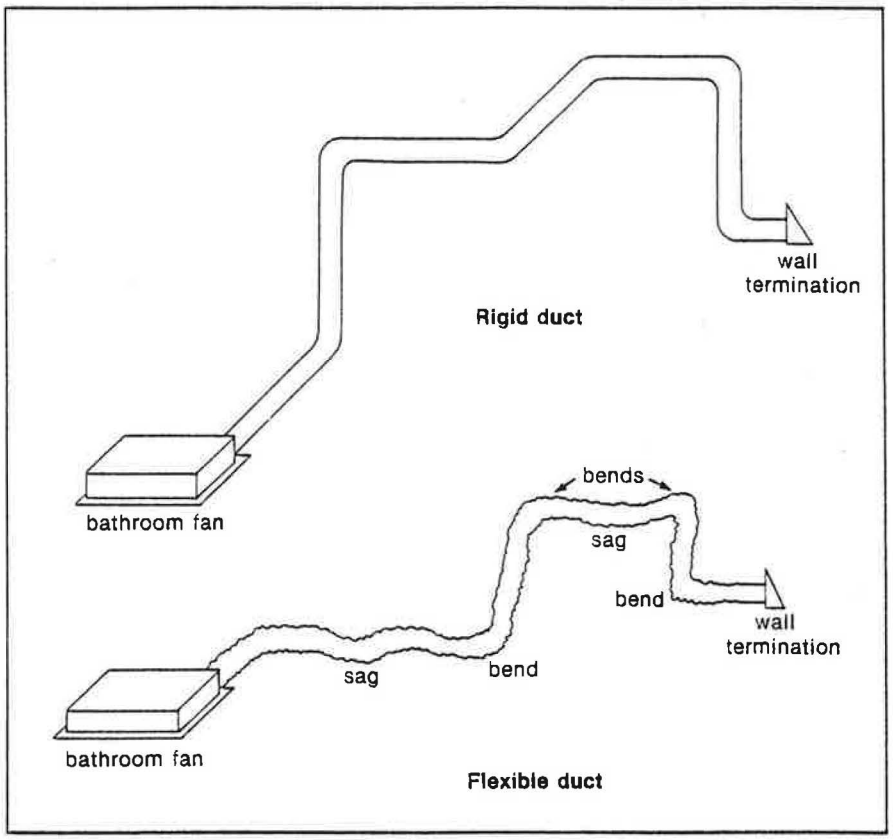

Fig. 4 Comparison of rigid and flexible duct configurations. In laboratory tests, the substitution of flexible duct caused a 30 percent reduction in flow.

Flexible ducts — a caution

Flexible ducts cause greater resistance to air flow than metal ducts because they are not smooth inside. When improperly installed, with many sags, or bends that are too sharp, the air flow through flexible ducts may be reduced by a further 15 percent.

If you use flexible duct for a bathroom fan, increase the duct diameter by 25 mm (1 inch). Do not use flexible ducts for range hoods, except to isolate vibration between the fan and the duct system; in this case, use a short length of metal flex duct.

Insulation

Isolate ducts that pass through unheated spaces to ensure that condensation does not form within the duct. This is a requirement of the National Building Code and some provincial codes.

In regions where the amount of insulation is not specified, the recommendations in table 1 should be followed:

Table 1. Recommended Levels of Insulation

Outside Design Temperature Degrees C	Recommended Thermal Resistance of Insulation	
	RSI	R
− 7 to −11	0.5	3
−12 to −17	0.9	5
−18 to −24	1.2	7
−25 to −29	1.4	8
−30 to −34	1.8	10
−35 or colder	2.1	12

Duct Leakage

Leakage can be a problem if it occurs in an uninsulated space or a cold interior space. It can produce condensation and possibly lead to structural damage. Laboratory research shows that when round metal exhaust ducts are not taped, up to 25 percent of the air delivered by the exhaust fan will leak out before it exits the house. Elbows are especially susceptible to leakage. Systems with rectangular and flexible ducts have less leakage, hence duct taping may not be required, except at the ends of the flexible duct.

Configuration

Duct runs should be as straight as possible to maximize air flow. In the field survey, as many as five elbows in one exhaust duct and actual duct lengths of up to 9 m (30 ft), were observed, with consequent low exhaust airflows.

Future Trends

Research has shown that houses being built to the latest code requirements have less natural infiltration, and so are more likely to experience indoor air quality and moisture problems. Since poor ventilation is difficult to detect unless accompanied by excess humidity, the use of the intermittent exhaust devices described in this guide may not provide adequate protection to homeowners.

Though there will likely always be a need for exhaust fans at specific pollution sources (ranges, bathrooms), builders may have to provide more thoroughly designed systems in future, in accordance with CSA Standard F326, Residential Ventilation Requirements. If builders understand the components of ventilation systems (fans, ducting, terminations, controls, and so on) they will be able to cope with the more sophisticated systems.

The trend to more stringent building code enforcement means that builders will have to make sure that the exhaust systems they install actually exhaust the quantity of air required by the code. This is already becoming apparent in British Columbia, where the 1985 National Building Code was adopted in 1987.

The growing public awareness and concern about ventilation issues means that builders are more likely to be held liable if exhaust systems do not meet code requirements.

Houses that are better insulated and sealed have lower background noise levels. Quiet exhaust fans should therefore be selected to prevent complaints from consumers about undue noise.

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