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CMHC GUIDE TO VENTILATION SYSTEMS

CONSUMER SERIES

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CONSUMERS SERIES

PREPARED BY

UNIES Ltd.

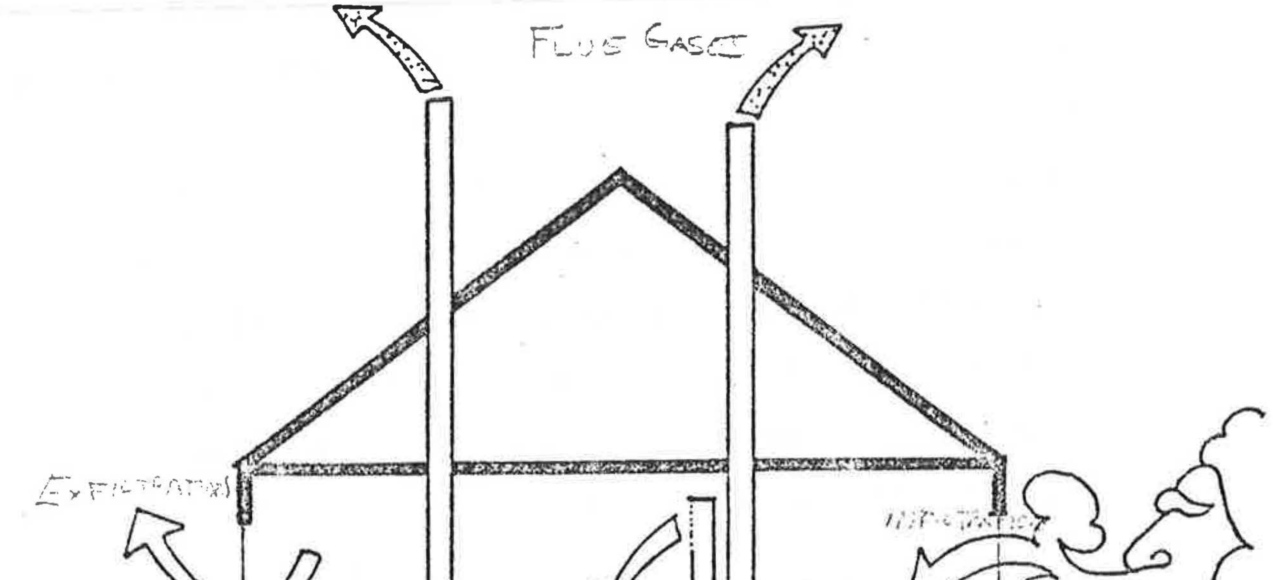
MARCH 1988

TABLE OF CONTENTS

VENTILATION

There's been a change in the way houses are built and operated in Canada in recent years. Thanks to the energy crisis of the 1970s, Canadians have become much more conscious about heating and utility bills, and have taken steps to improve the energy efficiency of their homes. In many cases, that meant upgrading insulation levels and sealing and caulking their homes to reduce air leakage. In new houses, extensive measures are now taken while the house is being built to reduce the amount of potential air leakage. While tightening the home can reduce energy costs, there is an unexpected side effect--the amount of fresh air that can enter the house is drastically reduced.

Without this ventilation--the replacement of stale air inside the house with fresh air from outdoors--all the pollutants produced inside the house are trapped there. And there are a considerable number of potential indoor air pollutants whose effects can be toxic to the occupants, structurally damaging to the house, or just bothersome. But all have ramifications. Since you spend up to 90 percent of your time indoors, it's important that these pollutants be exhausted from the house; in other words, you must now provide increased ventilation, especially in winter when doors and windows are opened infrequently. If you live in an area where the outdoor air is not suitable for ventilation, you must consider various air treatment methods to maintain the quality of indoor air. Ventilation, as discussed in this manual, is not useful for you



SOURCES OF VENTILATION AIR

PAGE 1
"VENTILATION

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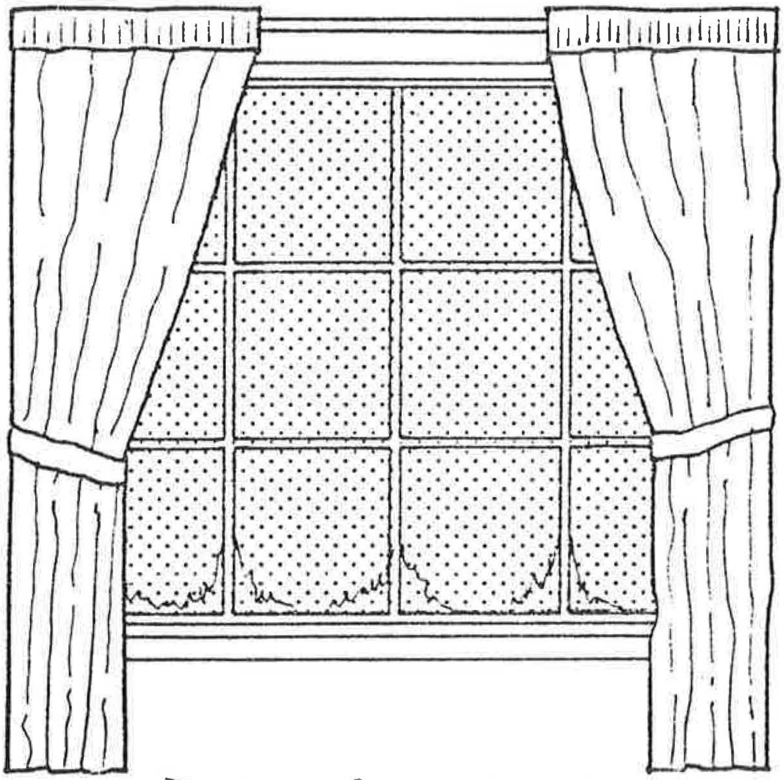
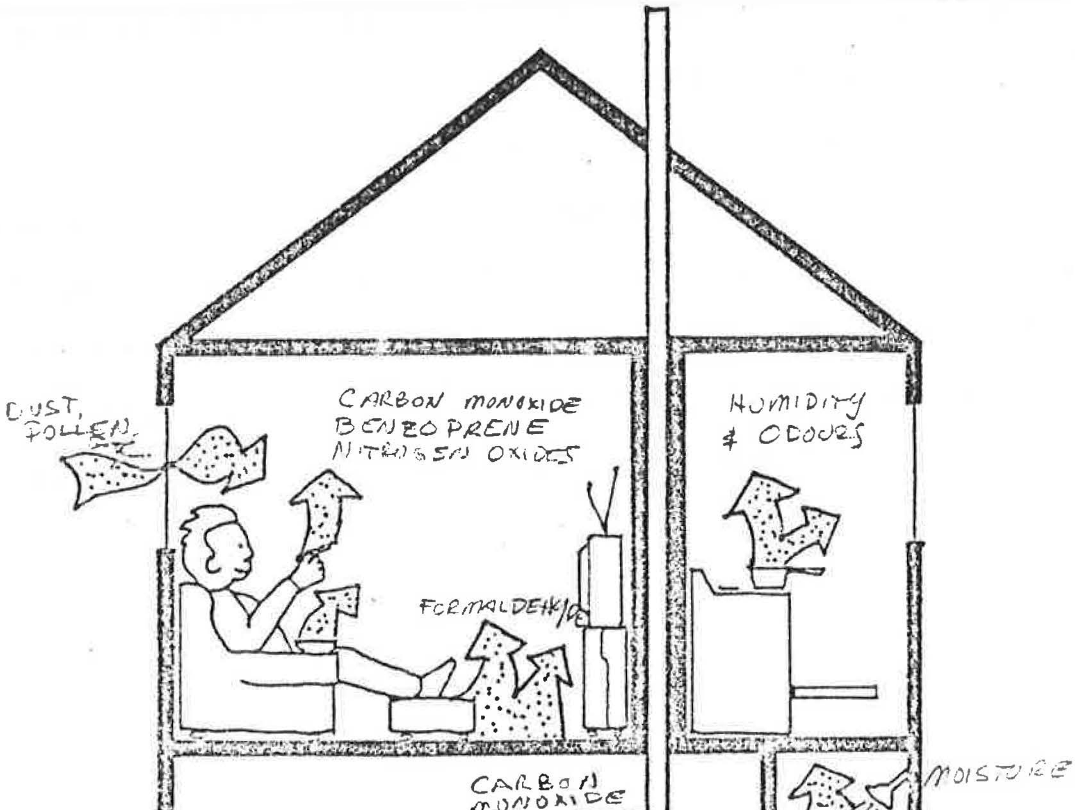


FROST & CONDENSATION ON WINDOWS IS ONE OBVIOUS INDICATOR OF INADEQUATE VENTILATION

VENTILATION PROBLEM INDICATORS

It's in winter that the signs of poor ventilation show up. Symptoms of inadequate ventilation include: frost or condensation on windows, damp spots or mildew on walls or ceilings, damp spots or mildew in closets, paint peeling from exterior walls, lingering odors, high incidence of allergies or flu-like symptoms, burning eyes, headaches, and nausea.

If any of these indicators appear in your house, steps should be taken to improve indoor air quality through increased ventilation. This manual will help you understand more about ventilation and ventilation systems. But first, we must understand what types of pollutants can be found in the average house.



CONTAMINANT SOURCES

Part I

INDOOR AIR POLLUTANTS

The contaminants inside our houses may be divided into three broad categories: Moisture, Chemical, and Odors. It's important to understand the potential effects of each.

Moisture:

Although it may seem harmless, moisture is one of the more serious of indoor air contaminants because of its potential effects both on occupant health and the structure itself. Normal household activities produce a considerable amount of moisture. Cooking, washing, bathing and even breathing put water vapour into the air. In addition, large amounts of moisture may also come through basement walls and floors, and from construction materials--especially in new houses. Drying firewood indoors can also generate a great deal of moisture.

Building components and furnishings in the house absorb moisture during periods of high relative humidity and release moisture to the air during periods of low relative humidity. (Notice that wood furnishings often develop cracks in winter when relative humidity is low, but the cracks close up in summer when relative humidities rise.) During warm, humid weather, the house and its furnishings may absorb half a tonne or more of moisture from the air. If the weather suddenly turns cold, the absorbed moisture will be re-released into household air, keeping relative humidity levels higher than normal and possibly creating severe condensation problems. If the warm fall weather suddenly turns cold, you may notice excessive condensation on windows.

In any given day, more than 20 litres of moisture can be put into the air inside the house. If this moisture can't escape--if ventilation rates aren't high enough--there are several possible results.

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RELATIVE HUMIDITY AND DEW POINT

The maximum amount of water vapour which can be suspended in the air depends on its temperature--the lower the temperature, the smaller the amount of water vapour that the air can hold. The ratio of the actual amount of water vapour in the air to the total amount it can hold is referred to as the relative humidity. If the amount of water vapour in the air remains constant as the temperature drops, the relative humidity will increase. When air is cooled to the temperature at which it contains all the water vapour it can hold, the relative humidity becomes 100 per cent. The temperature at which the relative humidity becomes 100 per cent is known as the Dew Point temperature. Any further decrease in temperature will force some of the vapour to condense as water when the temperature is above freezing, or as frost when the temperature is below freezing. At normal atmospheric temperatures (-40 C to +40 C) the moisture carrying capacity of air approximately doubles (halves) with each 8 degree to 10 degree C rise (fall) in temperature.

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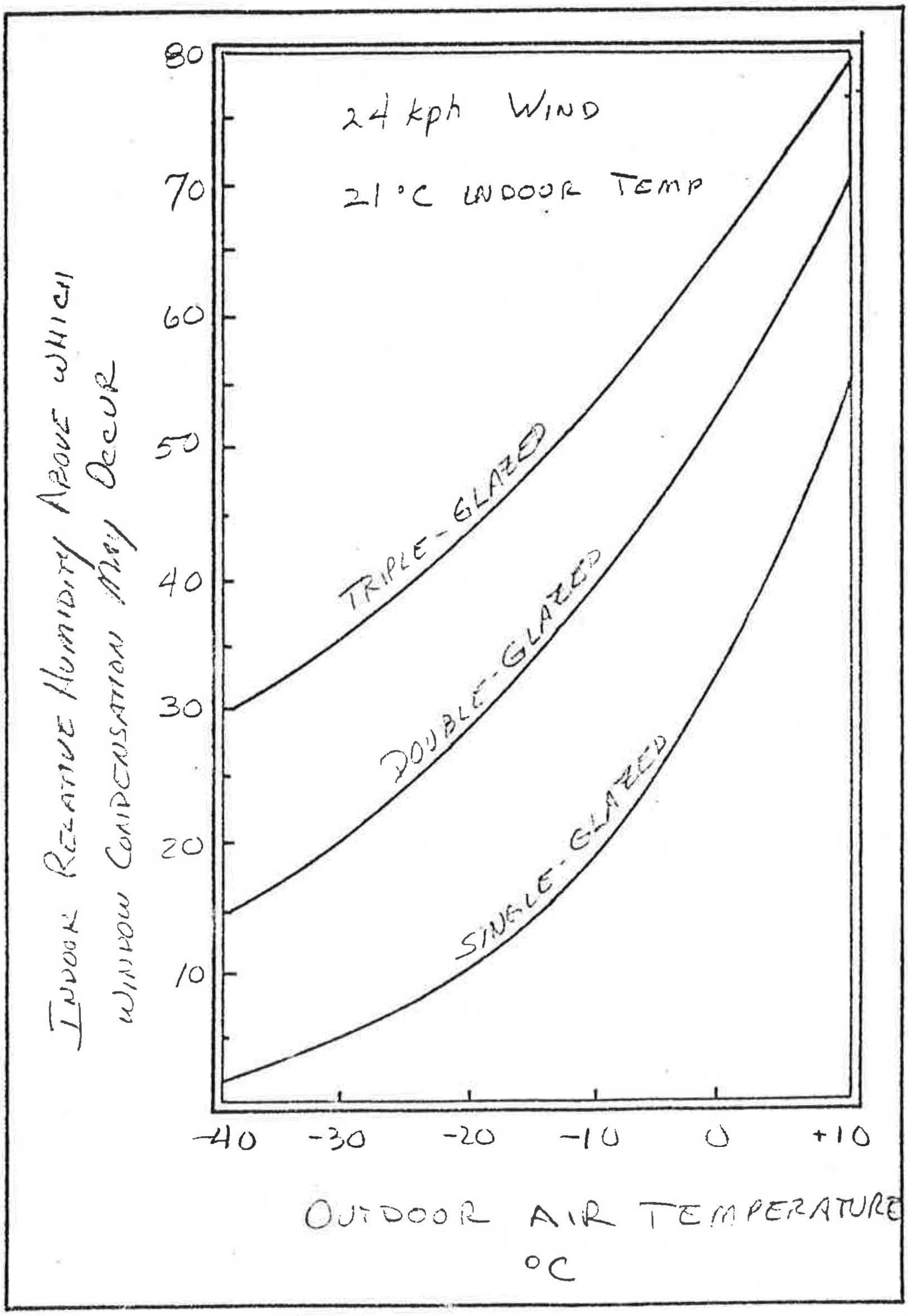


TOP PARAGRAGH
PAGE 6

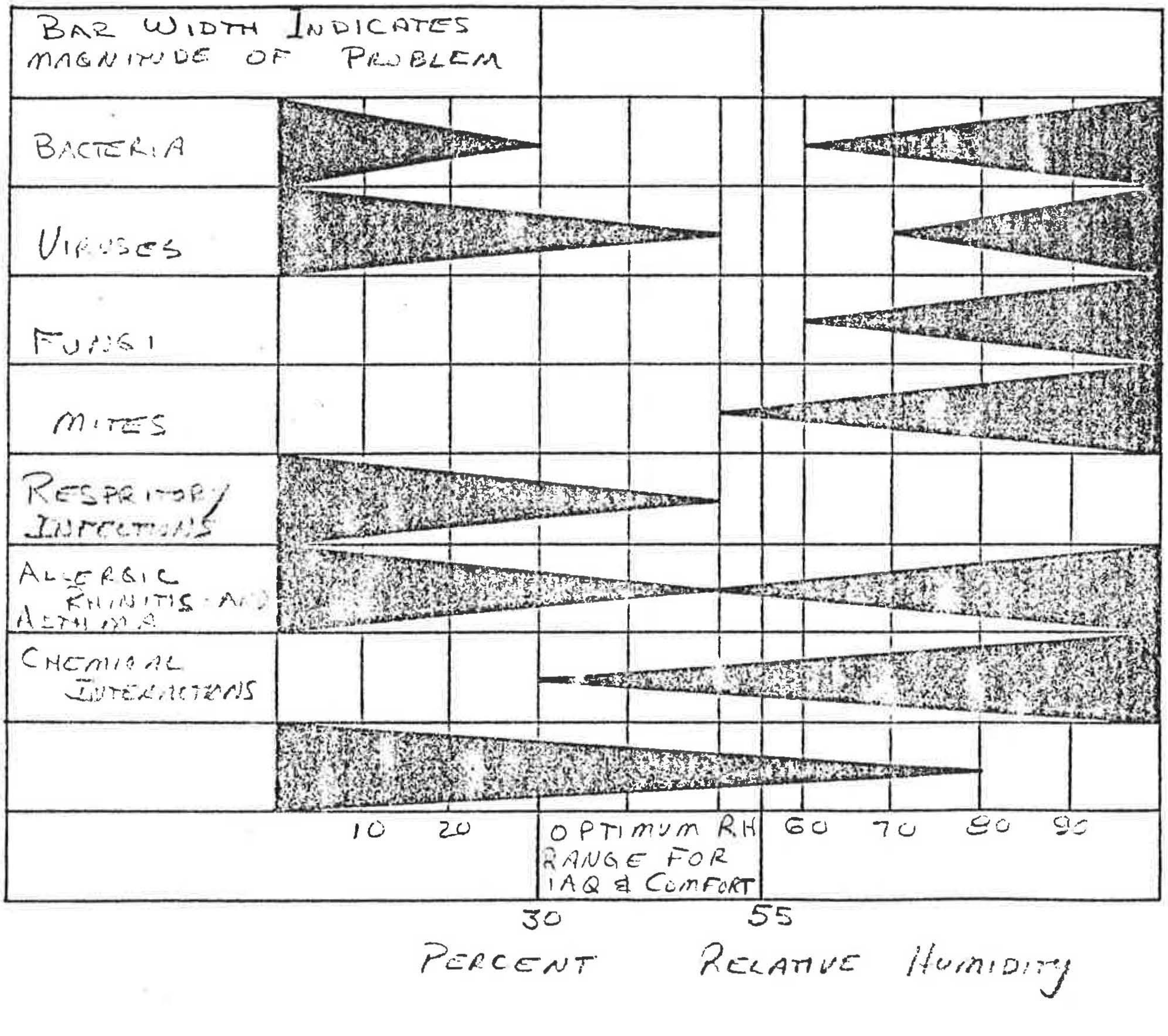
PART I "INDOOR AIR POLLUTANTS - MOISTURE"

When warm air with a high relative humidity comes in contact with a cold surface, some of that air will be cooled to its dew point and some water vapour will condense onto the cold surface. On a cold winter day, relative humidity levels above about 35 per cent will cause condensation on typical triple-glazed windows (windows are much cooler than other surfaces in the house). This is surface condensation, and can cause staining of window casings, walls and drapes.

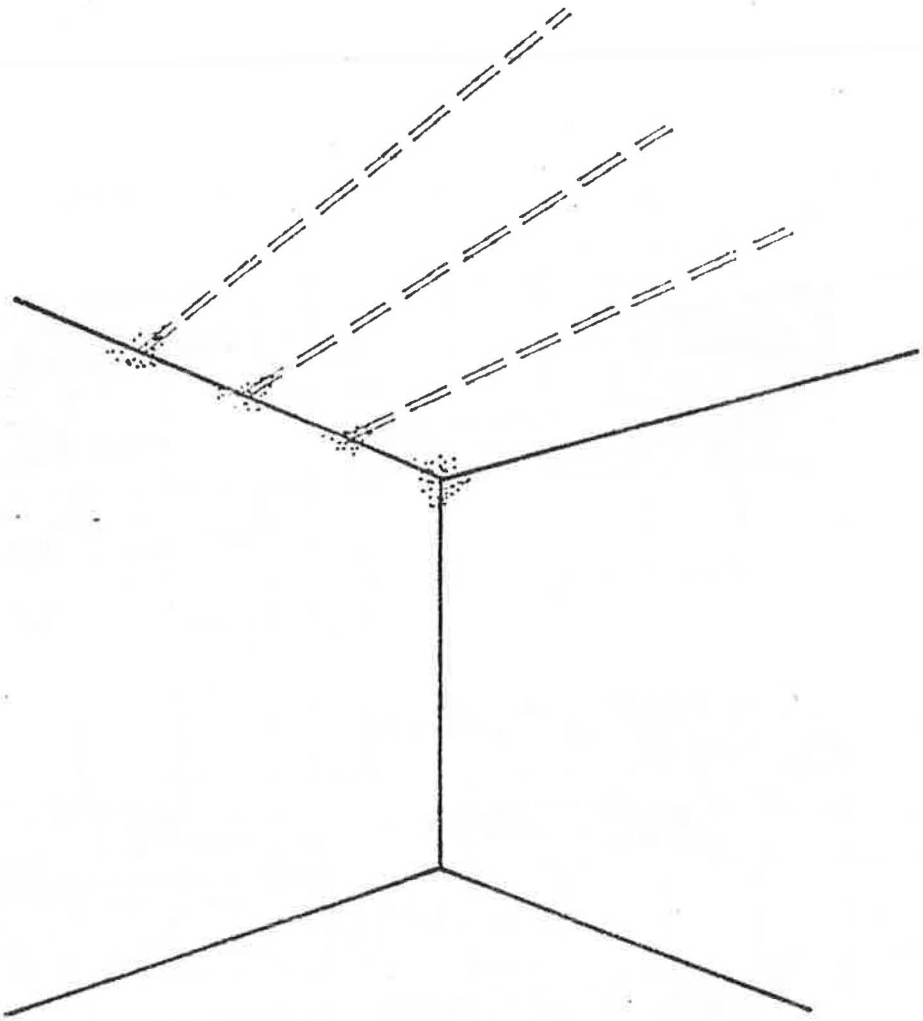
If water vapour leaks into exterior walls or attics and condenses, it is called concealed condensation, and it can eventually cause serious structural damage to the house. Signs of concealed condensation include: an apparently leaky roof; paint peeling from exterior wood siding; efflorescence (salt stains) on upper floor exterior walls of brick houses; damp spots on interior walls and ceilings; plaster damage; damp spots around light fixtures or water collecting in light fixtures.

High relative humidity levels can also promote mold and mildew growths on walls and in closets. Mold and mildew can produce allergic reactions and respiratory diseases in some people. Health and Welfare Canada recommends indoor relative humidity levels should be kept in the 30-55 per cent range for comfort and health.

It might seem logical to use a dehumidifier to control winter humidity and prevent condensation, since this would reduce the need for ventilation. Even the energy used to run the dehumidifier would end up as heat in the house, thus reducing



PARAGRAPH 3 PAGE 6
PART I "INDOOR AIR POLLUTANTS – MOISTURE"

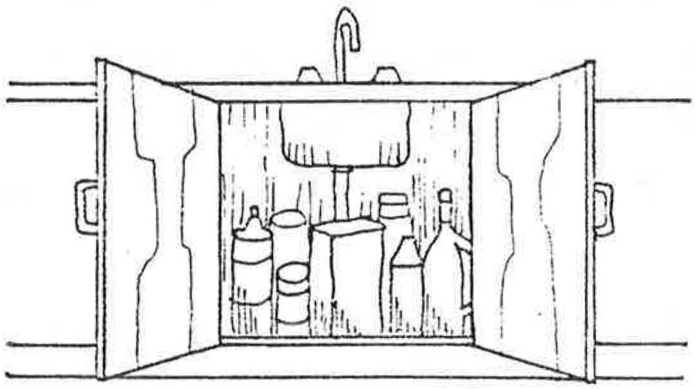


MOLD AND MILDEW GROWTH OFTEN OCCURS IN "COLD" CORNERS WHEN R.H. IS TOO HIGH.

other heating costs. Unfortunately, the dehumidifiers currently available for household use are designed only for summer conditions. The amount of water vapour they can condense out of the air is very small once the relative humidity goes below 60 per cent--which is still much too high to prevent condensation problems in winter.

If there are signs of surface condensation, it means that ventilation rates should be increased or moisture-producing activities should be reduced or steps taken to reduce cold surfaces (e.g. upgrade windows). The CMHC publication, "Moisture and Air, Problems and Remedies," discusses the signs, causes and practical solutions to moisture problems in the home.

Conversely, occupants of some homes may experience health problems when relative humidity levels are too low. This typically occurs in winter in homes with high leakage rates--cold air holds less moisture than warm air, and when cold air enters the house and is warmed, indoor relative humidities reduced; air escaping from the house takes its moisture with it. When humidity levels are low, occupants can develop "scratchy" throats, and the incidence of viral infections may increase. In these cases, some humidification may be required, but homeowners should be aware that humidifiers must be cleaned once a week to avoid the growth of baceteria in the water tank.



MANY HOUSEHOLD PRODUCTS
ARE CHEMICAL POLLUTANTS

PAGE 8
"CHEMICALS"

Chemicals:

There are literally hundreds of chemicals present in the air in most homes. Their number and their concentration depend on a variety of factors. The age of the house is important, because newer homes are built with materials which contain a number of different chemical compounds; typically their concentration will drop as the house ages. Chemical compounds are also released by furnishings, such as carpets and other floor coverings. The airtightness of the home also has a significant effect. The type and effectiveness of the heating system also play a role--homes with electric baseboard heaters or radiant heating have lower air flows, so concentrations of chemical compounds can build up in specific areas of the house. Occupant activities, outdoor temperatures and wind speed also play a role.

Many chemical air contaminants are odorless and colorless and are not easily detectable, but they may still pose a health hazard. In many homes, cigarette smoke is the most significant source of chemical air contamination. Cleaning compounds, paints and hobby supplies also add to chemical contamination. Unvented natural gas appliances, such as ranges, can also be a significant source of indoor air pollution.

The impact of chemical pollutants on occupants will depend on the concentration of the various contaminants, the general health and sensitivity of the individual to the contaminant, and the effect of the combination of the chemicals. Health impacts may range from short-term allergic reactions to long-term health problems. Generally, the symptoms are most pronounced in the very young and the elderly, who spend a great deal of time indoors, or in allergic or sickly residents.

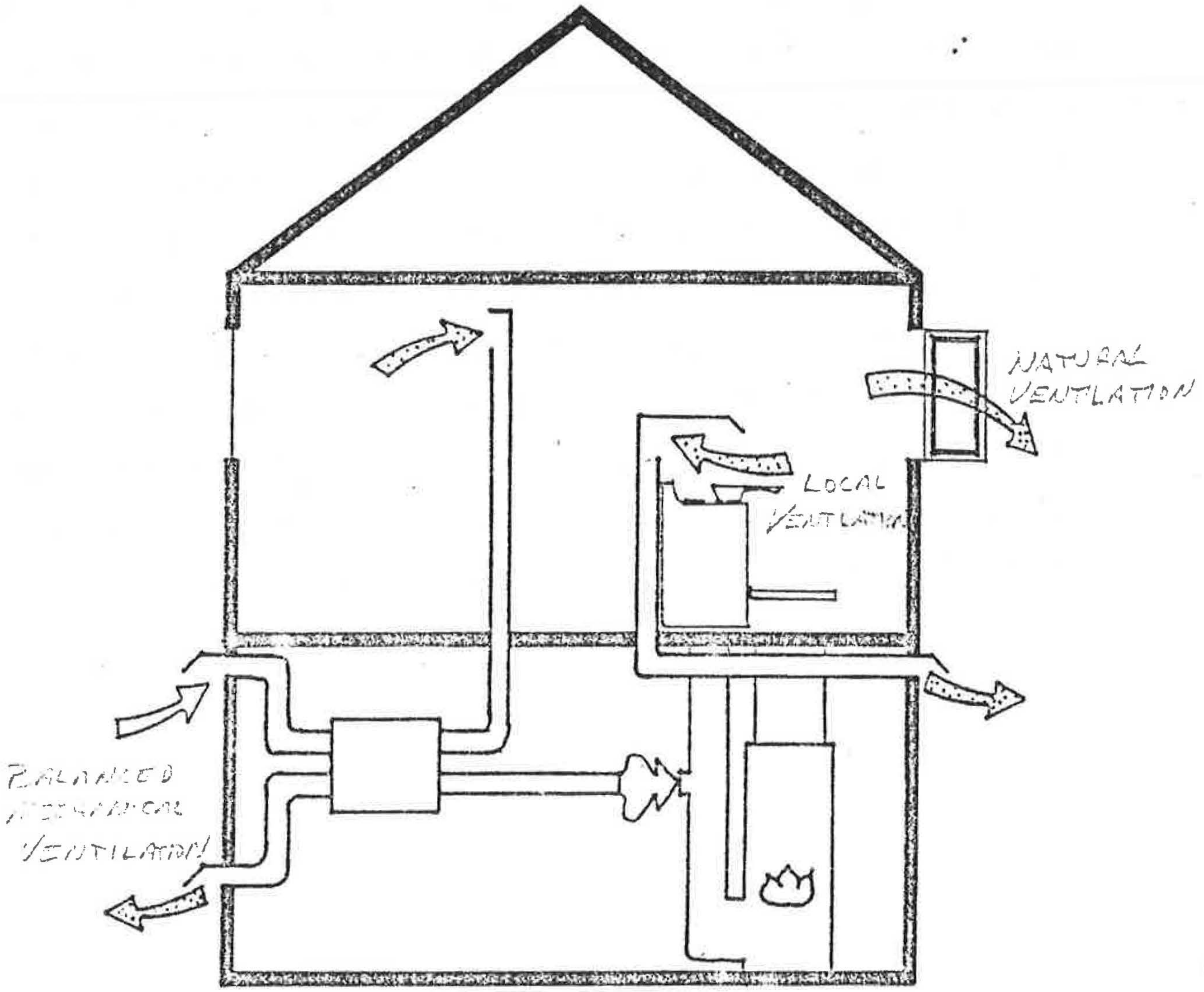
Severe short-term problems are indicated by excessive coughing, dizziness, eye, nose and throat irritations, headaches or nausea. Long-term concerns include respiratory system damage and cancers.

If you wish further information on this topic, refer to CMHC's publication "Air Quality in the Home".

Odors:

These are the most noticeable of indoor air contaminants. Odors are produced by cooking, pets, people, and household activities. Many odors, though offensive, are harmless. If odors linger long after the source has been removed--for example, cooking odors--household ventilation is probably not adequate. A properly operating ventilation system will freshen up the kitchen and house within an hour after the meal has been prepared.

The CMHC publication "Air Quality in the Home" more fully discusses the sources and implications of various pollutants found in the home. If you think the air quality in your home is affecting your family's or your health, refer to this booklet so you may better identify the pollutants in your home and determine how best to control them.



INCREASE VENTILATION RATES

PAGE 11 PARA 2

"METHODS OF CONTROLLING CONTAMINANT LEVELS

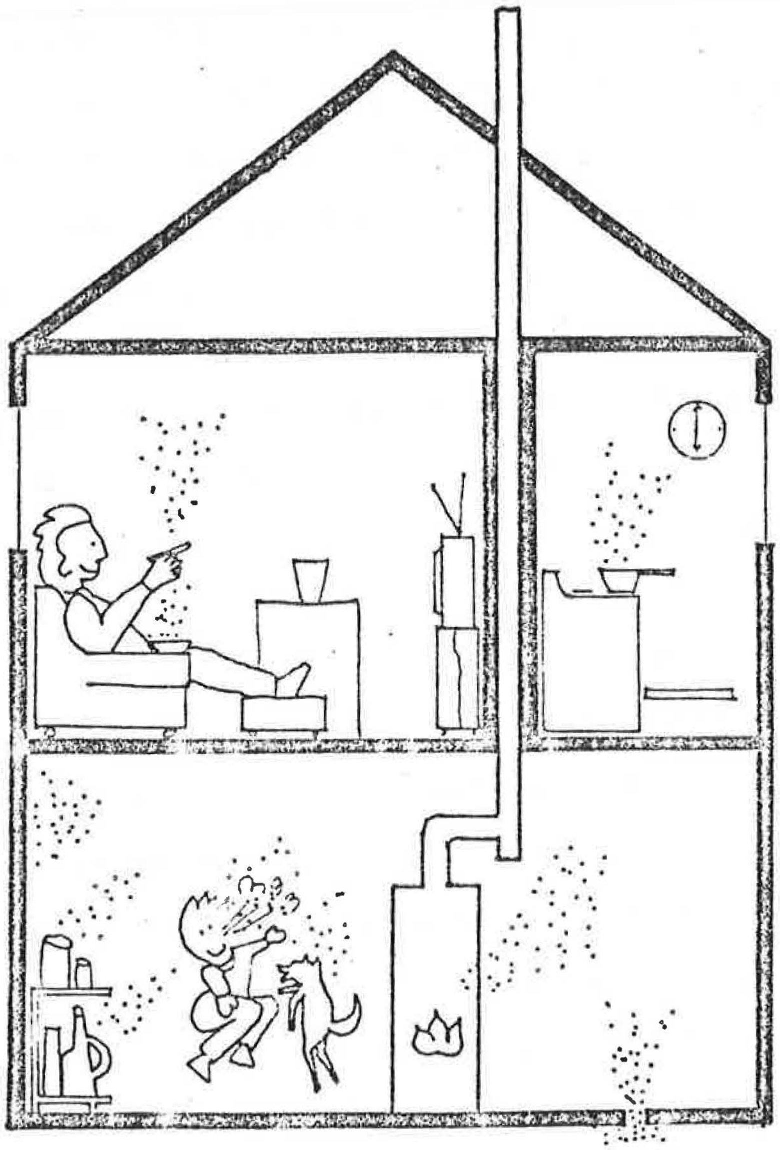
METHODS OF CONTROLLING CONTAMINANT LEVELS

Prior to about 1975, houses were built without much attention paid to air leakage control. In fact, air leakage was often so great that houses were drafty and too dry in winter; indoor air quality could be maintained by natural ventilation or air leakage. However, relying solely on natural ventilation is not enough: occupant comfort is adversely affected because of drafts; heating bills will be higher, "pockets" of pollutants may collect in specific areas of the house, and the homeowner has no control of ventilation rates--on some days there will be too much air entering the house, on other days, not enough. Occupants of older, leaky houses may at times have good indoor air quality, but there's no guarantee. What is more likely, however, is that they are less comfortable in their homes than occupants of homes sealed against air leakage.

Modern construction methods make new houses more resistant to air leakage, and mechanical ventilation systems are used. These have the advantage that they can be controlled--that is, you get the amount of ventilation needed where it's needed, when it's needed, instead of relying on natural forces like wind and temperature. With a properly operated mechanical ventilation system, occupants can be assured the indoor air quality is maintained.

Ventilation isn't the only way of controlling the build-up of contaminants in indoor air. There are some basic and common sense approaches which should be considered, even if the house

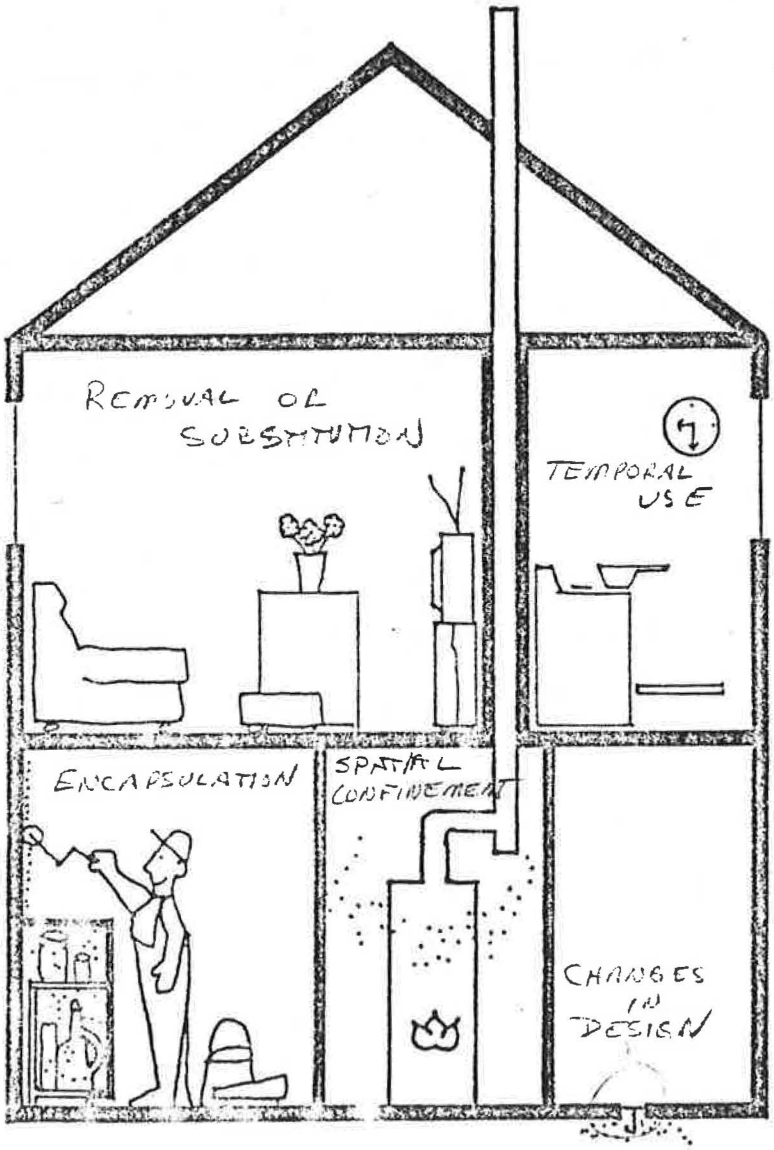
BEFORE



SOURCES OF CONTAMINANTS "BEFORE" - TO BE COUPLED WITH NEXT ILLUSTRATION "AFTER"

PAGE 12 PART 1
"METHODS OF CONTROLLING CONTAMINANT LEVELS"

AFTER



REMOVE, ENCLOSE OR RESTRICT
USE OF SOURCE OF CONTAMINATION

PAGE 12
PART I
"METHODS OF CONTROLLING
CONTAMINANT LEVELS"

has a good mechanical ventilation system. These include:

.Removing the source of the contaminant. Store fuels and solvents outside; store composition or particle board outside; limit chemical-producing hobby activities in winter; avoid redecorating in winter; restrict smoking in the house. If occupants start showing severe allergic reactions, a lifestyle change (such as trading a cat for a goldfish) may be required.

.Substituting the contaminant. Rather than using aerosol waxes, deodorants or hairsprays, use liquid or solid ones; use traditional rather than chemcial cleaning methods.

.Changing the design or operation of the source. Use an electric heater instead of an unvented kerosene space heater; turn off the pilot light of a gas stove when the stove is not in use, or replace the pilot light with an electronic igniter; install a combustion air supply duct for the furnace, domestic hot water heater, fireplace or other combustion device which may be prone to backdrafting.

.Encapsulating or sealing the source. Store hobby supplies which emit pollutants (e.g. glues and paints) in airtight containers when not in use; paint or varnish particle or composition board to slow down the emission of formaldehyde from these products. Put a cover on a pot of water boiling on the stove.

.Confining the source. Build an enclosure around a hobby shop from which airborne contaminants are produced and install an exhaust fan.

.Timing activities. Undertake contaminant-producing tasks when those with sensitivities are away from home (e.g. redecorate the house when the family is away for a weekend or holiday).

.Air treatment or filtration. Remove airborne contaminants with charcoal filters in recirculating range hoods, or install an electronic or electrostatic air cleaner on the furnace. Normal furnace filters remove only the largest 5 per cent of dust particles, and cannot remove smoke or airborne chemicals. Smaller dust particles, chemicals and smoke can be removed by adsorption filters, electronic air cleaners and high efficiency furnace filters. These systems must be maintained (i.e. change media in absorption filters).

WHY MECHANICAL VENTILATION?

While the above methods for controlling or reducing indoor air contaminants have practical applications, they do not maintain acceptable levels of indoor air quality all the time. For this reason, we rely on mechanical ventilation to remove stale, moist and polluted air from the house, and replace it with fresh outdoor air. A basic assumption here is that the outdoor air is not itself polluted, so that when it is mixed with indoor air, it will improve indoor air quality.

You may ask: "Why should I spend a pile of money to make my house airtight, then spend a pile more to install a mechanical ventilation system to achieve what all the air leaks did in the first place? Why not just build a nice, old-fashioned leaky house?"

There are several reasons not to rely on natural ventilation to maintain good indoor air quality. These include comfort, control, energy costs, and building life.

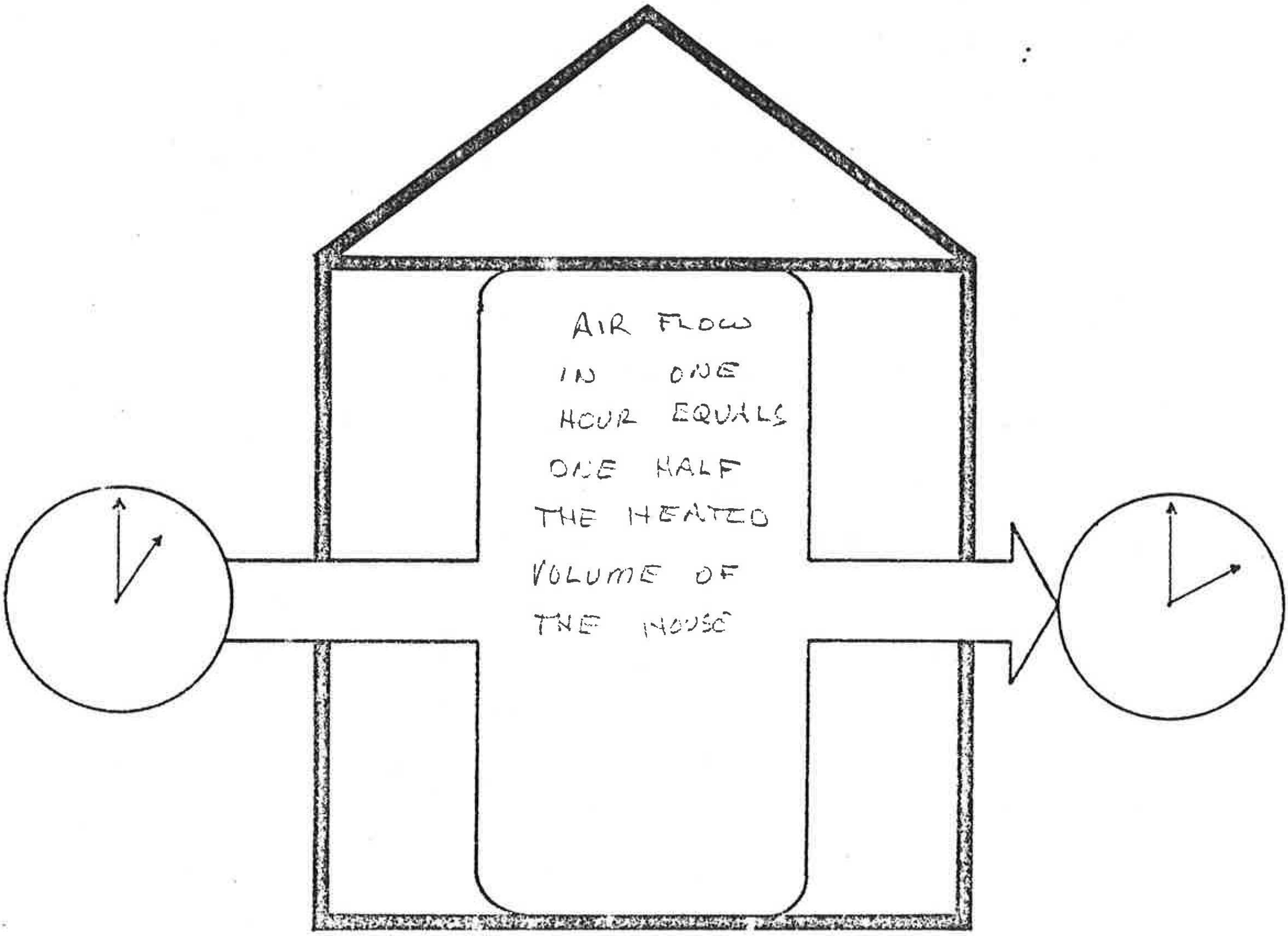
Comfort--Houses with high natural ventilation rates are drafty; when cold air leaks into a house it affects occupant comfort. The colder the weather, the stronger the draft and the greater the discomfort. Mechanical ventilation allows you to preheat ventilation air before introducing it into a room, thus avoiding cold drafts. A second comfort-related factor deals with moisture levels: leaky houses become very dry in cold weather. The dryness may irritate the nose and throat of occupants or cause irritation of nasal passages. To overcome this, many homeowners operate humidifiers in winter.

Control--With natural ventilation, there is very little control over ventilation rates. In cold weather, houses leak more air; when the wind blows, air leakage increases. Yet on a calm summer day it may not be possible to get adequate ventilation even by opening windows or doors. There is no guarantee you will get ventilation when and where it's needed, and no way of stopping it when you don't need it. Usually a leaky house is over-ventilated in cold or windy weather, and under-ventilated in warm, calm weather. You also can get ventilation where you want it - in a well-designed system.

Energy costs--It will cost more to heat a leaky house than an airtight house with an adequate mechanical ventilation system, even if both houses have the same average ventilation rate over the year. This is because a leaky house has the highest ventilation rate in the coldest weather, when the cost of heating ventilation air is the greatest; you will pay more to heat the house, but because of drafts, the house may seem colder and less comfortable. This often results in setting the thermostat at a higher temperature to maintain the same apparent comfort level. To combat the discomfort of dry air, occupants may humidify the air, another measure that uses energy.

Building life--Air leakage may affect the life of various building components. If the house is leaky, air containing water will migrate into wall cavities and ceilings, where the moisture will condense or freeze. If enough moisture condenses or freezes in attics, that moisture can cause ceiling damage when it melts in spring. Continual wetting of structural components can lead to wood rot, and eventually to structural failure.

These topics are further discussed in "Health and Safety Considerations" in Part II of this manual.



HALF AN AIR CHANGE PER HOUR
(½ ACH)

PARAGRAPH 2 PAGE 17

PART 1 "HOW MUCH VENTILATION IS ENOUGH"

HOW MUCH VENTILATION IS ENOUGH?

How much ventilation is required? The answer depends on the number of occupants in the house, their life style, the type of heating system and the outdoor temperature. A house occupied by a couple who both work away from the home requires far less ventilation than a home occupied by a family with a non working, smoking mother and three small children. A house where the family takes showers needs more ventilation than a house were baths are taken. Normally, a ventilation system is sized to meet the "typical peak" requirements for a house of that size, and then the ventilation system is controlled by the occupants to meet their specific needs.

The 1985 National Building Code calls for a ventilation system that is capable of providing at least half an air change an hour during the heating season--that is, an amount of air equal to half the volume of the interior of the house can be replaced with fresh outside air in an hour. Energy-efficient houses, which are built to be extremely resistant to air leakage, require ventilation systems that provide specific quantities of fresh air in each room of the house. The Canadian Standards Association (CSA) is preparing a new standard for ventilation, which calls for continuous ventilation in all new housing. It states that roughly 5 l/s (10 cfm) of fresh air should be provided for each room in the house continuously. A three-bedroom home, with kitchen, living room, dining room, utility room and basement would therefore require a ventilation system capable of continuously supplying 40 l/s (80 cfm); as well, an exhaust capacity of 50 l/s (100 cfm) from the kitchen, and 25 l/s (50 cfm) from each bathroom is required.

In older homes, which are generally less airtight, lower ventilation rates should suffice. What is more important is that the system work effectively, removing stale or polluted air near its source before it spreads throughout the house, and provides fresh air throughout the house to maintain good indoor air quality.

A rule of thumb is that if you smell odors when entering the house, even though the odor-producing activity was completed an hour or so previously, or if condensation starts building up on windows or walls in winter, ventilation rates should be increased. For specific advice on residential ventilation, contact a reputable heating contractor, one who has attended HRAI (Heating, Refrigerating and Air Conditioning Institute of Canada) sponsored courses on residential ventilation, and who has been certified by HRAI as a ventilation system installer.

HOW MUCH DOES VENTILATION COST?

With both natural and mechanical ventilation, there is a cost in winter, for the outdoor air entering the house must be heated. The cost will vary with the climate--the more severe the climate, the greater the cost. For example, if a house in Vancouver has a continuous ventilation rate of 50 litres per second (100 cubic feet per minute), and natural gas for a standard furnace (65 per cent seasonal efficiency) costs 40 cents per hundred cubic feet (ccf), then it may cost about $80 to heat that ventilation air over the course of the average heating season. In Toronto, the cost would be closer to $105 annually. But for a house in Edmonton or Winnipeg, where the climate is more severe, the same ventilation rate might cost about $145.

PART II

HEALTH AND SAFETY CONSIDERATIONS

There are two main reasons for installing mechanical ventilation systems in houses:

(1) to improve or maintain indoor air quality for occupant health and comfort and;

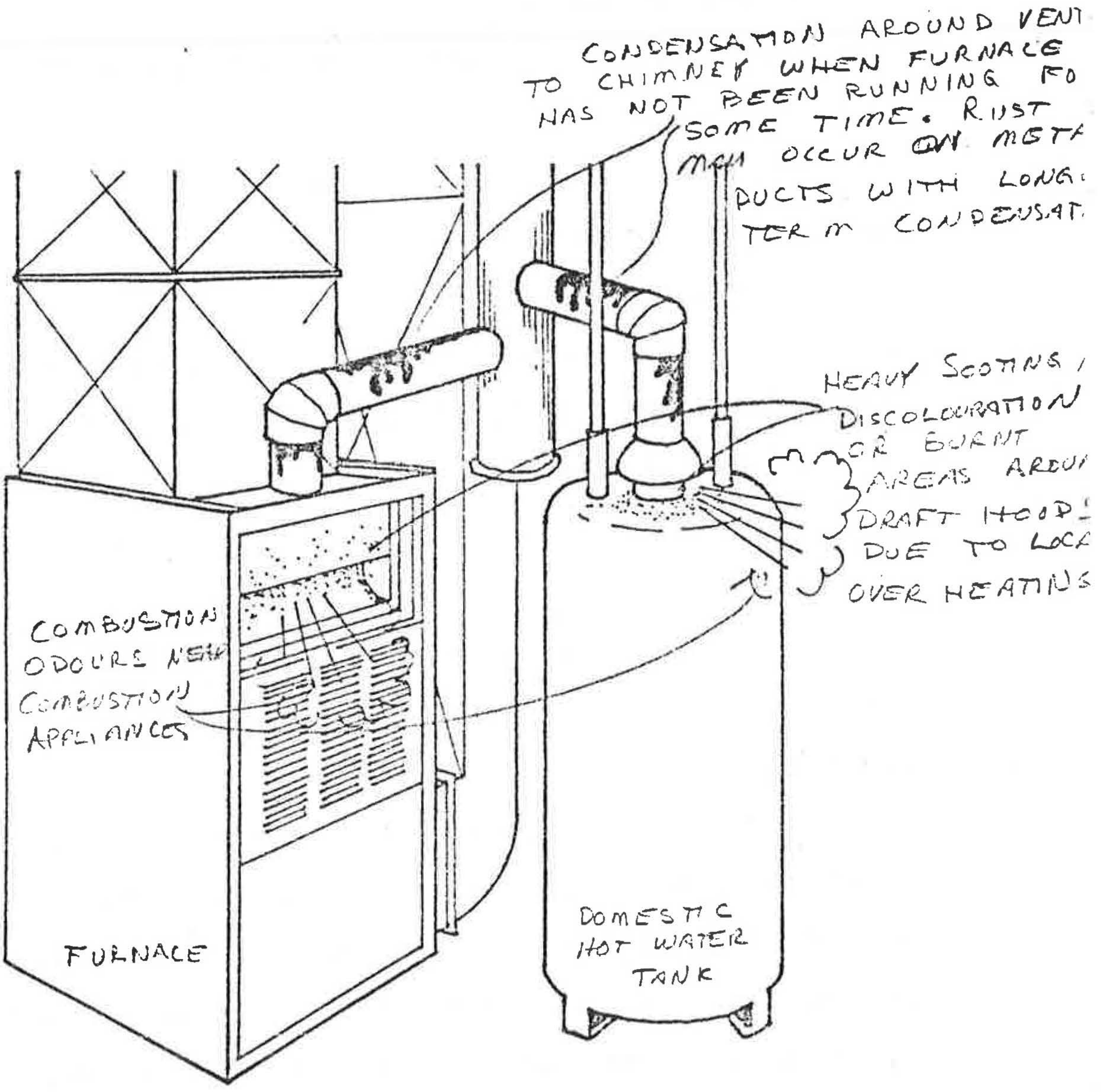
(2) to control the amount of moisture in the house to prevent condensation damage.

But under some circumstances, it is possible to operate the ventilation system in a manner which can jeopardize occupant health and safety, or which may make moisture problems worse. These potential problems and their solutions are discussed in this section of the manual. For a more complete discussion of these issues, read the CMHC publication "Ventilation; Health and Safety Issues, Problems, causes and solutions", NHA 5888 01/87 ($1).

Backdrafting

In houses with combustion appliances, it is possible for a ventilation system running under negative pressure (i.e. one that exhausts more air than enters through the supply air system) to reverse the chimney draft and flue gases containing carbon monoxide will be vented into the house. Symptoms of carbon monoxide poisoning include dizziness, headaches, nausea and vomiting. At high concentrations, carbon monoxide can cause death.

Normally, the products of combustion are vented directly up



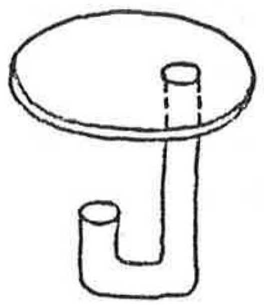
SIGNS OF BACKDRAFTING

the chimney and out of the house. However, if the ventilation system is exhausting more air out of the house than enters through infiltration and the supply air system, the chimney can "backdraft" and flue gases will enter the house. In houses which are airtight, backdrafting is a potentially serious problem. Other factors such as wind speed and direction and outdoor temperatures can contribute to backdrafting.

To avoid backdrafting, all combustion appliances should have their own independent supply of combustion air through a vent which brings fresh air directly to the combustion appliance. This is a requirement for new housing built under the 1985 National Building Code. If you wish to install combustion air supplies for a fireplace or furnace in your home, consult your heating contractor or a local building code official for guidance on sizing and locating the supply duct. WARNING: Do NOT plug or block combustion air vents for any reason. Doing so may cause serious backdrafting problems.

Even if the system was designed as a balanced ventilation system (i.e. exhaust air flows are equal to supply air flows), it may operate under negative pressure if supply air inlet filters or screens become plugged with dust, grass clippings, snow, etc. This could lead to backdrafting of combustion appliances. Inlet filters should be checked and cleaned regularly to avoid this problem.

Checking whether backdrafting is a potential problem in your house is not difficult, though it does require some time and



"RADON TRAP" FLOOR DRAIN IS A PLUMBING TRAP ON A SOLID FLOOR DRAIN COVER. TO BE EFFECTIVE, TRAP MUST BE KEPT FULL OF WATER effort. CMHC has developed a checklist to assist homeowners in identifying combustion backdrafting hazards. This checklist is at the back of this manual. (Also see CMHC publication "Ventilation; Health and Safety Issues" referenced above.)

Radon, Soil and Sewer Gas

When the house operates under a negative pressure, radon gas, soil gas (i.e. air from the earth) and sewer gases can be drawn into the house through airleaks in basement walls, floors, weeping tiles and sewer drains. Radon gas is a potential cause of lung cancer. Soil and sewer gas may contain radon and other contaminants with health implications. Odors or sewer smells may cause occupant discomfort.

To eliminate this problem, ensure that drains have water in their traps to prevent the backflow of sewer gases. Floor drain covers which have traps to allow spilled liquids to escape but which seal the floor drain are also available on the market. Another solution is to provide a makeup air supply to reduce the unbalance. For information on how to identify and solve these types of problems refer to CMHC's publication "Guide to Radon Control".

Poor Supply-Air Quality or Quantity

If supply air inlets are improperly located, the quality and quantity of air coming into the house may be inadequate, or may contain contaminants which are offensive or detrimental to occupant health.

The supply air pickup for ventilation systems should be positioned where good air quality is assured. Locations to avoid include: inside garages, over driveways, near gas meters or oil fill spouts, near exhaust air outlets or dryer vents, near the exhaust of any combustion appliance (e.g. a condensing furnace), or beside a dog run. Homeowners should consider contaminant sources not only in the area around their house, but also sources from neighboring properties.

Supply air inlets should be at least 450 mm (18") above the ground (higher is better) to prevent snow blockage and to keep lawn clippings and wind-blown dust and debris from blocking the hood or filter. The hood and filters should be conveniently located for ease of checking and maintenance, and should be checked regularly - year 'round.

Moisture Build-up in Walls and Attics

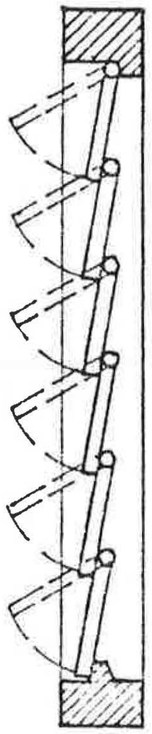
If the house operates under a positive pressure, moist indoor air will leak out of the house through cracks and crevices in the building envelope and into walls and attics. This air leakage can be around windows and doors, and through electrical outlets. In cold weather, moisture from the house air leaking through the walls will condense in the insulation in the walls and attics; over long periods of cold weather, several hundred litres of moisture can condense and form frost or ice in the attic.

When warm weather comes, this frost and ice melts into water which soaks insulation, reducing its effectiveness and increasing heating requirements. Severe moisture build-ups can damage drywall and plaster, and can promote the growth of mold and mildews and cause rotting of wooden structural members which may produce health problems for the occupants.

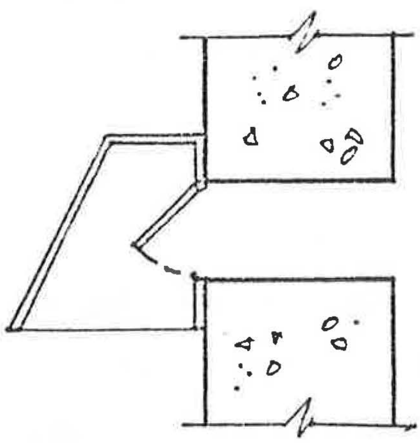
The amount of moisture that will migrate into the building envelope will depend on the air leakage rate of the house, the relative humidity of household air and weather conditions--the colder the outdoor air, the greater the rate of air leakage. To reduce this potential problem, the ventilation system should be balanced, or a "relief" vent should be installed to allow excess air out of the house. Ensure attic ventilation is adequate--67 cm2 of ventilation area for every square metre of attic area (1 square foot per 150 square feet). However, the use of power ventilators ("whirly-birds") is not recommended in cold climates because they can pull increased amounts of moist air through the ceiling into the attic, aggravating the moisture build-up problem.

Exhaust Air Condensing in the Attic

Where an exhaust air duct which leaks moist air passes through a cold attic, moisture will build up in the insulation and on structural members. The effects of moisture build-up are described above. To determine if this is a problem, inspect the attic during winter for ice or frost build ups, or in spring for



BACKDRAFT DAMPERS ARE NORMALLY CLOSED TO STOP WIND OR OUTSIDE AIR FROM BACKING INTO EXHAUST DUCTWORK. WHEN THE EXHAUST FAN RUNS, THE EXHAUST AIR PUSHES THE DAMPERS OPEN



signs of sodden insulation.

Exhaust air condensation problems in attics may be the result of two exhaust system deficiencies. First, the exhaust fan may have been installed to vent directly into the attic. Even when the fan is not used, warm moist air continually rises through the open ductwork and condenses in the attic.

The second deficiency may be the result of uninsulated exhaust ductwork running through a cold attic. As the moist exhaust air is cooled, condensation forms inside the duct. If the duct is not sloped to drain, or has leaky seams, the condensed moisture may run into the insulation in the attic. Or it may leak back into the house, staining the ceiling or wall.

Ensure the exhaust fan does not vent directly into the attic, and that all seams in the ductwork are taped with duct tape to prevent air leakage. The ductwork should be sloped downwards to allow any condensed water to drain out of the house. To prevent cold air from backdrafting into the house, the exhaust system ductwork can be run down the wall cavity and between basement joists to the outside (see illustration).

<u>Cold Air Backdrafts</u>

If the house is under negative pressure for any reason, cold air may backdraft through the exhaust ductwork into the house due to a poor backdraft damper, causing cold drafts and occupant discomfort. The solution is to install a good backdraft damper or reroute the ductwork so it runs down and out (see illustration).

PART III

PLANNING NEW VENTILATION SYSTEMS

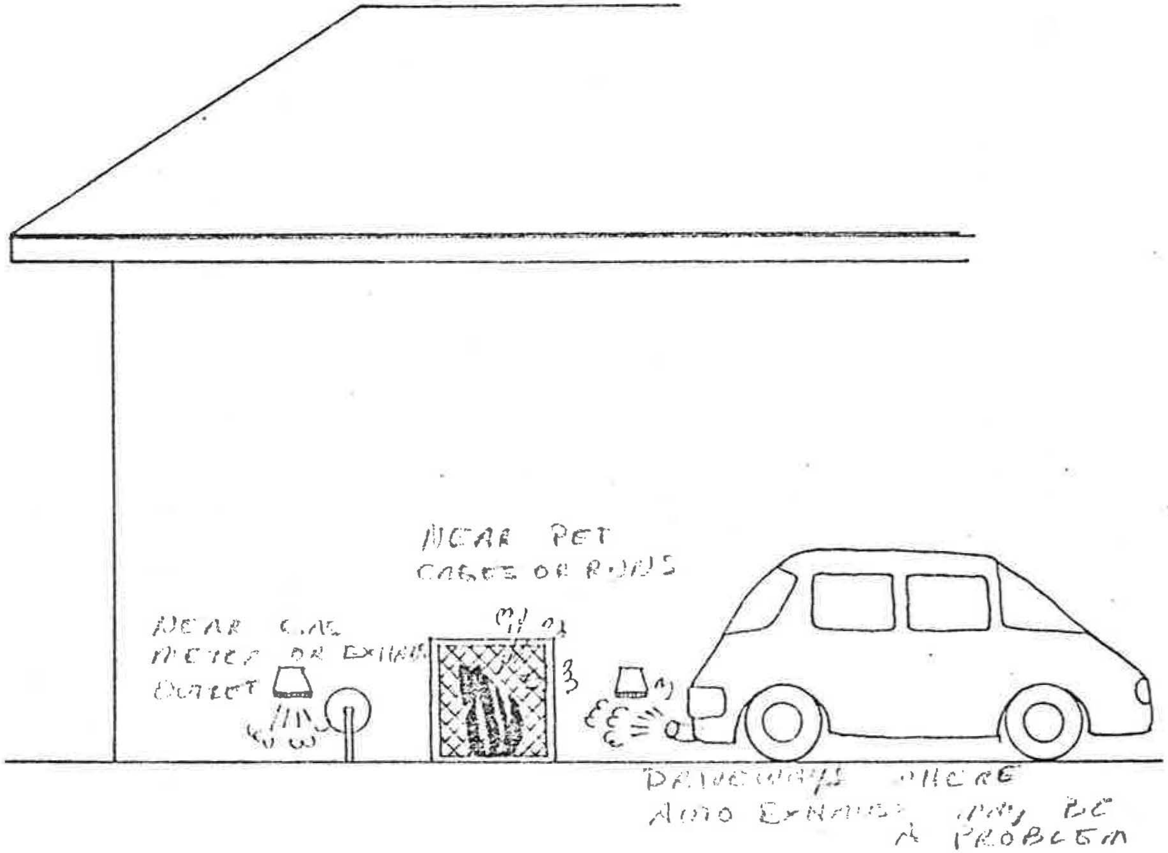
If you are renovating or retrofitting an existing house, or building a new one, there are a number of important factors to keep in mind when planning its ventilation system.

Your budget is obviously a major consideration, since upgrading a ventilation system can be an expensive proposition. If both budget and the extent of the renovations are limited, perhaps the best way to improve ventilation in your home is to install a fresh air inlet ducted to the return air plenum of the forced air furnace, to provide both fresh air and to prevent backdrafting. If your house has electric baseboard or radiant heating, some means of circulating fresh air around the house should be a major consideration. If odors or airborn contaminants (such as cigarette smoke) are a problem, an electronic or electrostatic furnace filter may be a solution. If your ventilation problem is limited to one room (excessive condensation in the bathroom, for example), an upgraded exhaust fan may be the answer. Every house is different, and there may be structural limitations affecting the type of ventilation system that can be installed. Lifestyle also plays an important role in any decision to improve the ventilation system. First you must decide whether it will be an exhaust-only or a balanced ventilation system. A balanced system is preferable, but is more expensive to install than an exhaust-only system. Balanced systems are also preferred in houses with naturally-aspirated combustion appliances unless those appliances have their own combustion air intakes. Unless you know for sure that all combustion appliances (i.e. furnace, DHW tank, fireplace, etc.) in the house have sealed combustion chambers with external air supplies, or are of the "induced draft" type, assume they are naturally aspirated.

Then you must decide how much ventilation to provide. The proposed CSA standard states new houses shall be continuously ventilated at the following rates: 5 l/s (10 cfm) for each habitable room, kitchen and bathroom(s) and 10 l/s (20 cfm) for unfinished basements and utility rooms. The 1985 National Building Code requires one-half air change per hour. (Note that these are total requirements only.) There should also be provision for exhaust: 50 l/s (100 cfm) for kitchens and 25 l/s (50 cfm) for each bathroom. A heating contractor who has attended HRAI courses in residential ventilation will be able to advise you on ventilation rates for your specific house.

In existing houses, you have the advantage of knowing how airtight the house is. If you are not doing anything to reduce air leakage (e.g. air sealing, or replacing windows or doors), you will know whether existing natural and mechanical ventilation rates are adequate and where additional ventilation is required.

Unfortunately, upgrading ventilation in an existing house can be both difficult and expensive, especially in a house with electric baseboard or radiant heating (i.e. without ductwork).



AREAS TO AVOID WHEN LOCATING
FRESH AIR INTAKES

Installing or improving ductwork in an existing house can often only be done when the house is being renovated and walls are being opened. Any major home renovation should include provision for improving the air moving capabilities of the ventilation system.

Installing the ductwork has some limitations. Exhausting air directly into the stud space in the wall is not recommended for it is not uncommon that holes have been drilled in the top plate of the wall to allow for wiring or plumbing vents. Exhaust air would then leak into the attic.

Avoid running exhaust ductwork through unheated spaces if at all possible and never exhaust household air into the attic, crawl space, basement or garage. If the exhaust ductwork must pass through unheated spaces, make sure it is well insulated, complete with an air/vapour barrier and is sloped to drain any condensation out of the duct. Ensure the condensate will not run anywhere where it can damage the house or cause a safety problem (e.g. ice on a sidewalk).

Avoid drawing fresh ventilation air from attics, crawl spaces or garages. Drawing ventilation air from a garage can result in serious air quality problems from gasoline fumes or carbon monoxide produced by vehicles.

Drawing ventilation air from an attic may cause two attic moisture problems. First, it may result in sucking airborn snow into the attic. Second and more serious is the negative pressure created in the attic may increase air leakage from the house through the ceiling; this, in turn, may produce condensation problems. Supply air intakes should be located where you are assured of high quality ventilation air, as discussed in Part V.

The controls you choose will play a significant part in determining the effectiveness and energy efficiency of the ventilation system. In general, if the ventilation system is operated to maintain acceptable winter humidity levels, indoor air quality will be good. A well placed dehumidistat can be used to control the ventilation system to help maintain air quality. Manual switches should be located in bathrooms and near the range. In cold climates, where low humidity may be a problem, a humidifier may be incorporated into the system.

Quality equipment is preferred and becomes essential in houses which require significant levels of mechanical ventilation. This is because quality equipment will operate more quietly and efficiently. Inexpensive fans are often noisy and noisy fans get turned off because noise is often perceived to be a greater problem than poor indoor air quality. If this happens, the ventilation system may as well not have been installed.

PART IV

EVALUATING EXISTING SYSTEMS

In older existing houses, the adequacy of the ventilation system can be evaluated by looking for signs of excessive cold weather humidity, such as black moisture or mildew stains on window sills, mold or mildew at the wall/ceiling junction, plaster or drywall damage to ceilings or walls especially near windows, or peeling or blistering paint on exterior walls.

In new houses, look for ductwork that avoids an excessive number of curves or bends, and has properly sized and quiet-running fans. The appearance of the ductwork is often the best indicator of the thought that went into the installation.

If the home has a heat recovery ventilator (HRV), ensure that the operator's manuals, the warranty information, and the installer's name are provided. You may even wish to have your builder arrange for you to meet with the installer for a briefing session on proper system operation and maintenance. Homeowner courses on HRV operation and maintenance are offered periodically by the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI). For further information, contact your local Energy, Mines and Resources Canada office.

Check that exhaust fans are properly vented to the outdoors. If you think that combustion appliance backdrafting may be a problem, do the backdrafting test on the house (see the test procedure at the back of this manual). Check the location of fresh air intakes to ensure there are no air contamination sources; exhaust air outlets should not be located near fresh air intakes.

Check the location of grilles: high-wall grilles are preferred for both fresh air supply and exhaust pick-ups. In a well-designed ventilation system, each room will have either an air supply or exhaust pick-up, or both.

You can check the strength of the draw of an exhaust fan by holding a lit cigarette near the grill when the fan is running. An effective system will pull the smoke into the grille. A wet finger or a piece of tissue paper on a coathanger can also be used to test for air movement to or from a grille.

PART V--MECHANICAL VENTILATION SYSTEMS

We have been discussing the need for ventilation, and have made reference to mechanical ventilation systems, but what exactly are they?

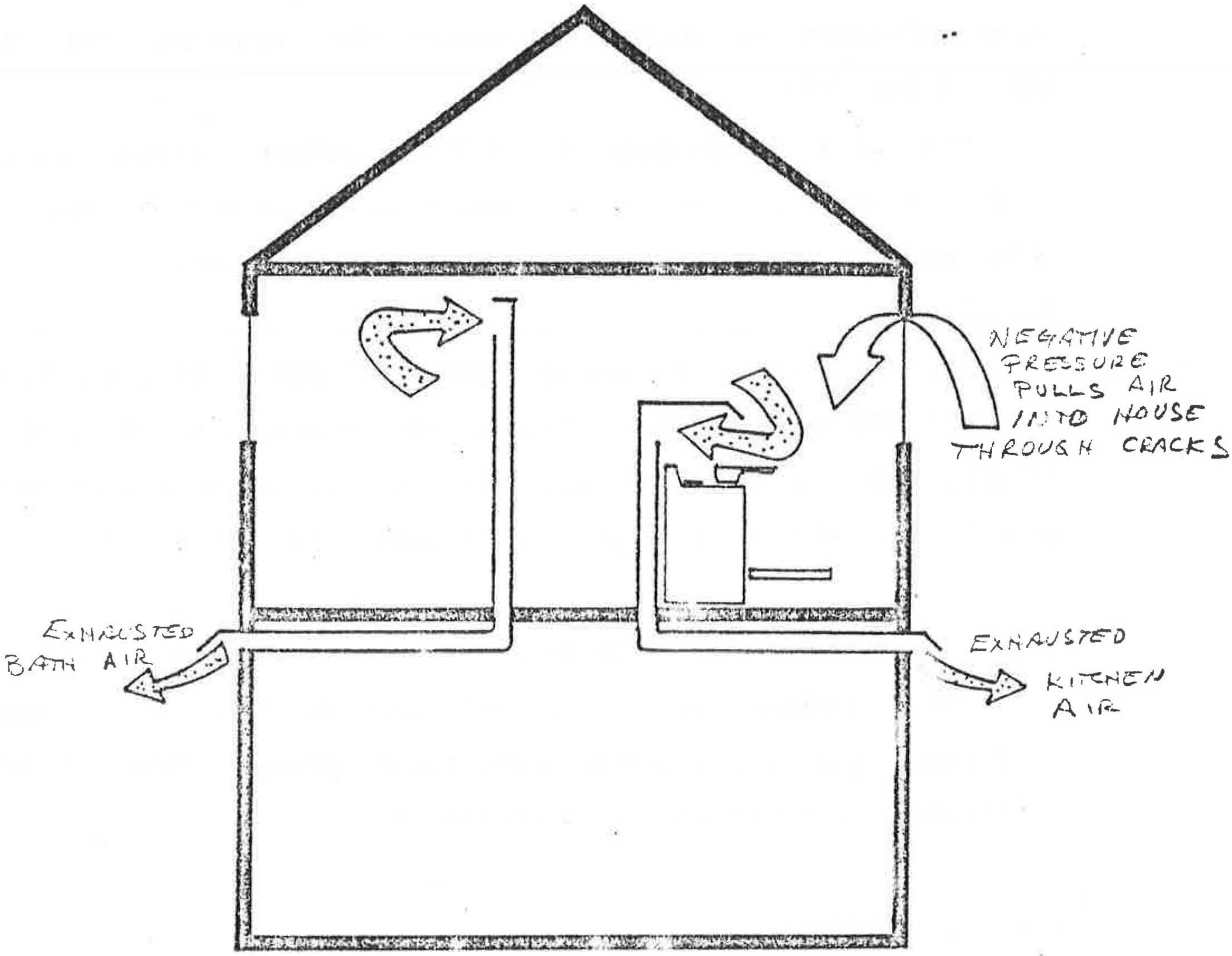
The term "mechanical ventilation system" refers to all components (fans, ductwork, grilles, registers and controls) that make up the system which provides forced ventilation in a building.

Different types of heating systems require different types of ventilation systems. Forced air natural gas and electric furnaces have ductwork and fans which can be used to distribute ventilation air throughout the house. Baseboard and radiant heating systems do not have fans or ductwork and therefore require a different strategy to distribute ventilation air.

This section of the manual describes some of the many different types of mechanical ventilation systems, their various components and their operating strategies.

Operating Modes:

Mechanical ventilation systems can be operated either intermittently or continuously. Intermittment operation means the system is turned on either by an occupant or by an automatic switch, such as a dehumidistat (which senses relative humidity levels) to meet periodic ventilation requirements. Bathroom exhaust fans and range hood fans are typical examples of



EXHAUST ONLY SYSTEMS CREATE NEGATIVE AIR PRESSURES INSIDE HOUSE. AIR LEAKS INTO HOUSE TO REPLACE AIR WHICH IS EXHAUSTED.

PAGE 33
PART V "PRESSURE REGIMES
"1. EXHAUST SYSTEMS"

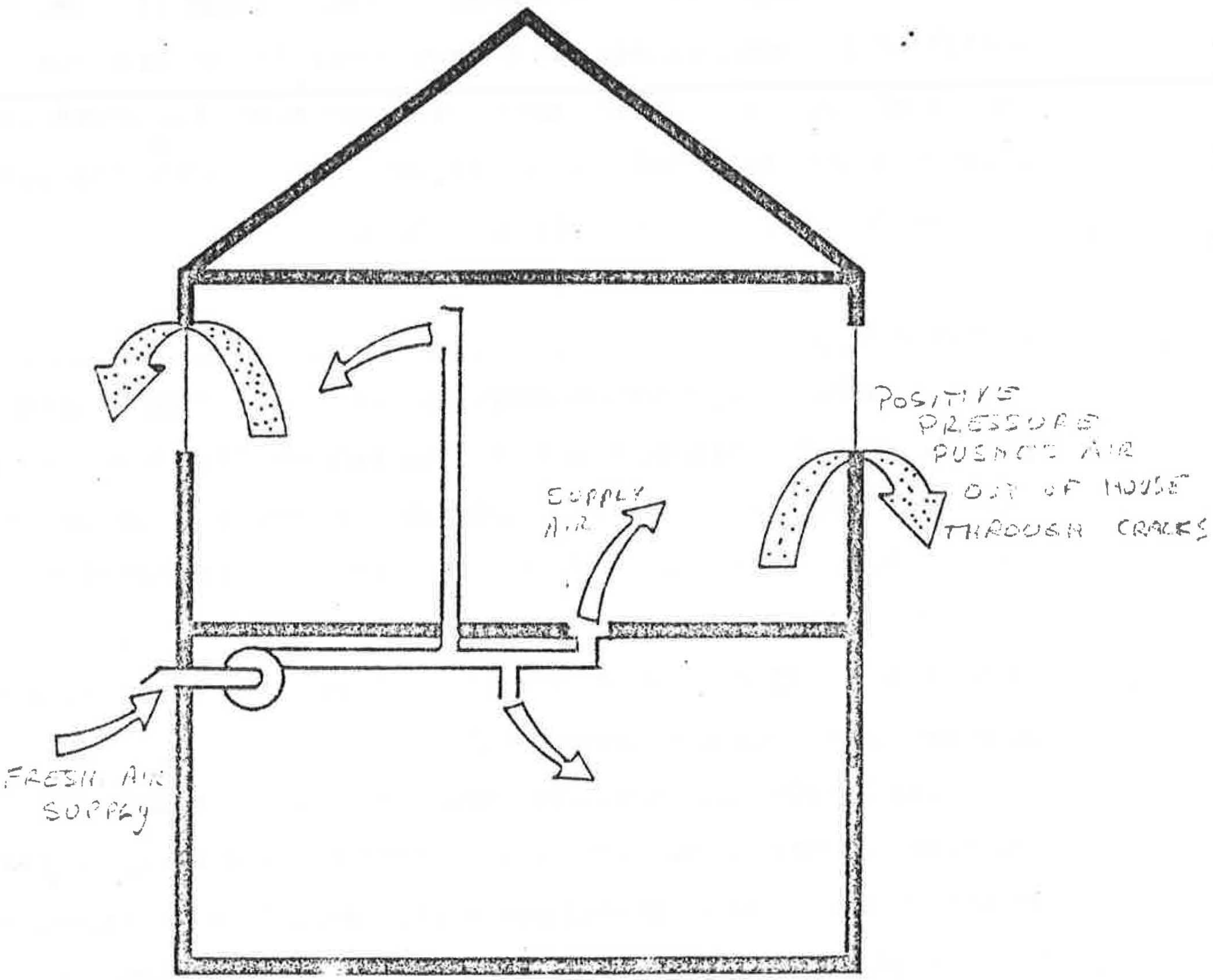
intermittently operated ventilation systems.

Continuous operation refers to a ventilation system which continuously ventilates the space. These types of systems are installed in most energy efficient homes to maintain acceptable indoor air quality. Often these systems have two-speed fans so they can be operated at a higher speed to rid the space of intermittently produced odors or moisture.

Pressure Regimes:

1. Exhaust Systems--Exhaust systems use either a number of individual fans--bathroom and kitchen exhaust fans are normal--or a central fan connected by ductwork to several parts of the house. This type of system is used in most Canadian homes. Because outside air is sucked into the house through cracks to replace the air exhausted from the house, the house is said to operate under "negative pressure."

High levels of negative pressure in a house can cause problems. The cold air drawn into the house may be felt as drafts by occupants. Combustion appliances, like furnaces, water heaters and wood stoves, can "backdraft" poisonous fumes into the house; for this reason, it is recommended that in tightly sealed houses, all combustion devices should have their own combustion air supply intake. If the house has combustion devices which do not have their own supply of combustion air, consideration should be given to installing a passive fresh air intake, which allows fresh air into the house if the house is operating under a



SUPPLY ONLY SYSTEMS CREATE POSITIVE AIR PRESSURES INSIDE HOUSE. AIR LEAKS OUT OF HOUSE TO REPLACE AIR WHICH IS EXHAUSTED.

PAGE 34
PART V "PRESSURE REGIMES - 2. SUPPLY [illegible]"

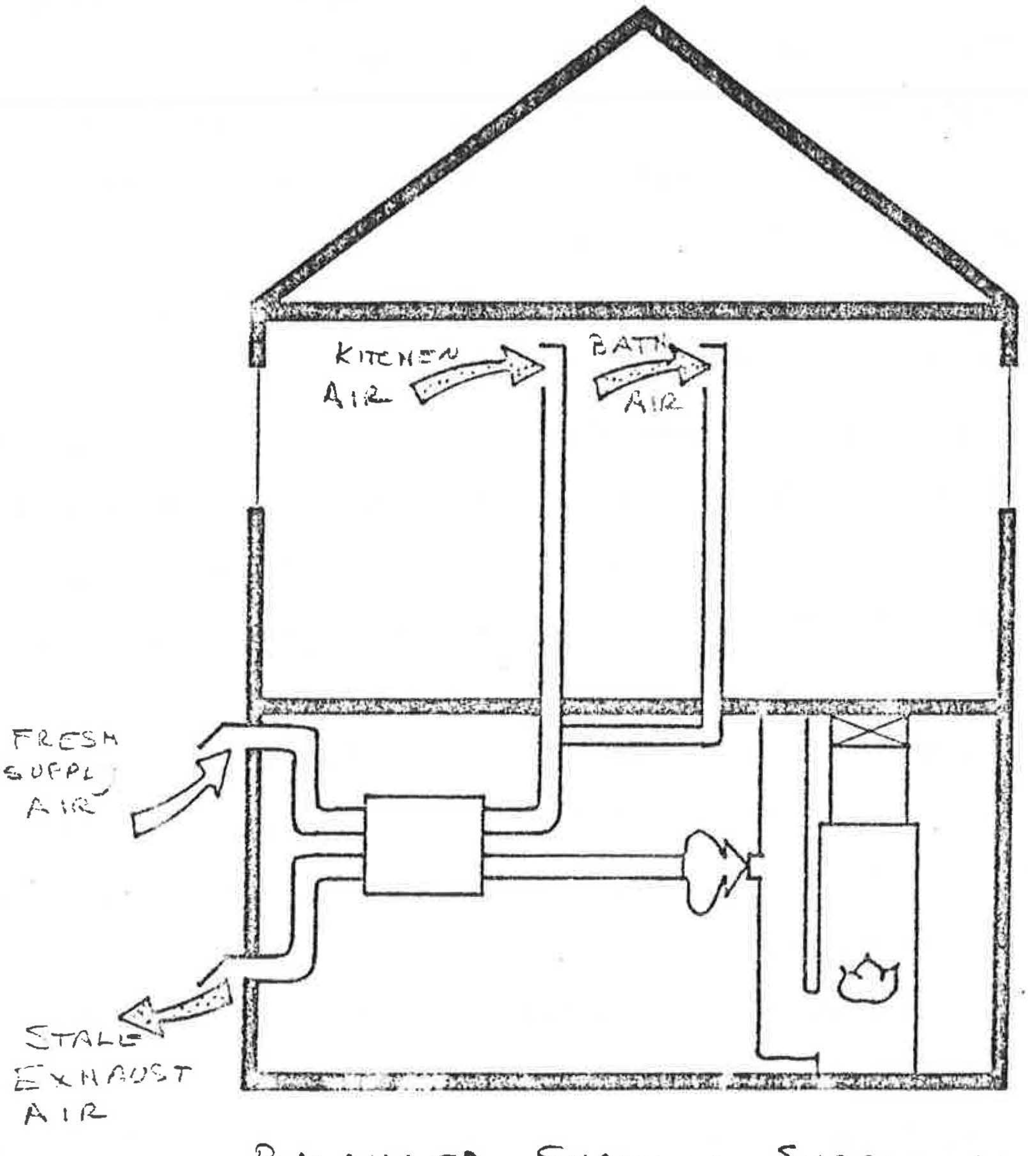
negative pressure. Exhaust systems can also promote the infiltration of sewer gas, radon gas and moisture from the below grade portions of the house (for a more complete discussion, see Safety Considerations, Part II of this manual).

2. Supply Air Systems--Supply-only systems draw outside air into the house through a number of fans or a central distribution system; the house operates under "positive pressure," and stale air is blown out of the house either through cracks in the building envelope or deliberate openings.

Supply systems eliminate the problem of cold drafts, but the pressurization of the house can produce problems. Excessive positive pressure can drive moist inside air into walls and ceilings; in cold weather, this moisture may condense and freeze. When this moisture melts in spring, it can wet insulation and reduce its effectiveness. Moisture trapped in walls and ceilings can lead to rotting of structural members. Finally, the cold incoming air must be preheated in so as not to cause cold spots or drafts in the house.

Supply-only systems are NOT recommended in cold climates.

3. Balanced Supply and Exhaust Systems--A balanced system uses both supply and exhaust fans to provide ventilation. The capacities of the fans are balanced (i.e. equal) so that a neutral pressure is created in the house. Balancing air flows requires specialized air flow measuring equipment which your mechanical contractor should have. Balancing air flows will avoid the problems of operating the house under either negative



BALANCED SYSTEMS SUPPLY AND EXHAUST EQUAL VOLUMES OF AIR, THUS MAINTAINING A NEUTRAL PRESSURE IN THE HOUSE,

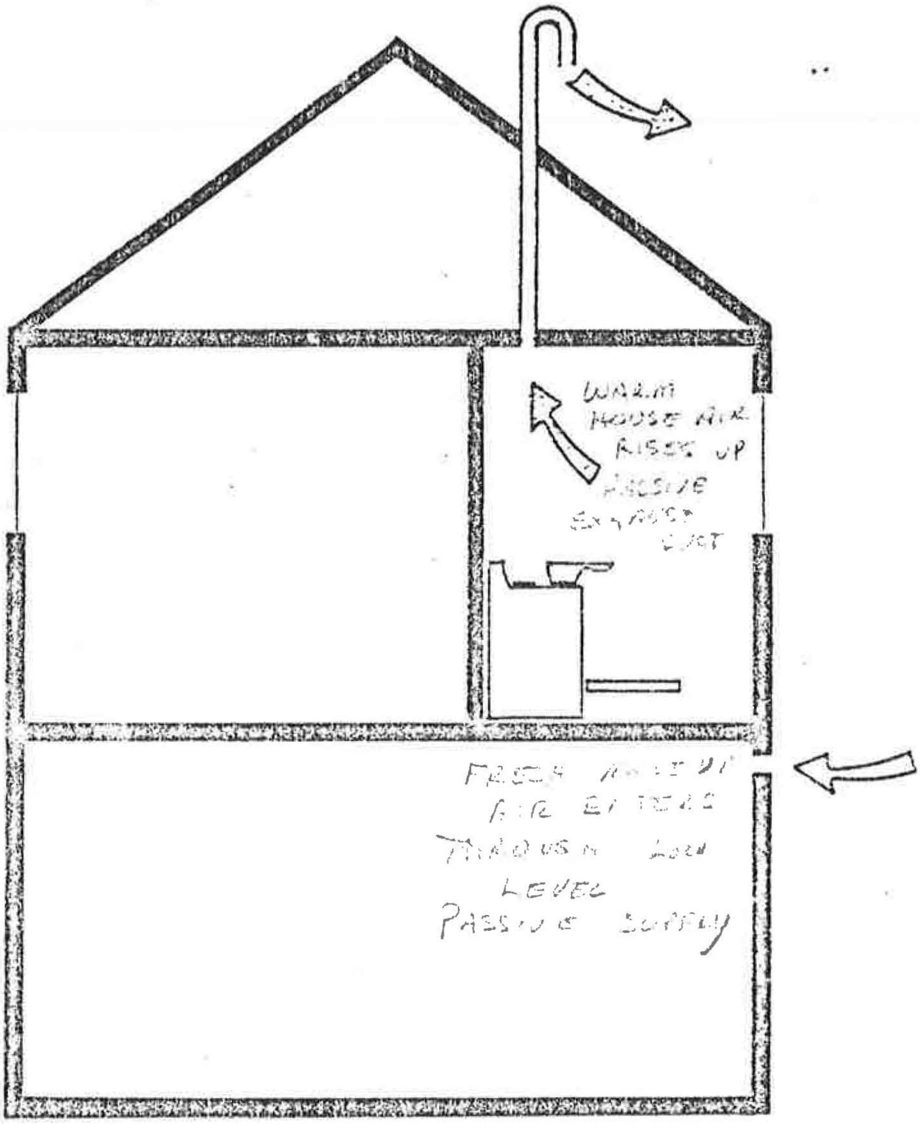
PAGE 34 PART V
"PRESSURE REGIMES - 3. BALANCED SUPPLY AND EXHAUST SYSTEMS"

or positive pressure. This type of system may require incoming supply air to be pre-heated.

Balanced systems are the most common types of ventilation systems in energy efficient homes. Most heat recovery ventilators (HRVs), also known as air-to-air heat exchangers, are designed to operate as balanced systems.

However, a balanced system does not necessarily require an HRV. For example you can set up an exhaust fan and a fresh air duct to the furnace return as a balanced system by wiring the furnace fan and exhaust fan so they run together. When the exhaust fan is switched on, the furnace fan would also come on. When the furnace fan comes on to heat the house, the exhaust fan would be run. This lower cost approach has the disadvantage that in the cold weather, household ventilation rates are highest, because the more the furnace runs, the greater the ventilation rate.

Passive ventilation systems are also balanced systems. Passive ventilation systems consist of passive exhaust air vents which carry exhaust air from the ceiling area of kitchens and washrooms up a pipe through the roof of the house, and fresh air vents which introduce make up air in the basement or other low, convenient location in the house. Passive systems, like natural ventilation, depend on wind and temperature to drive them. However, unlike natural ventilation, you control where air is exhausted from or supplied to the house, and you can block vents if you wish to reduce ventilation rates. Passive systems are



PASSIVE VENT

PAGE 35, BOTTOM
PAGE 36, TOP
PRESSURE READINGS

suited to houses in locations with limited or expensive electricity, or where fan maintenance or replacement is difficult or expensive.

System Components

Mechanical ventilation systems are made up of a number of components or sub-systems. These include:

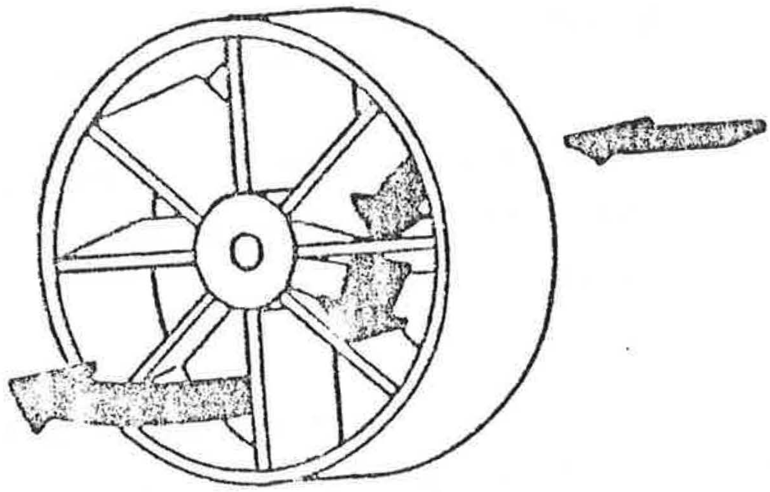
Fans--which move air into and/or out of the house.

Ductwork--which includes all ducts and fittings, grilles and registers, inlet and/or exhaust hoods, balancing dampers and filters, to distribute or collect air within the house.

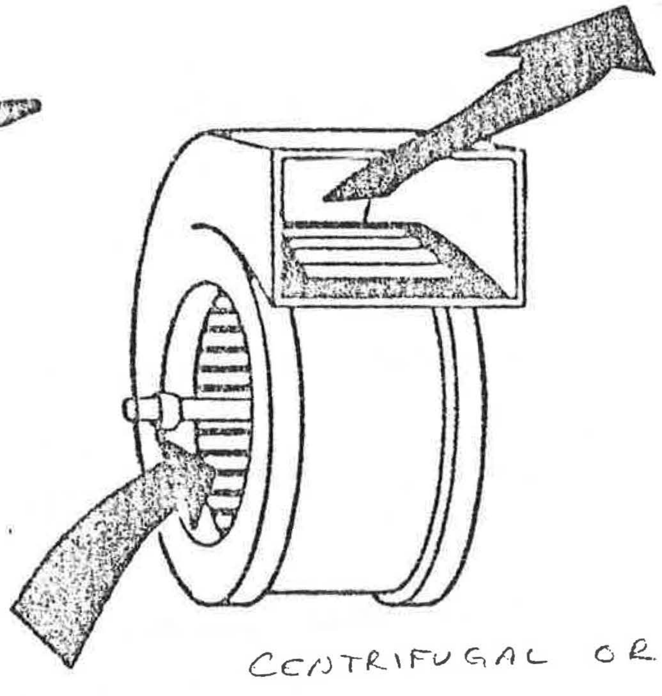
Controls--which include automatic or manual switches, timers and dehumidistats which operate the ventilation system to maintain desired indoor air quality.

Heat Recovery Equipment--which recovers heat from warm air being exhausted from the house, thereby reducing the costs of maintaining indoor air quality. Heat recovery ventilators and air-to-water heat pumps are examples of heat recovery equipment.

Ventilation equipment and components vary greatly in type, quality and cost. The "best" selection for a particular application will depend on the specific operating requirements.



AXIAL FLOW
OR
PROPELLER FAN



CENTRIFUGAL OR
SQUIRREL CAGE
FAN

The following section reviews ventilation system components in more detail.

Fans

There are two basic types of fans: propellor or axial flow fans, and centrifugal or radial flow fans. All fans should be CSA approved.

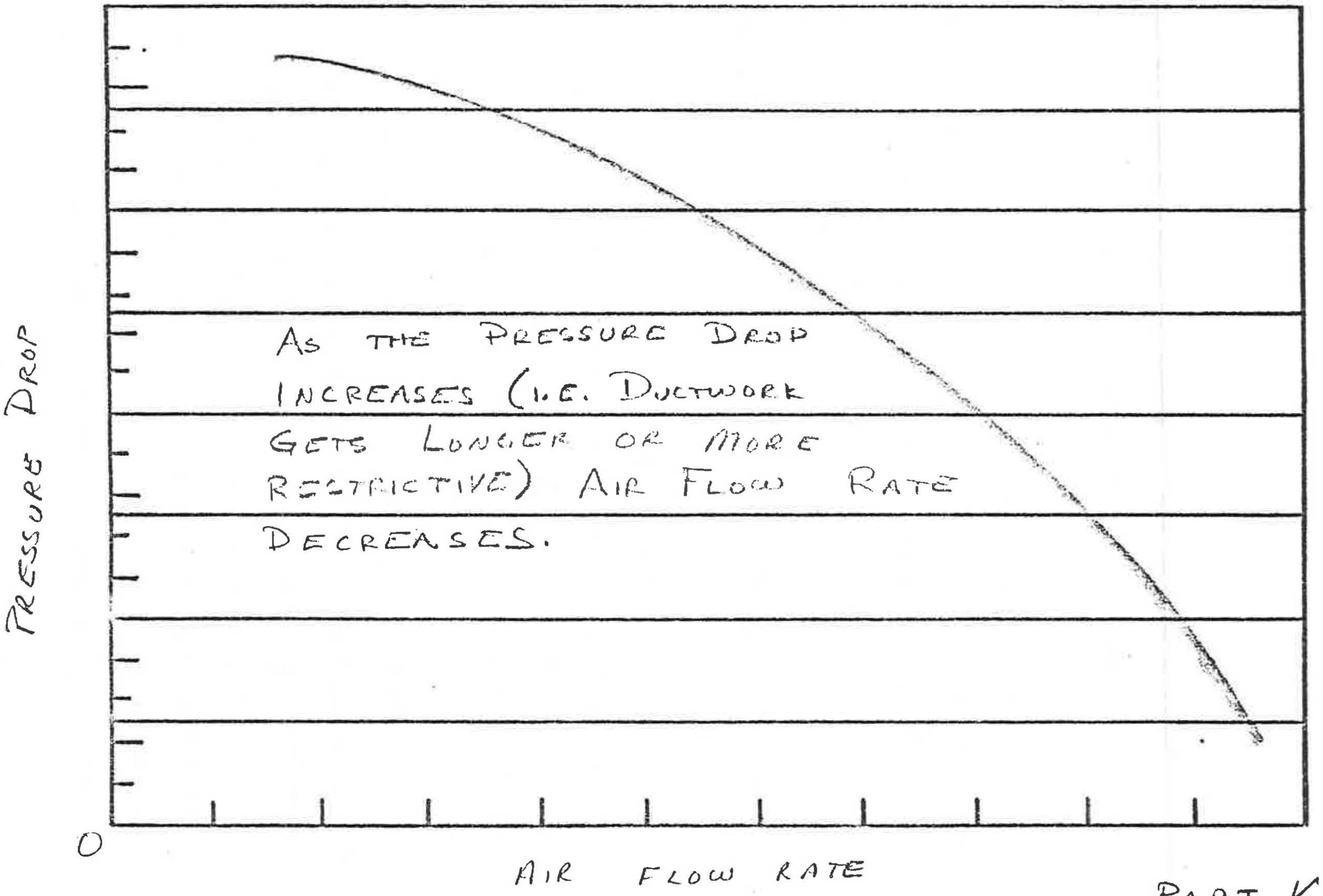
Propellor or axial flow fans--like desk fans, box fans, and ceiling fans--move air parallel to the axis of rotation of the fan. These can move large volumes of air if they do not have to overcome resistance to air movement caused by ductwork.

Centrifugal or radial-flow fans move air against higher resistance, or "head," than propellor fans. Centrifugal fans have a wheel or rotor mounted in a scroll spiral (snail-shaped) housing. Air enters parallel to the rotor shaft and is discharged from the wheel or rotor (and housing) in a radial fashion. Commonly called squirrel cage fans, they operate quietly, usually at low speed. Furnace fans are centrifugal fans.

All fans are rated according to air flow rate and pressure drop. Air flow rate, expressed in litres per second (l/s) or cubic feet per minute (cfm), is the amount of air being moved. Pressure drop is a measurement of how hard the fan can push air against the resistance created by the ductwork and still provide a given air flow.

Normally, as pressure drop (or resistance to air flow) is

TYPICAL FAN CURVE



PART V
BOTTOM PAGE 37/ TOP PAGE 38
"FANS"

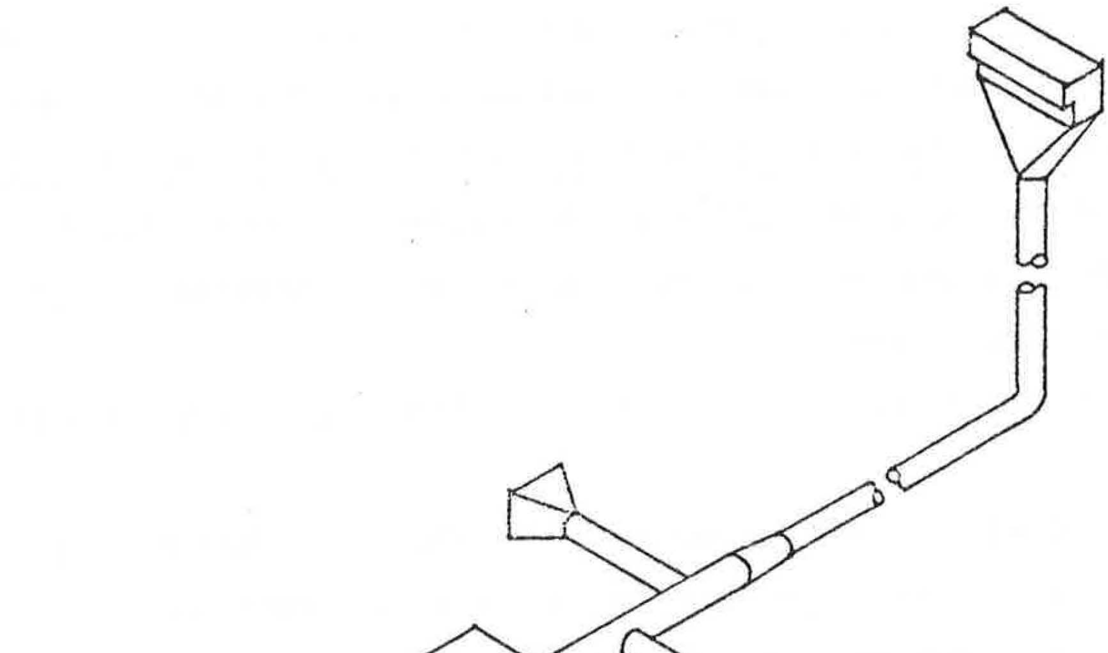
increased, the air flow rate is decreased. Fan curves are commonly used to show the flow/pressure relationship for a fan, and ventilation system designers use this data to select fans and size ductwork to provide the desired ventilation rate for the house.

Most household exhaust fans are propeller fans, rated at free flow conditions--that is, with no attached ductwork. When connected into ductwork, the actual output of a low-cost fan is commonly decreased by up to 70 per cent of the "rated" capacity. Better-quality fans will usually be rated at several "realistic" pressure drops that cover the range encountered in typical ventilation systems.

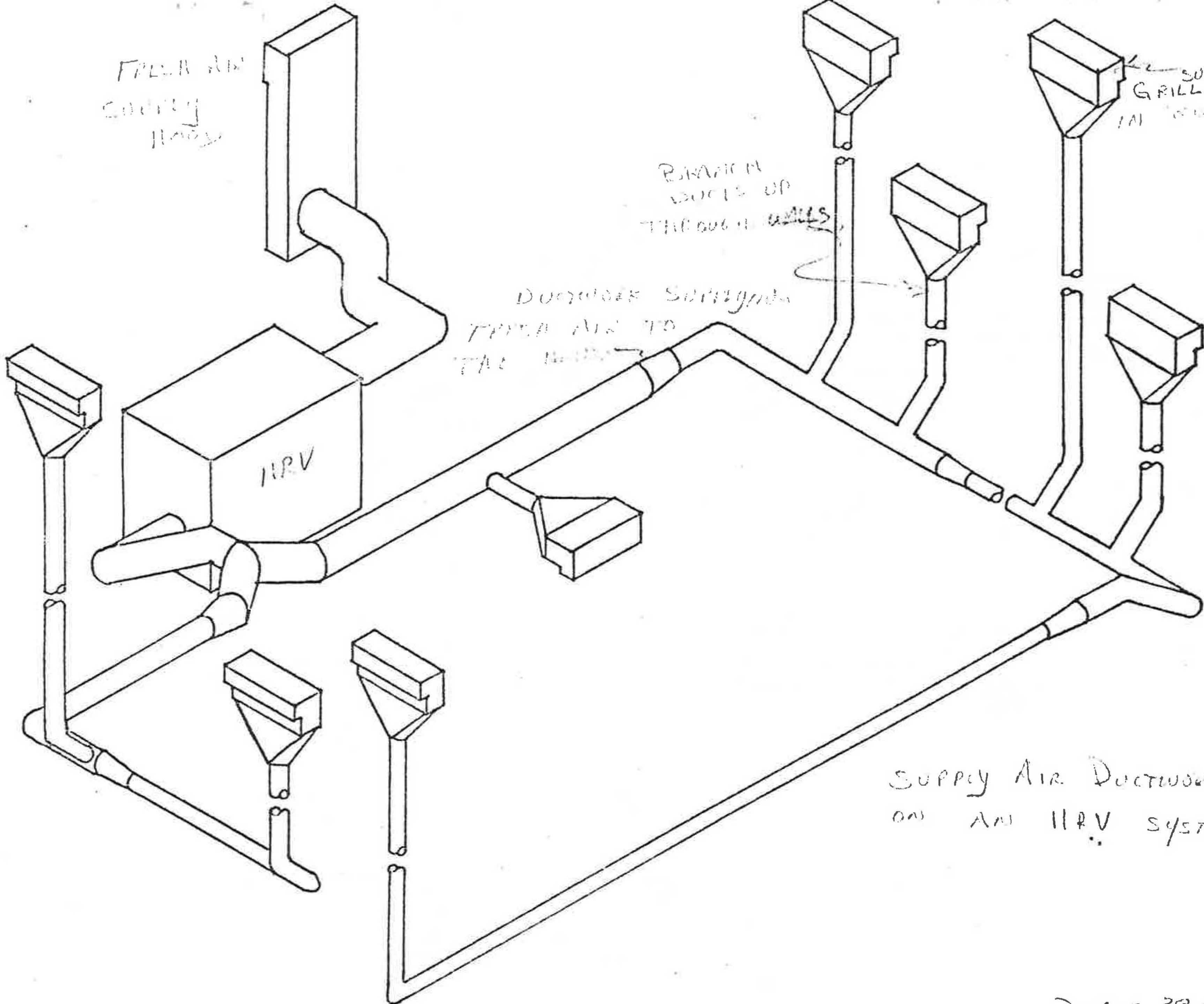
In airtight, energy efficient housing, fan quality is an important selection criteria for two reasons. Firstly, fans will be required to run for much or all the time. Low-quality fans have a short life expectancy in high-use applications. Secondly, the noise produced by a fan operating in an energy-efficient house is critical because energy-efficient houses are much quieter than conventional houses. The background noise from furnace or ventilation fans is more noticeable or intrusive. Noisy fans get turned off, and in an airtight house, this can lead to air quality problems.

<u>Ductwork</u>

The ductwork and all the associated fittings act to move air from a source to the fan (which moves the air), and then to a

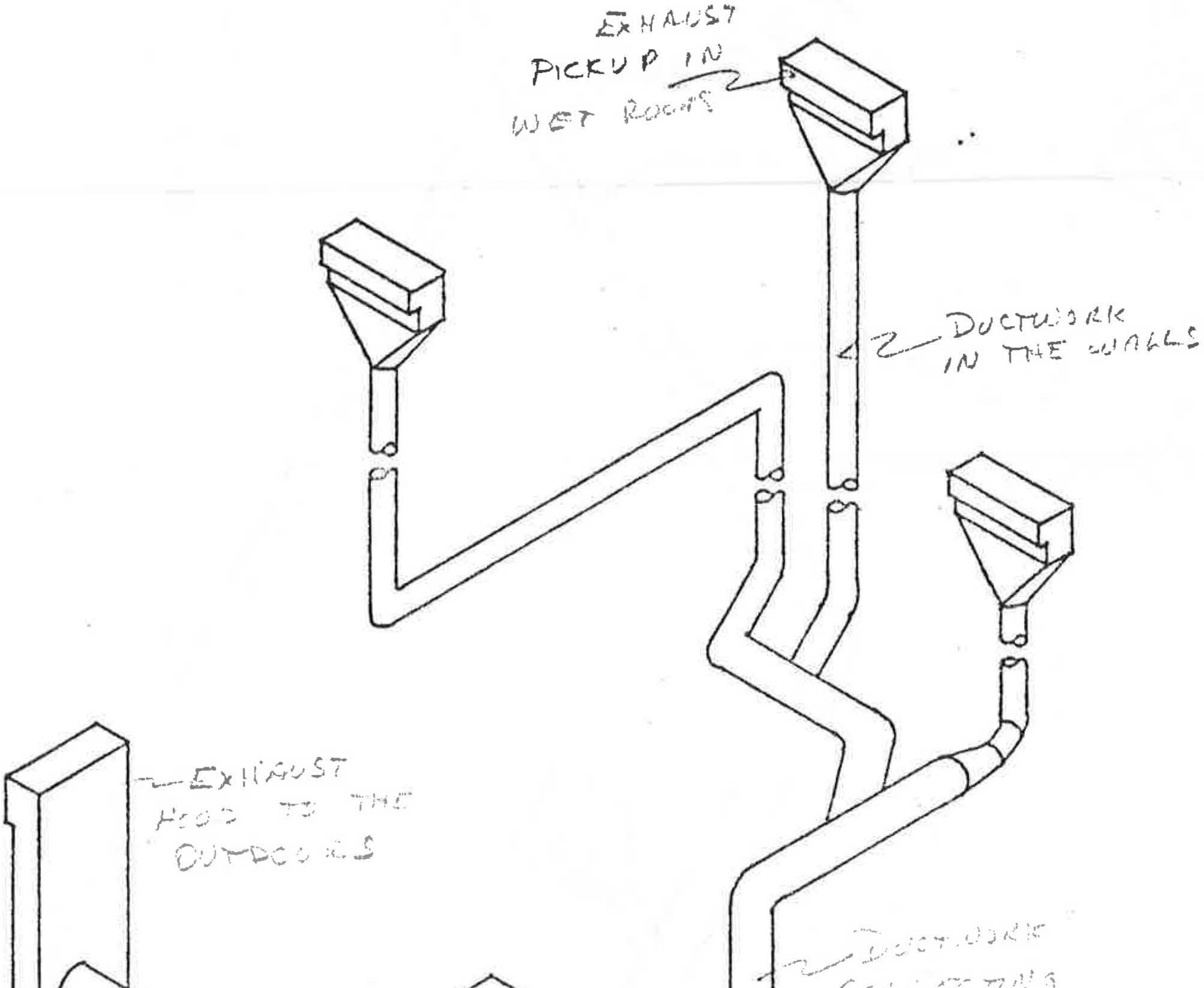


PAGE 38 + 39
"DUCTWORK"



SUPPLY AIR DUCTWORK ON AN HRV SYSTEM

PAGE 38 & 39
"DUCTWORK



EXHAUST AIR DUCTWORK ON AN HRV SYSTEM

desired destination. Although limited to some degree by structural and architectural considerations, the layout of the ductwork will largely determine how well the ventilation system will work.

It is the ductwork and its fittings that create the pressure drop which the fan must overcome when moving air into or out of the house. For example, a 90 degree elbow creates a pressure drop equal to ten feet of ductwork, a T fitting is equal to 50' of straight ductwork. Ductwork should be as short, smooth and straight as possible to minimize pressure drop and maximize air flow. Duct diameter has a major impact on pressure drop.

As a rule of thumb, use the largest diameter ducting practicable. A 6-inch duct has about half the resistance to air flow of a 5-inch duct, but twice the resistance of a 7-inch duct. Recommended minimum size of duct used in houses should be:

	Duct Diameter		Recommended Maximum Air Flow Rate	
	mm	inches	l/s	cfm
Bathrooms	125	5	24	50
Standard rangehood	150	6	48	100
Central fan serving both kitchen and bath(s)	175	7	83	175

Air leakage into and out of ductwork is a common problem. The usual round sheet metal duct used in most residential applications has a continuous "snap lock" seam along its length. This seam is generally very loose and leaky. On the discharge side of the fan, the air in the duct is pressurized and tends to leak out of the duct through the seam. Duct leakage may account for half the air flow through the fan. This reduces the effectiveness of the ventilation system. The seams and all joints and fittings in the ducting system should be sealed with duct tape by the homeowner or heating contractor; the number of joints and fittings should be kept to a minimum.

Although flex duct--the type commonly used for clothes drier exhaust--is airtight, its use is not recommended. It is expensive, compared to sheet metal ducting, and its interior roughness doubles the resistance to air flow compared to sheet metal duct.

Exhaust air ductwork in cold spaces such as attics, and supply air ductwork that carries unheated outdoor air through warm spaces should be insulated and have effective vapour barriers to prevent condensation problems. Condensation will form on the inside of exhaust air ductwork, so should be sloped to drain properly. Condensation will form on the outside of uninsulated cold supply air ductwork (like a glass of iced water on a warm day) and so it needs to be insulated and have an air/vapour barrier on the outside.

Grilles and Registers

Grilles and registers are the supply air outlets and exhaust pickups in the house. Registers are grilles equipped with control dampers that allow the occupant to adjust the air flow at the grille. Grilles and registers are often selected and positioned to mix the supply air with the room air or to aim it in a certain direction so it does not cause occupant discomfort from drafts and to promote good indoor air quality.

Exhaust air grilles or registers should ideally be located high on the wall in rooms where air contaminants are generated, typically the kitchen and bathrooms. This is because moisture in air rises, and moisture is the key contaminant to be removed from a house.

Supply air grilles should be located so they do not affect occupant comfort, for ventilation systems in many houses have been turned off in cold weather because the grille location caused drafts. If ventilation air is brought into a room at temperatures below 17 degrees C (63 degrees F), use high sidewall grilles to "shoot" the supply air into the room so the cooler air can mix with the warm room air before falling into the room. Generally, people don't mind a cool breeze around their heads, but feel uncomfortable or chilled with a cool breeze over their feet.

Balancing Dampers

Because resistance to air flow is a function of duct length

BALANCING DAMPERS ARE USED TO REDUCE AIR FLOW IN ONE DUCT TO INCREASE AIR FLOW IN OTHER DUCTS.

OPERATING HANDLE IS PARALLEL TO DAMPER BLADE.

PAGE 41 PART V
" BALANCING DAMPERS

and the number of bends in the duct, the ventilation system must be "balanced" to ensure the desired air flow goes into each room in the house. This is done by adjusting the dampers in branch ducts. Dampers on ducts with short, straight runs can be partially closed, while those on long, winding ducts should be fully opened. Air flows should be adjusted to provide the desired air quality. Remember, supplying more air to one area of the house is almost always done by decreasing air flow to another area.

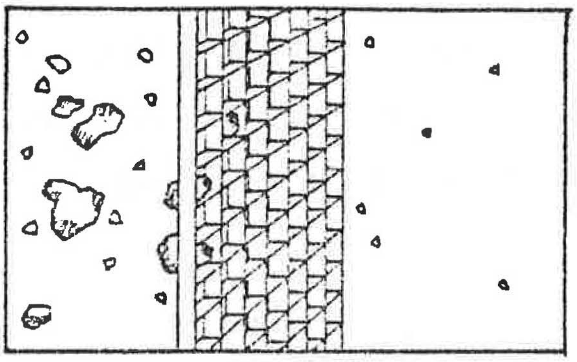
Filters

Air filters are used to remove dust and other large particles from air. However, normal glass fibre filters will not remove chemicals or cigarette smoke from indoor air. On a supply air system, air filters remove thistle and dandelion down, dust and insects from the air for the house. Where ventilation air is passed through heat recovery equipment, the filters prevent dust from fouling or plugging the heat exchange surfaces.

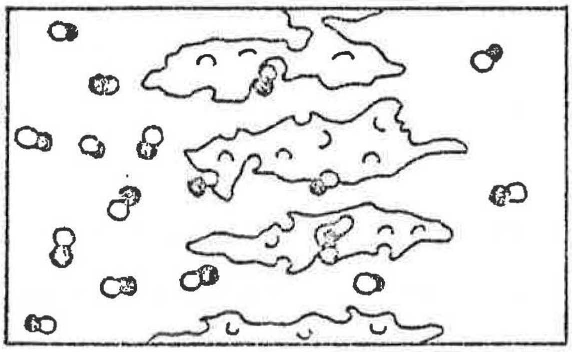
There are a variety of filters available on the market today whose capacity of removing airborne contaminants varies. It should be noted, however, that as the efficiency of fibre or mesh filters increases, air flow is more restricted, therefore a larger fan may be required to maintain adequate air flows.

The most common filter is the throw-away glass fibre furnace filter which should be replaced monthly during the heating season. Many homeowners prefer to use metal-framed filters,

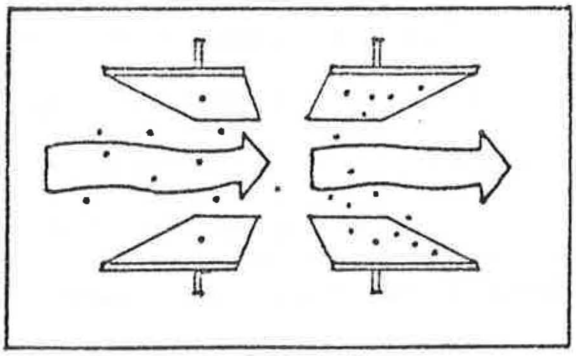
STANDARD FABRIC TYPE AIR FILTERS TYPICALLY REMOVE THE LARGEST 98% OF DUST PARTICLES FROM THE AIR.



ABSORPTION FILTERS CAN REMOVE CHEMICALS FROM AIR BUT ARE COSTLY TO MAINTAIN.



ELECTRONIC AND ELECTROSTATIC AIR CLEANERS REMOVE DUST PARTICLES



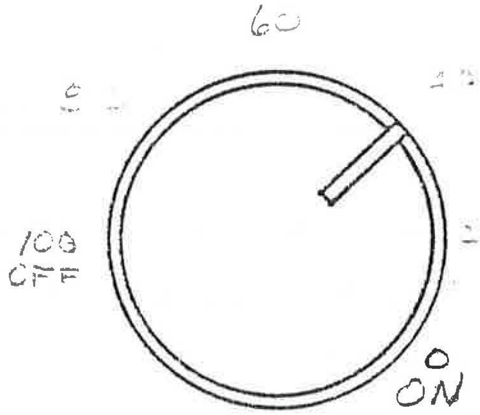
PAGE 42 & 43
"FILTERS"

which are then washed monthly to maintain their efficiency. These filters will only remove the largest particles from the air stream. High efficiency particulate air filters (HEPA filters) which remove over 99.9% of the dust from the air.are available and used in some commercial applications. However, these reduce air flows when used to replace conventional filters, are 7 to 15 cm thick (3 to 6 inches) and are installed downstream of low and medium efficiency filters. All this means is that they are not suitable for residential applications without significant modifications to the furnace fan and ductwork.

More efficient are electronic and electrostatic filters which give contaminant particles an electrical charge which causes them to attach themselves to a charged plate. These can remove most particulate contaminants, and any chemical contaminants that have attached themselves to dust particles.

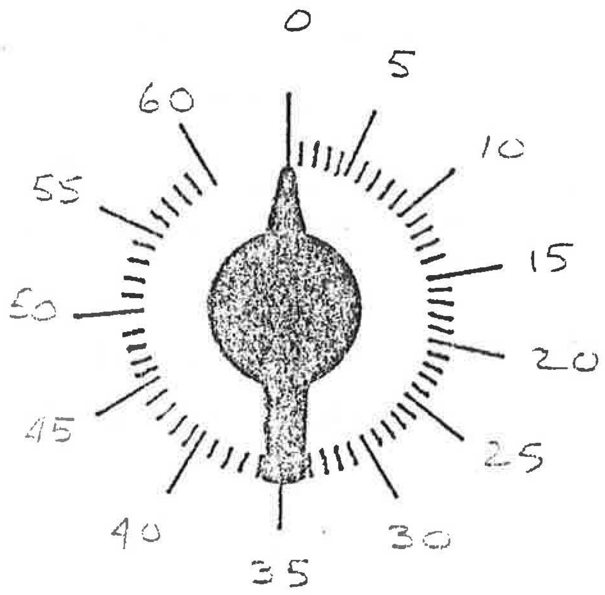
Filters on ventilation systems like HRVs should be checked at least every three months and cleaned or replaced if they are dirty. In houses with dust sources, such as a woodworker's hobby shop, more frequent servicing may be needed. The filters on exterior intake and exhaust hoods should be checked weekly to ensure they are not blocked by leaves, grass, debris or snow. To check for blockage, feel the breeze at a major supply grille on a regular basis. If there is a noticeable reduction in the air flow, check the filters for blockage.

Controls



OUTDOOR TEMP °C	°F	MAX R.H. RECOMMENDED = GLAZINGS DOUBLE	TRIPLE
SUMMER		— 100% OR OFF	
0	32	50	65
-10	14	30	55
-20	-4	25	45
-30	-22	20	35
-40	-40	15	30

DEHUMIDISTAT



CRANK TIMER
AUTOMATICALLY TURNS FAN OFF AFTER SET TIME

PAGE 43 + 44
"CONTROLS"

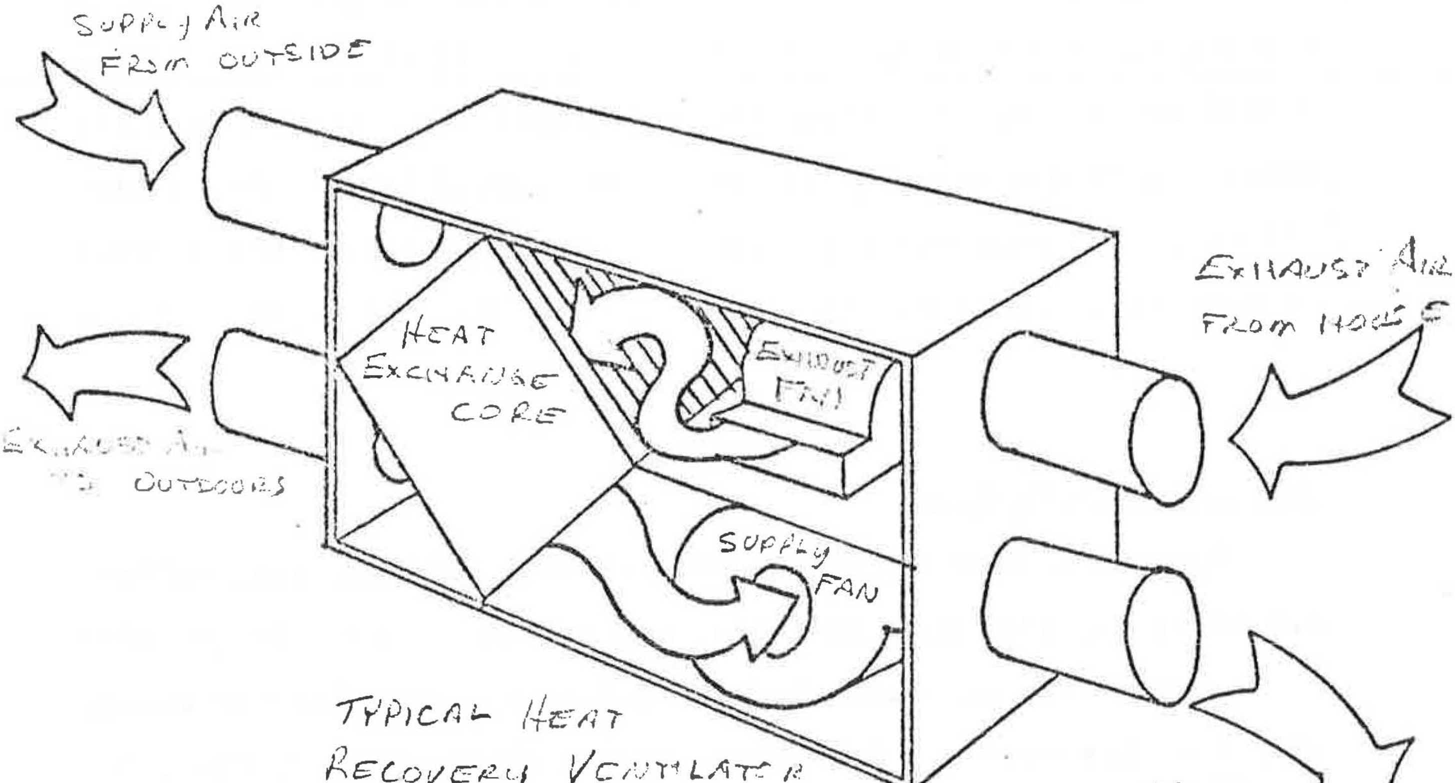
Controls are those switches, manual or automatic, which operate the ventilation system. Common types of controls include on/off switches on exhaust fans in kitchens and bathrooms, a dehumidistat which automatically starts the ventilation system whenever household humidity exceeds a set point, or an interval timer which automatically operates the ventilation system for pre-set time periods.

Installing the correct controls in the proper location is the key to effective operation of any ventilation system. There should be an on/off switch on the kitchen exhaust fan near the range. Bathroom exhaust fan switches should be located inside the bathroom near the light switch. Where possible, use a crank or electronic timer switches which turn the fan off after a preset time.

Heat Recovery Equipment

Equipment is available to recover heat from the warm exhaust air being expelled from the house and use it to preheat incoming cold supply air or domestic hot water thus reducing the energy bill for the house. Operation of the heat recovery equipment must not adversely affect the system's ability to ventilate. The first function of a ventilation system is to maintain healthful indoor air quality. While heat recovery is attractive, if it results in inadequate ventilation or poor air quality, the ventilation system will have failed its prime function.

A heat recovery ventilator (HRV) or air-to-air heat



TYPICAL HEAT RECOVERY VENTILATOR (HRV)

A.K.A. AIR TO AIR HEAT EXCHANGER.

exchanger is a device which captures heat from warm exhaust air and transfers it to incoming cold air, preheating the ventilation air to reduce costs. The economic benefits of heat recovery depend on ventilation rates, energy costs, and the outdoor temperatures during the heating season.

Many people will argue that the high initial cost of installing an HRV system ($1,500 to $2,500 for a "typical" installation, depending on house size and climate) makes it economically unattractive. However, the air being expelled from the house has been heated, thus ventilation does cost money. The more severe the climate, the higher the cost of ventilation, and the greater the economic attractiveness of heat recovery.

Even if heat recovery is not included in the ventilation system, incoming fresh air should be warmed to ensure the comfort of those living in the house. Remember that the "do nothing" option also has a cost--inadequate ventilation, reduced air quality, and possible health problems for occupants and structural problems for the house.

Ventilation System Quality

Several factors contribute to the quality of a mechanical ventilation system. These include: the quality of the components selected; the size and layout of the system, the controls which operate the system, the workmanship of the system and its installation, and how the occupant uses the controls and maintains the system. A "quality" ventilation system will operate quietly, run only when needed, and will not create drafts or uncomfortable areas in the house. If the house is being renovated, the ventilation system can be improved, often dramatically. If you're renovating, or purchasing a new home, the following points should help you determine the quality of a particular ventilation system:

1. Fans operate quietly.

2. Fans move a noticeable quantity of air out of and/or into the house.

3. Ductwork is straight, smooth and as short as possible.

4. Ductwork carrying warm air through cold spaces (eg. attic or crawl space) or cold air through warm spaces is well insulated and has a good, well-sealed air/moisture barrier on the outside.

5. Ductwork is properly suspended and sealed; all seams and joints are taped.

6. Fresh ventilation air is introduced into the space either in such a way as to not blow on occupants--e.g. high wall supply, or is preheated so the air movement will not create cold drafts and cause discomfort to occupants.

7. Fresh air supply and exhaust grilles are located in a room to encourage air movement throughout the space without adversely affecting occupant comfort.

8. Exhaust ductwork is run down and out to prevent cold air from entering the house.

9. Exhaust fans do not discharge into attics, crawlspaces, garages or other enclosed spaces where moisture build up can be a problem.

10. Supply air inlets are at least 450 mm (18 inches) above the ground and not located near exhaust fan discharges, dryer discharges, oil fill pipes, gas meters, garbage cans, driveways, or other areas with contaminant sources.

11. Filters, fans and other components which need maintenance are easily accessible for servicing.

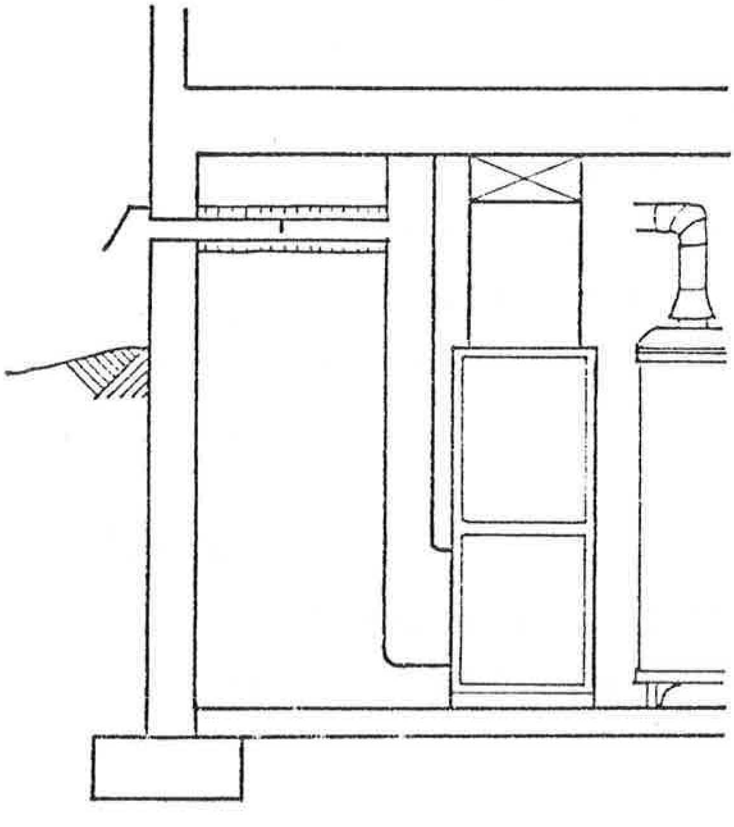
12. Controls are easily understood and conveniently located.

If you are planning a new ventilation system or upgrading an existing system, you may require some qualified advice. HRAI has a certification program for installers of residential ventilation systems. As well, they have courses on understanding, designing and installing residential ventilation systems. If you wish information on these courses or on certified installers in your region, contact the Heating, Refrigerating and Air Conditioning Institute of Canada, 5468 Dundas Street West, Suite 226, Islington, Ontario M9B 6E3.

SUMMARY

- o Become familiar with the ventilation requirements of your house.
- o Determine if you have problems caused by inadequate ventilation. Check for:
  - Prolonged condensation on your windows in winter
  - Symptoms of health problems resulting from indoor pollutants
  - Signs of combustion appliance backdrafting
- o Decide on the proper solution:
  - Turn the humidifier off
  - Install a fan in the kitchen
  - Eliminate pollutant sources
  - Install a combustion air vent to the furnace
  - If necessary, choose an appropriate ventilation system.

Providing adequate ventilation makes sense. With a good mechanical ventilation system, you will be better able to control your indoor environment and maintain a fresh, healthy atmosphere.



FRESH AIR CONNECTED TO FURNACE
RETURN AIR DUCT.