R-2000 BUILDER NOTES

NUMBER 1. WOODBURNING IN WELL-SEALED HOUSES

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The quality of indoor air has recently become a matter of increasing concern to the public and to housing technologists. One potential source of indoor air pollution is the leakage of combustion gases from wood stoves and fireplaces. Wood smoke in the house is more than unpleasant; it is unhealthy.

Almost all woodburning appliances rely on natural draft developed by the heat of combustion gases which rise and exhaust from the chimney. Natural draft is usually a weak force which can be affected by pressure variations within the house envelope, and by the type of woodburning appliance. For example, an open fireplace at full fire produces strong draft and consumes a large volume of room air. As a result, the operation of woodburning appliances can be affected by, and can affect, pressure within the house, depending on the characteristics of the building envelope.

When a woodburning device is installed in a well-sealed house, whether for space heating or aesthetic purposes, careful planning is needed to ensure effective and safe operation. Installation should involve a number of specialized features, like a ducted source of outdoor air and the correct type of chimney. The effect of the house ventilation system and other air-exhaust equipment must also be considered.

This bulletin provides information on the key concepts involved in this planning process and gives suggestions for reliable operation of woodburning appliances.

Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

Canadian Home Builders' Association | Association canadienne des constructeurs d'habitations

Key Concepts

Air Leakage

There is a natural tendency for warm air in a house to rise, creating a slight pressure differential between the basement and the upper floors. Discounting other influencing factors, the pressure in the basement will be lower than on the second floor, and at some level on the main floor the pressure will be neutral. This phenomenon, known as 'stack effect', creates a condition in which air tries to escape near the upper part of the building as outside air is drawn in near the lower part.

Before the advent of energy-efficient building techniques, houses often had leaky envelopes, allowing indoor air to exfiltrate and outdoor air to infiltrate relatively easily. Therefore indoor air could be exhausted by furnaces, fireplaces and fans, since the leaky envelope allowed replacement air to enter.

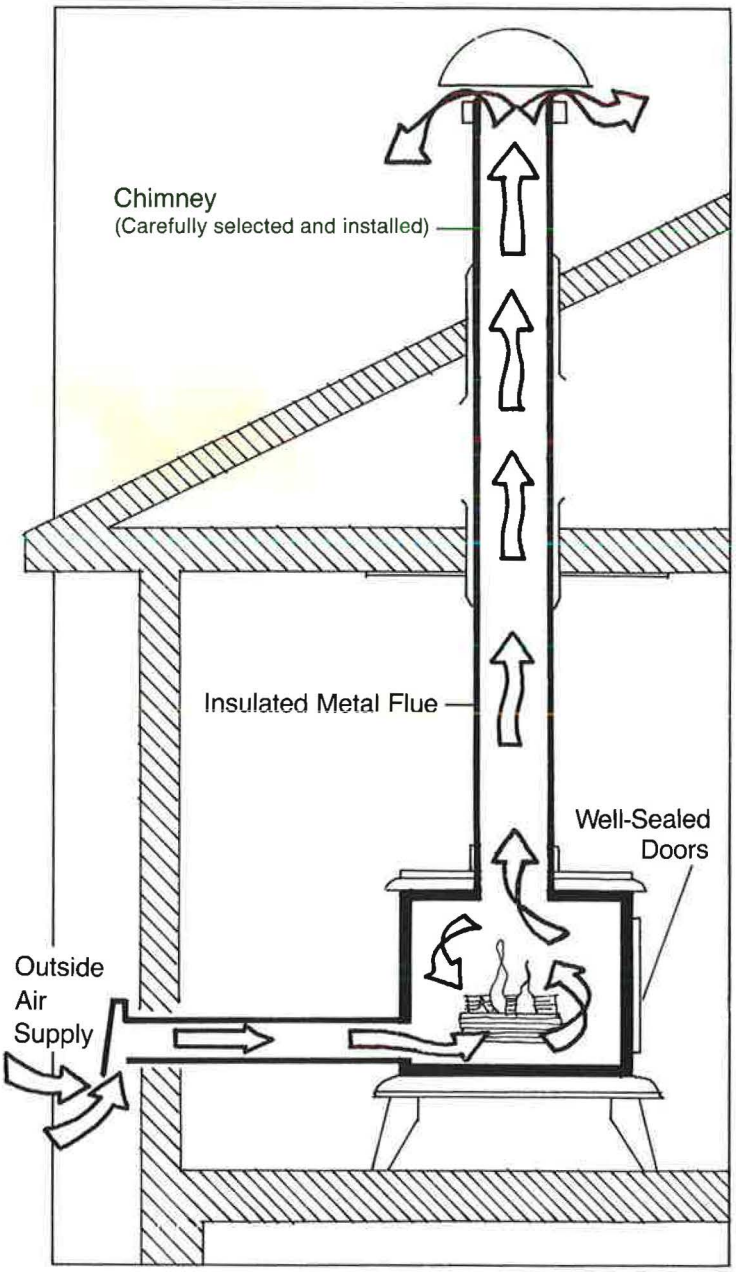
New energy-efficient homes incorporate air-sealing procedures which dramatically reduce this unregulated flow of air through the envelope. A well-sealed envelope resists the uncontrolled infiltration of replacement air to compensate for the air removed by exhaust systems. Therefore, when more air is exhausted than can be replaced by infiltration, the pressure in the house falls below atmospheric pressure. The house is then considered to be depressurized.

House Depressurization

R-2000 homes use mechanical ventilation systems, often incorporating heat recovery, to exchange moisture- and contaminant-laden indoor air for fresh outside air. The R-2000 technical criteria specify that these systems be balanced in order to avoid changing the pressures within the house envelope. The systems are intended to provide ventilation air for the occupants and not to supply air for combustion appliances.

In the 'real world' of house construction, the ventilation control which is necessary to maintain a relatively neutral pressure can be difficult to achieve. If the operation of the ventilation system or other air-exhaust equipment causes significant depressurization of a well-sealed house, the system(s) will compete for the available air. In this contest for air, mechanical systems usually win out over natural draft systems. The forced mechanical exhaust from a clothes dryer, central vacuum or high-volume kitchen fan may overcome the weak force of natural draft in chimneys and disrupt the operation of fireplaces and wood stoves. This disruption can range from causing an improper fuel-air mixture for combustion, or slight leakage of combustion products into the home, to the complete reversal of chimney flow and the spillage of all combustion products into the home.

During chimney flow reversal, the flue becomes an air supply route to the house. Although complete reversal is rare, it can occur during a smouldering or receding fire, when the flue temperature (and therefore draft) falls. A more common problem is slow leakage of exhaust gases from the appliance into the home. Leakage of any combustion gases into a well-sealed house must be considered a failure of the system. For this reason, separation of the air intake and combustion exhaust air flows of woodburning appliances from the rest of the house is important to their safe and effective operation during changes in house pressure.



Air Flow Separation for Woodburning Appliances

Air flow separation by isolating the combustion air and exhaust gas streams of the appliance from the air in the house makes the operation of combustion appliances resistant to disruption caused by variations in house pressures. Air flow separation is achieved by ducting outdoor air directly to the combustion air inlets of the appliance, and by ensuring that the appliance is isolated from the rest of the building — by installing well-sealed doors, for example. Significant depressurization of a house in which a woodburning appliance is installed should be avoided. For example, when the loading door is opened, no separation exists between the air in the house and the combustion gases, therefore depressurization of the house could still lead to spillage of combustion products into the room when more wood is added.

Suggestions For Reliable Appliance Operation

Appliance Sizing and Combustion Features

It is important that modern woodburning appliances be matched to the requirements of the space to be heated. R-2000 homes have very low space heating requirements, and should therefore be equipped with woodburning appliances which are able to operate efficiently at low heat output settings. In general, the smaller the firebox the more efficiently the appliance will operate at low heat outputs. Wherever possible, choose appliances which are physically smaller than average.

Some woodburning appliances incorporate catalytic combustors to increase efficiency. The combustor effectively lowers the ignition temperature of combustible wood gases. Of importance to R-2000 Home builders is the fact that these stoves tend to operate cleanly and efficiently at extremely low power outputs. For this reason, it may be beneficial to consider specifying catalytic appliances over conventional models. If catalyst-equipped appliances are unsuitable or unavailable, look for high-efficiency, non-catalytic appliances with small fireboxes. High-efficiency wood stoves have internal baffles to improve combustion at low outputs.

The Use of Mobile Home Appliances

For the builder of R-2000 homes, the most straightforward and reliable way of avoiding venting problems, such as smoke spillage, is to specify the use of woodburning appliances that are tested and certified for use in mobile homes. Because mobile homes are assumed to be relatively airtight, combustion appliances used in them have approximately the same characteristics as those needed for well-sealed, energy-efficient homes. During testing, mobile home appliances are enclosed in a test stand which is depressurized as the heater operates. Part of the certification requirements for these appliances is the provision of the necessary parts and instructions for the connection of outdoor air supply ducts to the combustion air inlets. Another advantage of using mobile home-certified appliances in energy-efficient homes is their lower heat output compared to standard appliances. A number of wood stoves and factory-built appliances are available with mobile home certification (see list at end).

Direct vs Indirect Combustion Air Supply

The R-2000 Home Program requires a direct outside air supply for wood stoves and fireplaces, as is required for mobile home-certified appliances. Direct connection to an outside air supply is always preferable. However, some appliances, such as wood-fired cooking ranges, are not available with mobile home certification or with combustion air controls which are suited to the direct connection of outdoor air ducts. Therefore the combustion air and flue gas stream of such appliances cannot easily be separated from the air in the house.

In these cases, combustion air may be supplied to a floor grille located near the appliance air inlets. The air duct should incorporate an atmospheric or negative pressure damper to prevent unnecessary leakage of outside air until it is demanded by the appliance. Note, however, that an indirect supply of combustion air will not be as effective as a ducted source in preventing smoke spillage during house depressurization. Also, while outside air may flow to the vicinity of the appliance, it may not be drawn into the air inlets. The appliance may not starve for air, but the result could be a cold draft across the floor.

Basement Installations

The negative pressure in the basement caused by stack effect can increase the likelihood of smoke leakage or backdrafting in basement installations and, although relatively minor, can be a significant factor when combined with other causes of negative pressure, such as the operation of exhaust fans.

The best approach to the prevention of venting failure in basement installations is to ensure compensation for stack effect-induced negative pressure. This can be accomplished by providing sufficient air to the basement from the air distribution ductwork. The duct system can be designed to provide slightly more supply air to the basement than is returned to the furnace fan.

Do not attempt to distribute heat from a basement woodburning installation by providing or increasing return air capacity from the room — severe depressurization of the basement room can result. The opposite approach is preferable; that is, the provision of slightly more supply air than return air in order to compensate for stack effect. This approach assumes continuous operation of the furnace circulating fan.

In homes without a central air distribution system, such as those heated with electric baseboards, the ventilation system should be designed to avoid creating excessive negative pressure in the basement by supplying outside air to the basement and keeping ventilation systems balanced.

Chimney Design and Installation

Because most woodburning appliances operate on natural draft, they are highly sensitive to the quality and performance of the chimney. Chimneys function best when the flue is isolated from outside cold. As a general guideline, chimneys which are intended to serve woodburning devices should be located inside the house rather than on an outside wall. If a chimney must be located on an outside wall, it is imperative that the liner be insulated, and that the continuity of the exterior wall insulation and air barrier be maintained. Most factory-built chimneys for woodburning appliances incorporate liner insulation. A noncombustible insulating material, such as vermiculite, may be used to insulate the liner of a masonry chimney.

The chimney flue should be straight to facilitate cleaning and to minimize creosote deposition. The chimney liner should be sized to match the cross-sectional area of the appliance flue collar. Oversized chimneys tend to perform poorly when venting controlled combustion woodburning appliances.

It is important to refer to the appliance manufacturer's specifications. For example, a minimum chimney height may be required in order to ensure that the appliance has proper draft. For some fireplaces, a chimney of more than 20 feet in height may be specified. This can affect the choice and location of an appliance for a particular house.

Where chimneys penetrate air barriers, careful sealing is important. Attic radiation shields may be sealed to the chimney with a bead of 500°F silicone sealant. Standard caulking may be used for flange-to-air barrier joints. Metal flashing strips can be used to bridge the clearance between masonry chimneys and combustible construction. Silicone sealant will provide a seal between the flashing strips and the masonry.

Selection of a Factory-Built Chimney

Specialized chimneys have been developed for woodburning appliances, since it was found that chimney fires could damage conventional chimneys and render them hazardous. New chimneys are available with stronger flue liners and more insulation than the older types. When selecting a metal chimney, be sure to specify the 650°C type, which has been tested in accordance with the standard developed by Underwriters' Laboratories of Canada. Air-cooled chimneys are not permitted in R-2000 homes, since some designs could lead to depressurization or condensation problems as warm room air comes into contact with the cold surface of the chimney.

Creosote buildup in chimneys can be a problem with woodburning appliances. In addition to the preceding suggestions for selecting appliances and chimneys, note that it is important to keep the single-wall flue pipe assembly as short and direct as possible. A shorter flue pipe with no more than two 90 degree elbows will ensure higher flue gas temperatures, better draft and less creosote in the chimney.

Conventional Masonry Fireplaces

New guidelines for masonry fireplaces and chimneys are being prepared by a committee of the Canadian Standards Association (CSA). The standard will include specifications for the supply of outdoor combustion air and for the insulation of the back wall of fireplaces situated on outside walls. The Canadian Home Builders' Association is seeking comment from the CSA committee on proposed designs and construction techniques for masonry fireplaces in R-2000 homes. Design guidelines for masonry fireplaces will be the subject of a future R-2000 publication.

While it is premature to state firm guidelines for masonry fireplaces in well-sealed homes, certain features should be incorporated. The fireplace should be provided with a source of outside combustion air ducted directly to the hearth area. Fireplaces should also have tight-fitting dampers located either at the fireplace throat or at the top of the chimney. The hearth opening should be provided with doors which fit as tightly as possible. Finally, masonry fireplaces and their chimneys should be located within the heated area of the home. If this is not possible, noncombustible insulation should be incorporated into the construction of the back wall of the fireplace and around the flue liner.

General Observations

R-2000 Home builders are often in the position of introducing consumers to new products and concepts and to the operation of unfamiliar systems. In the event that any of the specialized components fail to function properly, the homeowner may hold the builder responsible. The surest way to avoid homeowner dissatisfaction is to anticipate problems and take the necessary steps to prevent them from occurring.

When a house design includes a woodburning appliance, it is wise to assume that the appliance will not function properly unless specific measures are taken to make certain that it works. Such measures include the provision of a ducted source of outside air, slight pressurization of the room in which the appliance is located, and careful selection and installation of chimneys. Even if a woodburning appliance is not installed at the time of construction, it is wise to inform the homebuyer of the special precautions needed should he or she decide to install a unit later.

Do not assume that the heating subcontractor understands the air flow and pressure dynamics of a well-sealed house. Brief him thoroughly and provide guidelines for installing the appliance.

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1. OUTDOOR-AIRED, SOLID-FUEL SPACE HEATERS

Solid fuel-fired space heaters currently (June 1986) certified for use in mobile homes. These are outdoor-aired units.

CSA Standard B366.2-M1981

Manufacturer	Model No.	Certifying* Agency
Hunter Enterprises Ltd., P.O. Box 400, Orillia, Ontario	MH42 MH55	CSA
Pacific Energy, P.O. Box 514, Duncan, British Columbia	270/A 430/A	CSA
APR Industries, 131 Cordite Road, Winnipeg, Manitoba	Kozi-Mobile 11	ULC
Harthex Inc., 256 Woodlawn Road, W., Guelph, Ontario N1H 6J4	Harthex 300 series	ULC
Heatilator Inc., Tualatin, Oregon	1800A 2400A Fire Lite 3000	ULC WH
Kent Heating Ltd., Tidal Road, Mangere, Auckland, New Zealand	Sherwood Tile Fire OSA	ULC
Black Pine Mfg. Ltd., 421 Mount Paul Way, Kamloops, British Columbia V2M 1A7	Thompson Valley	WH
Concord Mfg. Corp., 20 Kitchener Ave., London, Ontario N5Z 2B2	ST 320 ST 420 ST 520 ST 620	WH
The Earth Stove Inc., 9775 S.W. Commercial Circle, Wilsonville, Oregon 97070	710M	WH
Heating Energy Systems Inc., P.O. Box 593, 14285 S.E. 98th Court, Clackamas, Oregon 97015	Hugger 25000 26000 33000 34000 Trailblazer	WH
Hevac Fireplace-Furnace Mfg. Ltd., 4390 Paletta Court, Burlington, Ontario L7L 4X5	Hevac WC120	WH

*NOTE: The certifying agencies are identified as follows:

CSA Canadian Standards Association
CGA Canadian Gas Association
ULC Underwriters' Laboratories of Canada
WH Warnock Hersey Professional Services Ltd.

OUTDOOR-AIRED, SOLID-FUEL SPACE HEATERS (continued)

Manufacturer	Model No.	Certifying Agency
Kingsman Industries Ltd., 43 Muir Road, Winnipeg, Manitoba R2Z 2X7	Chancellor	WH
Kodiak Canada Mfg. Ltd., P.O. Box 280, 7-817 Industrial Road 2, Cranbrook, British Columbia V1C 4H8	Lil' Scot Lil' Scot Mobile Home	WH
Lopi Energy International, 10850 — 117th Place, N.E., Kirkland, Washington 98033	440	WH
Meridian Fireplace Canada Ltd., 15304 Yellow Head Trail, Edmonton, Alberta T5V 1A1	Meridian MS-84	WH
Northwest Stoves Ltd., 1446 Charlotte Road, North Vancouver, British Columbia V7J 1H2	1 Celebration	WH
Oliver MacLeod Ltd., 5 Edward St., Gravenhurst, Ontario P0C 1G0	Canopus Large (CSL) Canopus Small (CSS) (with chimney HT 3103)	WH
Orley's Stove Company, P.O. Box 3011, 6011 — 196A Street, Langley, British Columbia V3A 4R3	UO WUO WUOS UOS Series Nos. 200, 202, 203, 220, 222, 223, 240, 242 and 243	WH
Osburn Industries Ltd., 6691 Mirah Road, R.R. No. 3, Victoria, British Columbia V8X 3X1	Regent 1000 Regent 1500	WH
Pacific Energy, P.O. Box 514, Duncan, British Columbia V9L 3X9	Super 27 Super 43 Cottage	WH
Pinehill Innovators Ltd., Unit 205 — 20701, Hwy. 10, Langley, British Columbia V3A 5E8	Challenger 700 Challenger 1000	WH
R.M.S. Engineering, 45831 Hocking Avenue, Chilliwack, British Columbia V2P 1B5	Mountain-Glo 15M	WH
R.S.F. Energy Ltd., 2965 Tatlow Road, P.O. Box 3637, Smithers, British Columbia V0J 2N0	HF65R HF45R HF50R HF70R Ardent Aurora 45S	WH
Ranger Stove Company, Lake Grove, Oregon	Ranger 828	WH
Regency Industries Ltd., 7830 Vantage Way, Delta, British Columbia V2G 1A7	Regency CC Norland Westwood Rancher	WH
Seefire Products Ltd., 3930 Hobbs Street, Victoria, British Columbia V8N 4C9	220 320	WH
C.E. Smith Company, 3035 E. Peters Creek Rd., N.W., Roanoake, Virginia 24019	Goldilocks	WH
Valley Comfort Systems Inc., P.O. Box 15, Crescent Valley, British Columbia V0G 1H0	VC 16	WH
Woodcutters Manufacturing Inc., Route 4, Box 218, Walla Walla, Washington 99352	PEJ-1002 PEJS-1002 PT PTJ PTS PTJS BT BTJ BTS BTJS Blaze King PWCS-1500 Blaze King	WH

2. OUTDOOR-AIRED, SOLID-FUEL FIREPLACES

Solid fuel-fired fireplaces currently (June 1986) certified for use in mobile homes. These are outdoor-aired units.

ULC-S610-M1979

Manufacturer	Model No.	Certifying Agency
Security Chimney Ltd., 2125 Monterey Street, Chomedy, Quebec	7C-36 7C-36MH	ULC
Heatilator Inc. Mt. Pleasant, Iowa	RF36C RF36D	ULC
Selkirk Metalbestos Household Manufacturing Canada Inc., Brockville, Ontario	3620	ULC
Standex Energy Systems, P.O. Box 558, Medina, Ohio 44256	Numerous	WH