Residential Combustion Venting Failure - A Systems Approach

Project 5

Remedial Measures for Wood-burning Fireplaces:
Airtight Doors with Direct Air Supply

RESIDENTIAL COMBUSTION VENTING FAILURE

A SYSTEMS APPROACH

FINAL TECHNICAL REPORT

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:

AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Sheltair Scientific Ltd.
Scanada-Sheltair Consortium Inc.

Principal Consultant:	Sebastian Moffatt Sheltair Scientific Ltd.
CMHC Project Manager:	Don Fugler
CMHC Scientific Authority:	Jim H. White

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STATEMENT OF PART V FUNDS

Canada Mortgage and Housing Corporation, the Federal Governments' housing agency, is responsible for administering the National Housing Act.

This legislation is designed to aid in the improvement of housing and living conditions in Canada. As a result, the Corporation has interests in all aspects of housing and urban growth and development.

Under Part V of this Act, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research. CMHC therefore has a statutory responsibility to make widely available, information which may be useful in the improvement of housing and living conditions.

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SUMMARY

This report presents an evaluation of airtight doors and direct air supply for conventional wood burning fireplaces, in terms of their ability to remedy pressure-induced spillage problems. The report is one of a series of reports on remedial measures for combustion venting failures, prepared by the Scanada-Sheltair Consortium Inc. on behalf of CMHC, as part of a larger research project entitled "Residential Combustion Venting Failures - A Systems Approach."

The installation of airtight doors with direct air supply was seen as a promising remedial measure for two reasons. First, it eliminated the fireplace as a powerful exhaust device in a house, thus avoiding spillage from other chimneys. Secondly, it eliminated the potential for spillage from the fireplace during low burn, when fireplaces are particularly susceptible to backdrafting or spillage, thus avoiding the associated health hazards and comfort problems.

A Vancouver test house with a history of fireplace spillage problems was used to evaluate the performance of airtight doors. A number of experts were consulted about the optimum design for airtight doors, and in the absence of any suitable commercial doors for fireplaces, a customized door was manufactured locally. The leakage area of the door was tested using a depressurization fan, and compared with leakage areas of conventional fireplace doors. Temperature mapping was conducted with a computerized data acquisition system. It recorded temperatures around the fireplace opening as well as inside the firebox, flue, and structural materials surrounding the chimney. Airflows and temperature inside and around the fireplace were monitored before and after installation of airtight doors, and under varying degrees of house depressurization.

Special design considerations were required for airtight doors, including a ceramic-like glass and a heavier gauge steel frame with glass fibre gasketing material. A heat exchanger was incorporated into the door, to compensate for the loss of radiated heat and to help in dissipating heat built up in the firebox. The optimum location for combustion air supply was determined to be the front of the fire, blowing downwards or around the glass. A retrofitted ash-cleanout was rejected as an air supply route. Instead, combustion air was drawn from outside through the back of the firebox, and directed to the front of the fire by means of a duct beside the heat exchanger.

The installed cost of the airtight doors with direct air supply was $600. This is not considered excessive in comparison with conventional doors. It compares well with the much higher cost alternative of installing an airtight fireplace insert and re-lining and insulating the chimney.

The installation procedure for airtight doors is documented with photographs. Decisions were made to leave the fireplace damper operational and to use a single-damper system for combustion air employing a tight-fitting piston design. Tests showed that the careful sealing of the door frame to the masonry was essential for proper operation, and that application of silicone sealant was needed prior to installing the door frame. Questions raised about the durability of such a seal could not be answered within the time-frame of this project.

The effect of airtight doors on the fireplace was to increase the House Depressurization Limit (pressure at which spillage occurs) from 8 Pascals to 22 Pascals when a strong fire was burning.

The ELA of conventional doors was shown to vary from 84 to 123 cm^2, in comparison with 14 cm^2 for the airtight doors.

The possibility of increased fire hazard after installing airtight doors was identified as a major concern during the project. All provincial fire commissioners were contacted to assess the number of fires related to fireplace doors. Evidence was found of fireplace doors being implicated in house fires, although the data was inconsistent and could not be used to establish whether doors increased or decreased the hazard. Recommendations from the fire commissioner's office (British Columbia) suggested that all fireplaces with add-on doors meet the latest code requirements. This is apparently impossible for most existing fireplaces. An alternative strategy, presented in this report, includes undersizing the combustion air, extracting heat from the fireplace with a heat exchanger, and a step-by-step procedure for determining combustion clearances in the field prior to determining whether airtight doors should be installed. A limited amount of monitoring of the test fireplace with airtight doors indicated safe temperature ranges for combustible materials next to the fireplace chimney.

Before wide-spread application of airtight doors is recommended, a variety of issues remain to be resolved, especially the durability of the seal between the masonry and the door frame, and potential for increased fire hazard after installation of airtight doors.

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1.0 INTRODUCTION

This report is one of a series of reports on remedial measures for combustion venting failures, prepared by the Scanada-Sheltair Consortium Inc. on behalf of CMHC, as part of a larger research project entitled "Residential Combustion Venting Failures - A Systems Approach." (Refer to Appendix 7 for an overview of the entire research project.)

A fireplace is the source of two types of venting failures. Firstly as a powerful exhaust device it greatly increases the chance of spillage from other chimneys - such as a furnace or DHW heater. Secondly, as a combustion appliance, a fire place often operates at a weak draft, and can be caused to spill at back pressures as low as 2 and 3 Pascals. This research report describes a remedial measures for fireplaces that would correct or avoid both these types of venting failures.

The measure consists of installing airtight ceramic doors with direct outdoor air supply on an open fire place. Although airtight doors for fireplaces are usually a costly retrofit, they were considered a high priority because they appear to be the only way to retain the fireplace while correcting venting problems. Moreover the use of truly airtight doors is currently rare, despite their promotion by some builders and fireplace supply outlets. Numerous issues remain to be resolved, such as fire safety, and the proper procedure for sizing, routing, installing and dampering the combustion air supply.

Two primary objectives guided the research. The first was to develop guidelines for identifying houses and fireplaces where the installation of airtight doors can be considered a safe, acceptable, remedial measure.

Special emphasis was placed on the need to avoid high temperatures and associated fire hazards. A second objective was to identify, through computer modeling and field research, the acceptable parameters of airtightness for doors, and the best procedures for installing direct air supply into a fireplace chamber for optimum performance.

2.0 RESEARCH METHOD

2.1 Test House Selection

One of 3 test houses rented in Vancouver by Sheltair for this project was used for detailed evaluation of the effectiveness and safety of fireplace doors with direct air supply. The test house was a 2 storey, wood frame building with a full basement and 230 m² of living space. The fireplace is located in the ground floor living room, and is connected to an unlined exterior masonry chimney. The fireplace design, illustrated in Figure 1, is typical of many existing houses, although dimensions were slightly smaller that average.

The existence of a frame wood wall at the mantle level permitted an evaluation of the fire safety issues.

The house had a history of spillage and backdrafting problems with the fireplace due to competing exhaust devices and a tight house envelope. For these reasons the occupants had stopped using the fireplace entirely.

2.2 Design Process

To determine the optimum design for doors, discussions were conducted with manufactures of airtight doors, and local experts such as the Warnock Hersey Testing Laboratories and the B.C. Fire Commissioner's Office. From these sources data was collected on problems with airtight doors, and possible solutions.

Fire hazard concerns were also discussed with the technical consultants employed for this project, J. Gulland of Performance Woodburning, and M. Hatzinikolas, Technical Director of Alberta Masonry Institute. Testing of the new safety doors was conducted in the company of the local fire inspector, and special emphasis was given to evaluating fire safety.

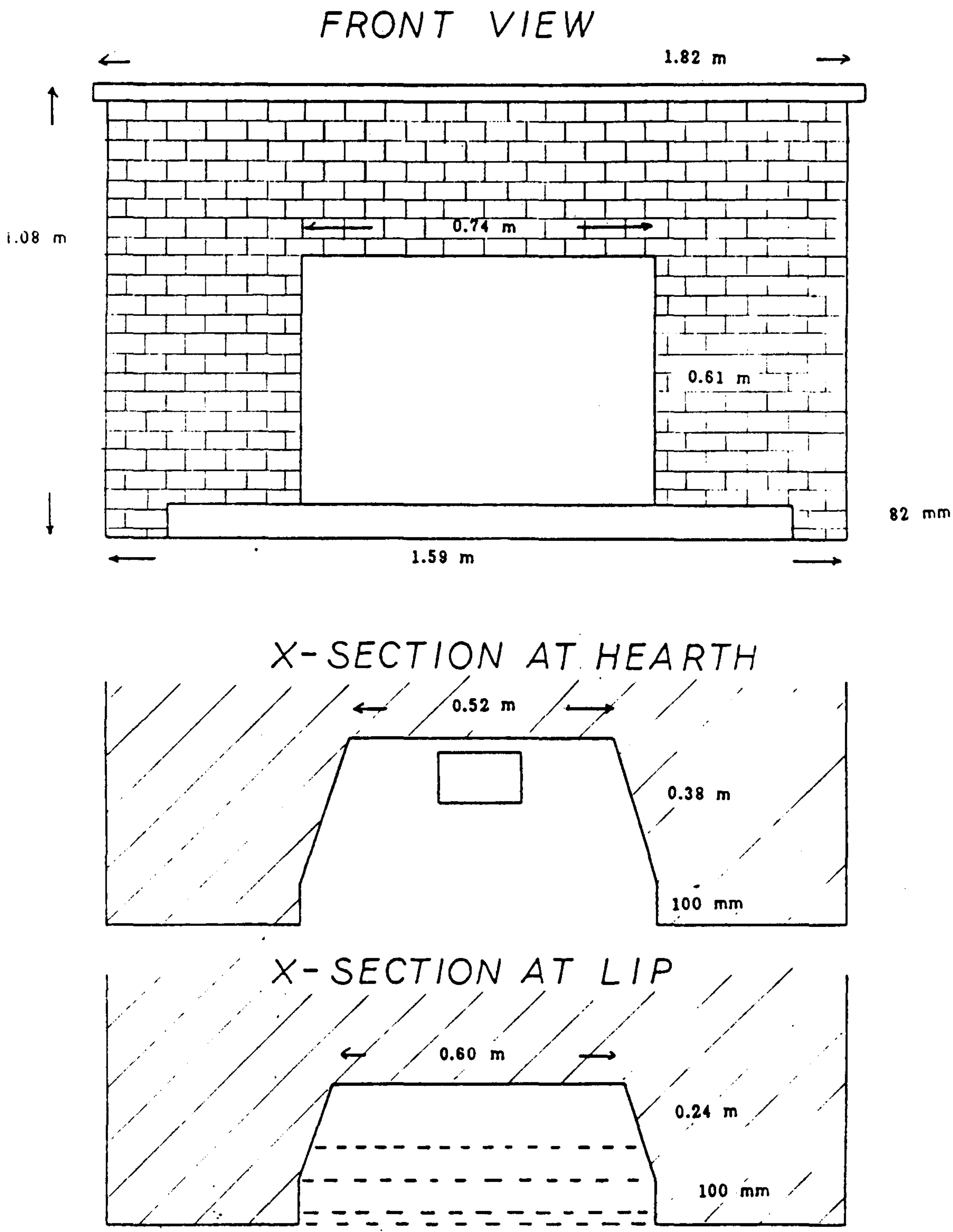


FIGURE 1: Schematic of Fireplace in Test House

2.3 Temperature Mapping

Multiple type E thermocouples were used, in conjunction with a Sciemetrics Data Acquisition System, to monitor temperatures of the fireplace and surrounding materials on an IBM computer. Holes were drilled into the masonry, and thermocouples were inserted at different depths to measure temperatures of combustibles, and combustion gasses, while altering the configuration of the fireplace doors and air supply, and rate of burn.

2.4 Leakage Area of Doors

A calibrated Retrotec door fan was used to determine the tightness of the door, firstly as installed by the manufacturer, and secondly as a tighter unit sealed to the facing brick with masonry silicone. The size of the combustion air was also measured using the calibrated door fan, although the small dimensions of these areas relative to the house, made the process of measuring difficult and time consuming.

2.5 Determining Effectiveness

To determine the degree to which the fireplace was isolated form the house, a Dwyer inclined manometer was used to measure draft in the hot fire box before and after sealing the frame, and with the door open and closed. At the same time the House Depressurization Limit for the fireplace doors was determined by causing backdrafting or spillage under three different operating conditions: door closed and unsealed, door closed and sealed, and door wide open.

2.6 Sizing of Combustion Air

The sizing of the combustion air intake was to be calculated with assistance from FLUE SIMULATOR, a computer model for simulating the dynamic operation of combustion appliances and flues. Unfortunately the FLUE SIMULATOR fireplace module under development by Scanada was not yet completed to a point where such use was possible. Instead, the sizing was determined in consultation with the manufacturer, with the object of preventing very hot fires by minimizing the combustion air supply area.

2.7 HD Limits for Conventional Doors

ELA's of existing glass doors were determined to evaluate their effect on HD Limits for fireplaces. The leakage area of typical glass door was calculated from pressure data using the calibrated door fan. (The ELA, was also hand measured using a micrometer although this proved difficult.) Several shops selling conventional glass doors were visited and a number of doors were measured to determine the typical range of crack area for existing fireplace doors. The data collected on glass doors is presented in Table 3.

2.8 Locating Combustion Air Supply

Combustion air supply strategies were investigated by examining industrial practices, and by discussing options with the project's consultants. On this basis a number of design objectives were identified, and testing procedures proposed. Field evaluations are not completed since the computer module was considered essential in identifying the most workable strategies, and in generalizing from the test results to typical styles of fireplaces.

3.0 RESULTS: DESIGN

3.1 Conventional Designs

Conventional glass doors are usually bought for aesthetic and comfort reasons. Doors can block out unsightly remains of a fire and can reduce (slightly) the cold down drafts caused by poor fitting or warped chimney dampers. The glass is tempered and is rarely gasketed to the frame. Leakage around the glass panels on these doors is an intentional design, serving to constantly bath and cool the glass with room air. (Tight fitting doors have been known to explode because restrictive fastening prevents expansion during a hot fire.)

The door frames of conventional fireplace doors are made of light weight metal that will discolour and deform under high fireplace temperatures. When doors are shut, a large percentage of the heat is reflected back to fire box, and the efficiency of heat transfer to the room is negligible. Sound and sight of the fire are also reduced. For the above reasons conventional doors are commonly only left open during a fire. (This might be a worthwhile recommendation for all owners of conventional glass doors.)

3.2 Special Design Considerations

If the fireplace door is designed to be airtight, radical changes are required to the materials and design. The glass must be ceramic, similar to airtight wood stoves; and the frame must be constructed from steel, 6 mm or thicker. Glass fiber gasketing material must be used to seal the glass to the frame, while still allowing movement.

The above attributes were found on several commercially available glass door units for fireplaces, designed for energy efficiency. The units typically combined highest quality ceramic glass doors with heat exchange pipes that sit inside the fire box. However all commercial units examined were designed to allow air leakage above or below the glass door apparently to help keep the glass clean, and to use household air for draft and combustion. These holes did not suit the research objectives of isolating the fire from the house environment.

3.3 Design Specification for the Test House

Since no commercially available units could satisfy the research objectives, a special unit was designed and fabricated. Figure 2 presents the design of unit. One of the manufacturers contacted during the investigations was particularly interested in the project, and offered to alter the design of his unit to suit research objectives.

3.4 Heat Exchanger

It was decided to include the heat exchanger portion of the unit to help in dissipating heat build up in the fire box (rather than for the heat recovery purpose). The unit was built with a centrifugal fan to circulate room air through the exchanger, to accelerate heat transfer.

3.5 Combustion Air

The manufacturer was particularly interested in the idea of an outdoor air supply, and assisted in the design along with the project's consultants. It was determined that an optimum location for a combustion air supply would accomplish some or all of the following:

- prevent blow back when the door was opened for feeding the fire;
- avoid obstructing installation of fireplace doors;
- prevent the air supply duct from reversing, and becoming a second chimney due to heat transfer and vertical placement of ducts; and

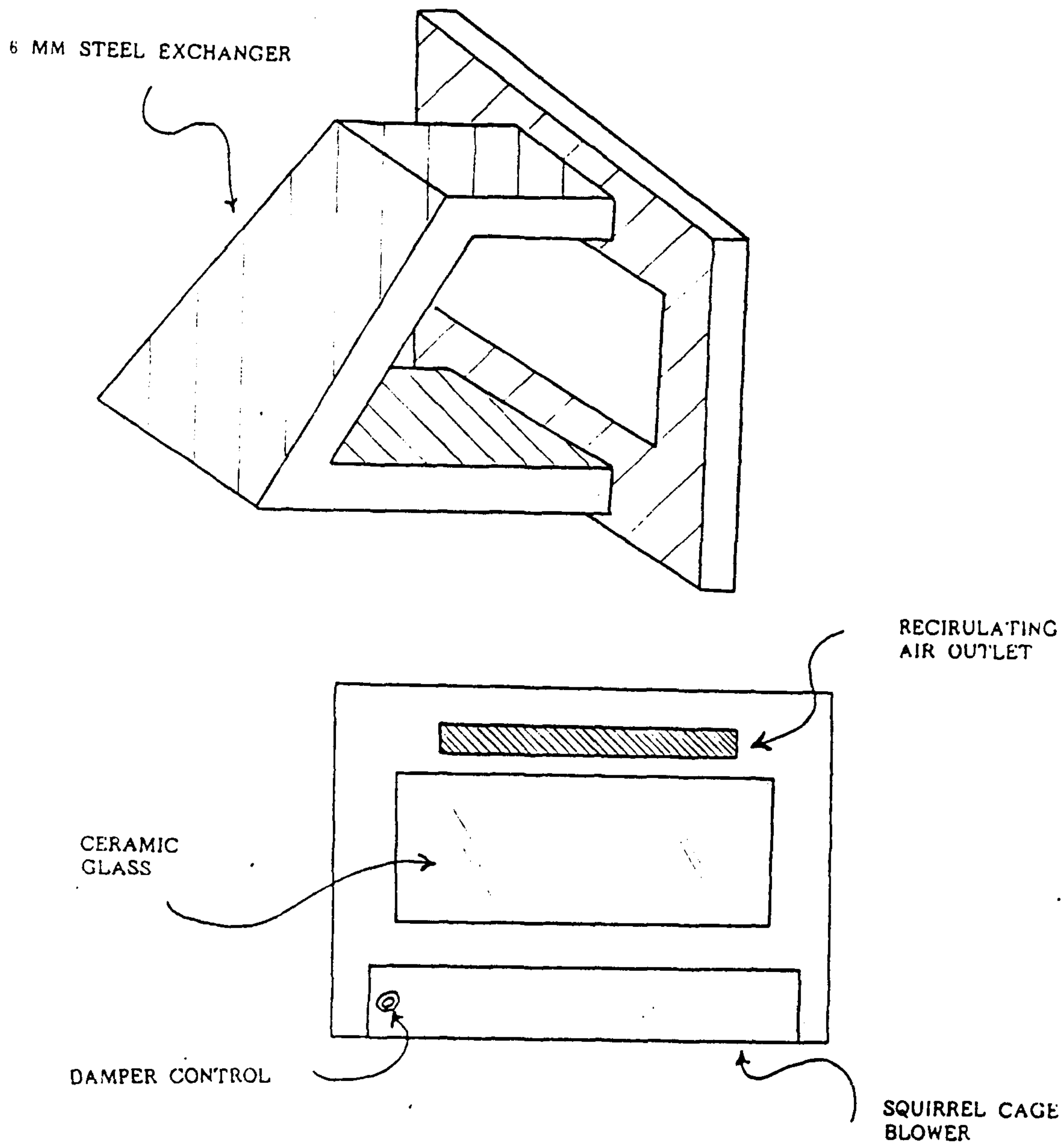


FIGURE 2: Schematic of Glass Door/Exchanger Unit (Manufactured by F.P. Decors Ltd.)

- minimize the chance of hot embers being drawn outside, in the event of downdrafts or low pressure at the inlet due to wind loading around the building.

It was concluded that the best location to supply combustion air was to the front of the fire, blowing downwards. Hot embers would be least affected by this location. It would be difficult for embers to be entrained by a backdrafting inlet and embers would not naturally be blown towards the door if it were open. For ease of installation, the air duct needed to be designed so as to avoid obstructing the installation of the fireplace door unit. Because most airtight doors are likely to incorporate heat exchangers, the duct requires either a low profile, or a routing along the side of the fire box. There were two basic choices for supplying combustion air to the fireplace.

3.5.1 Option 1: Ash Clean-out

Option one was to use the existing ash clean out. A prefabricated metal liner would fit into the clean out and direct the combustion air out to the front of the fire box. Dampers controlled from the front of the glass doors would be designed into the unit. A commercially available unit, the Ram-air, has been designed along these lines and is presented in Figure 3.

The disadvantage of this design was that the air could not be supplied so as to blow downwards at the front of the fire. Also, it could be difficult to install under the heat exchanger given a clearance of only 40 mm.

3.5.2 Option 2: Through the Wall

A second option was to adapt the door unit so that combustion air could be drawn from outside through the back of the fire box, and directed to

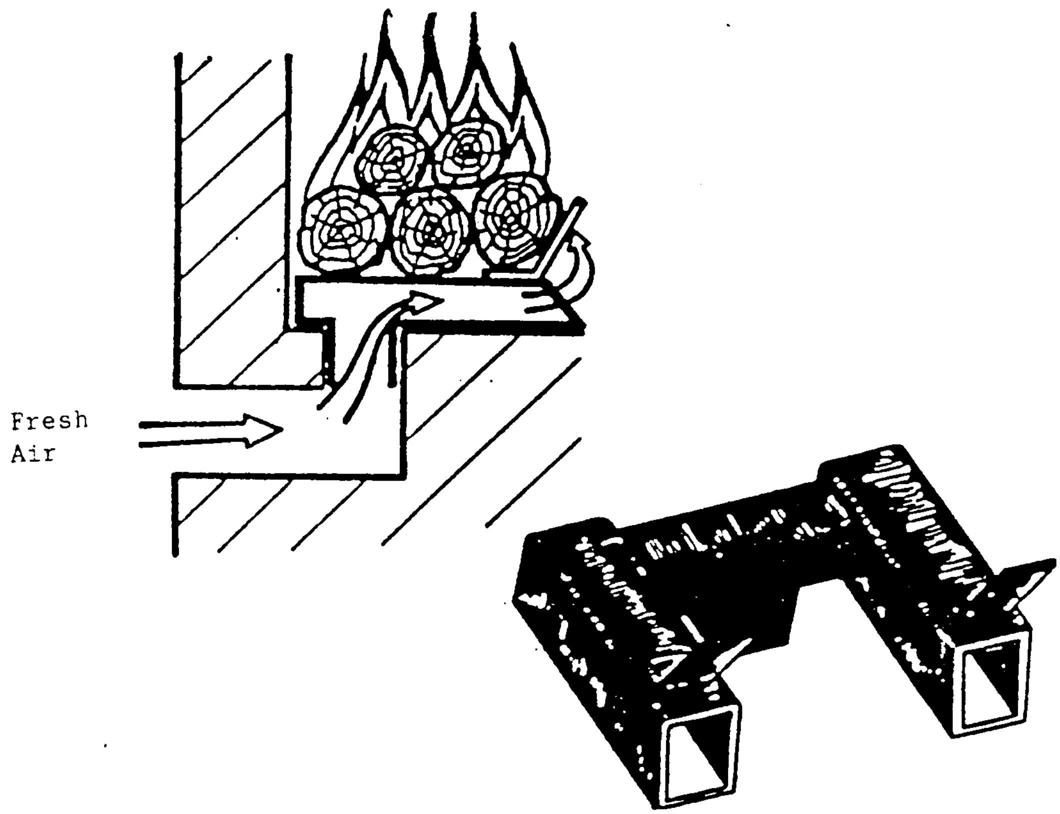


FIGURE 3: Diagram of Ram-Air (From H. Morstead, "Fireplace Technology in an Energy Efficient World."

the front of the fire by means of a duct beside the heat exchanger. A channel along the front of the unit would effectively supply air along the entire front of the fire. A tight fitting damper, with a control cable at the lower front of the unit, provides control over the quantity of combustion air entering the fire box.

A schematic of this combustion air supply design can be seen in Figure 4. This was the design selected for evaluation.

The fireplace module of FLUE SIMULATOR was not available to determine the optimum size of a combustion air duct into the fireplace. Given clearances to combustibles, height of chimney, size of fire box, and measured ELA of fireplace doors, the module should allow us to choose a safe and effective combustion air duct size for any fireplace. If safety requirements demand a size that can not keep a fire burning properly, then the remedial measure of airtight door with direct combustion air supply should be abandoned.

In consultation with the manufacturer, it was decided to use a combustion air duct with a 75 mm diameter. This single duct was intended to provide all the combustion and draft air requirements. The small size of the duct was intended to prevent the burning of excessively hot fires.

3.6 Draft Air

There may be a need to uncouple the fire box from the effects of wind. Winds blowing down the chimney can create a fire hazard if the door is open or if the embers are forced out the combustion air duct. Winds blowing across the top of the chimney can create excessive draft in the chimney. Reports of such problems were documented during the design phase of this research.

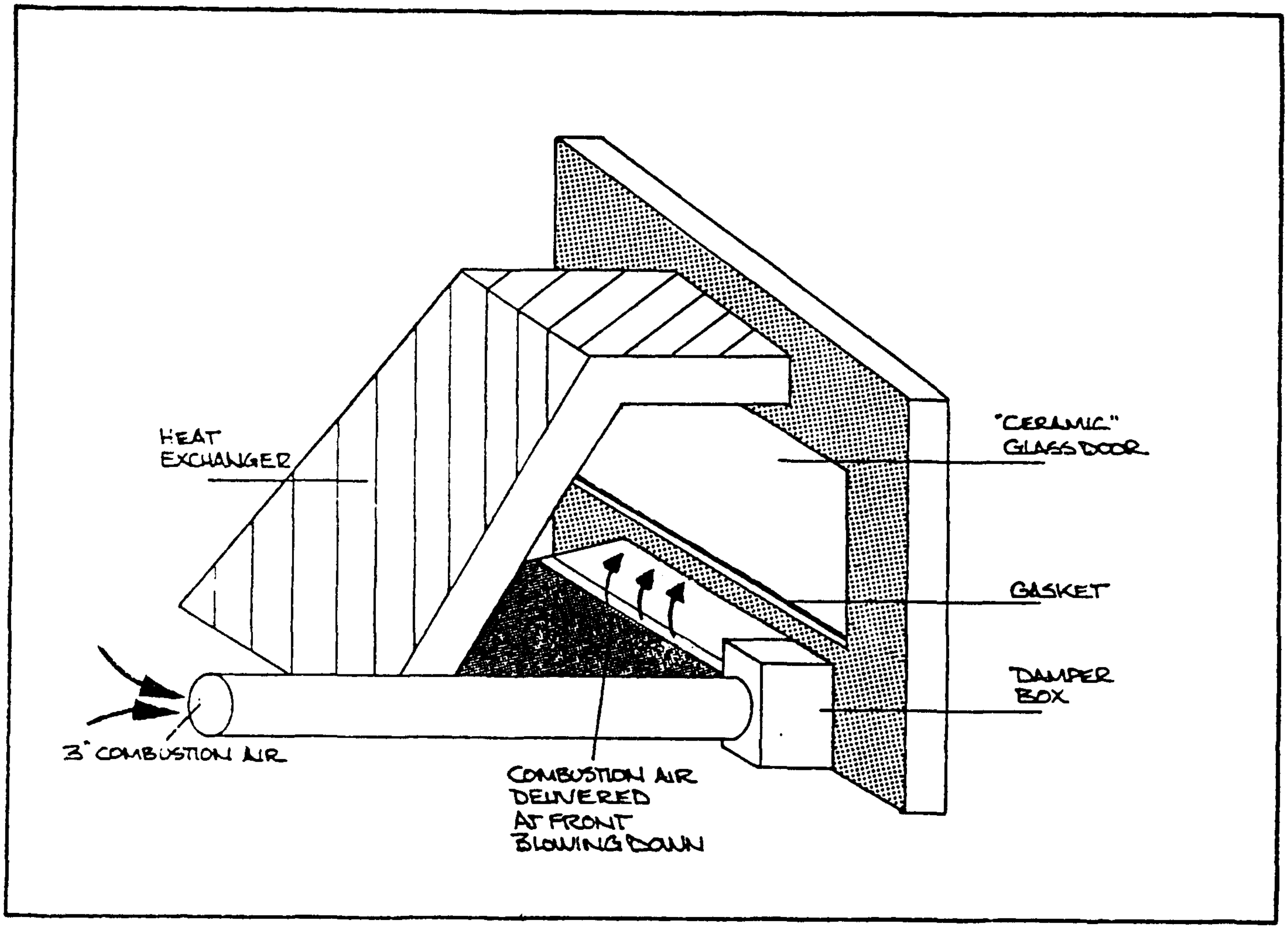


FIGURE 4: Glass Door Unit Showing Combustion Air Supply

Scanada Consultants have suggested that fireplaces could be designed with a draft air inlet, to operate in a similar manner to gas furnaces. A separate dilution air opening from the outdoors located above the fire box, could uncouple the fire from the chimney. A possible design for such a dilution air inlet can be found in Figure 5.

If dilution air were introduced in the critical area below the throat of the fire box, temperatures of combustion exhaust may also be reduced, for improved fire safety. In conventional fireplaces, much of the excess draft air passes up the front face of the flue liner, helping to keep masonry cooler in the region closest to the wood header. A draft air inlet could be designed to perform the same task, using outdoor air.

3.7 Cost

Cost comparisons for conventional glass doors and for airtight doors are detailed in Table 1. The final cost of the airtight doors with direct air supply remedial measure came to $600.00 installed (not including the fan heat recovery option). Photos of the installed unit can be seen in Appendix 4. The unit is aesthetically pleasing, especially with the large viewing door. The cost of the airtight door option is only marginally more expensive than a set of conventional glass doors in Table 1. In fact, when compared to higher cost conventional doors, there may be no difference in price. The added benefits of improved energy efficiency and improved venting, should make the airtight doors a preferred investment. There is a difficulty in obtaining the product, and in finding a competent installer. A better alternative to installing an airtight door may be the installation of an airtight insert, in combination with relining and insulating the chimney. It is estimated, however, that an insert and liner will entail costs of close to $2,000, more than 3 times the value of airtight doors.

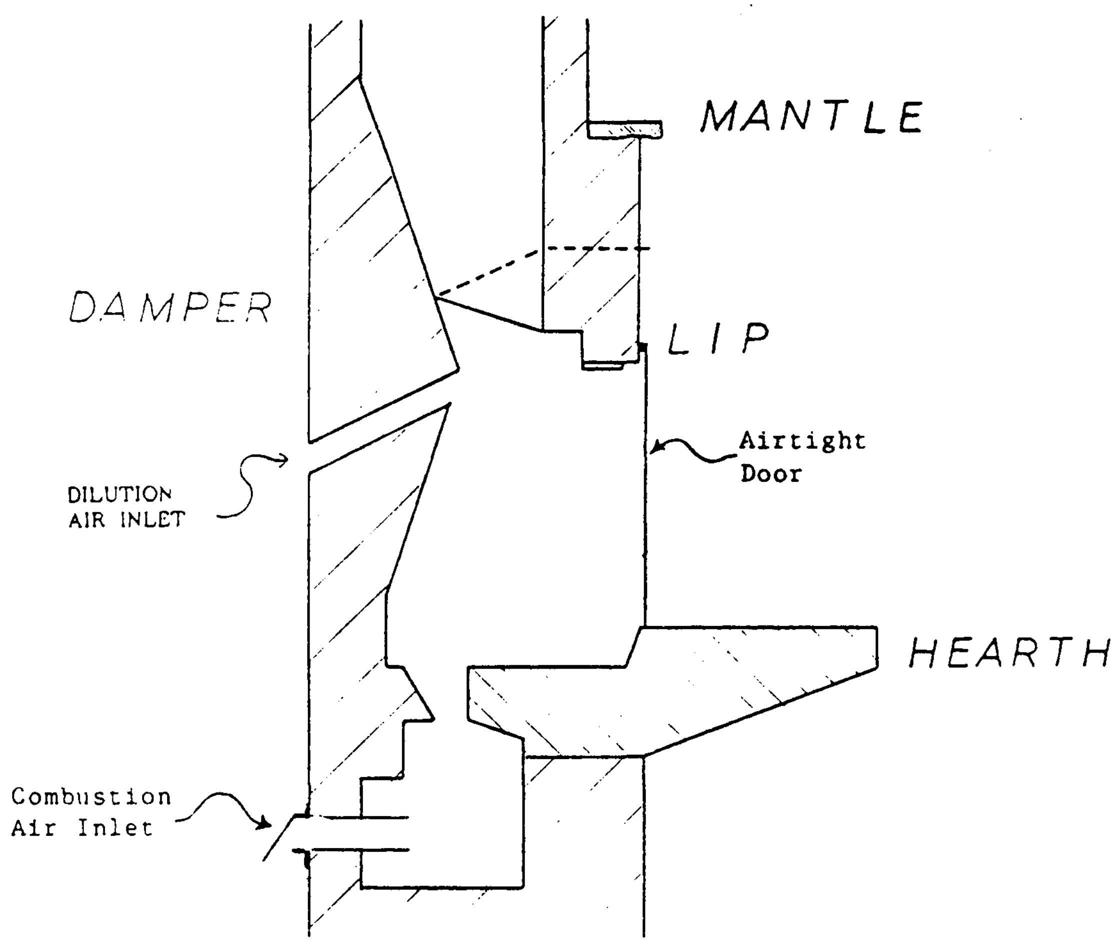


FIGURE 5: An Option for Supplying Separate Dilution Air to a Masonry Fireplace

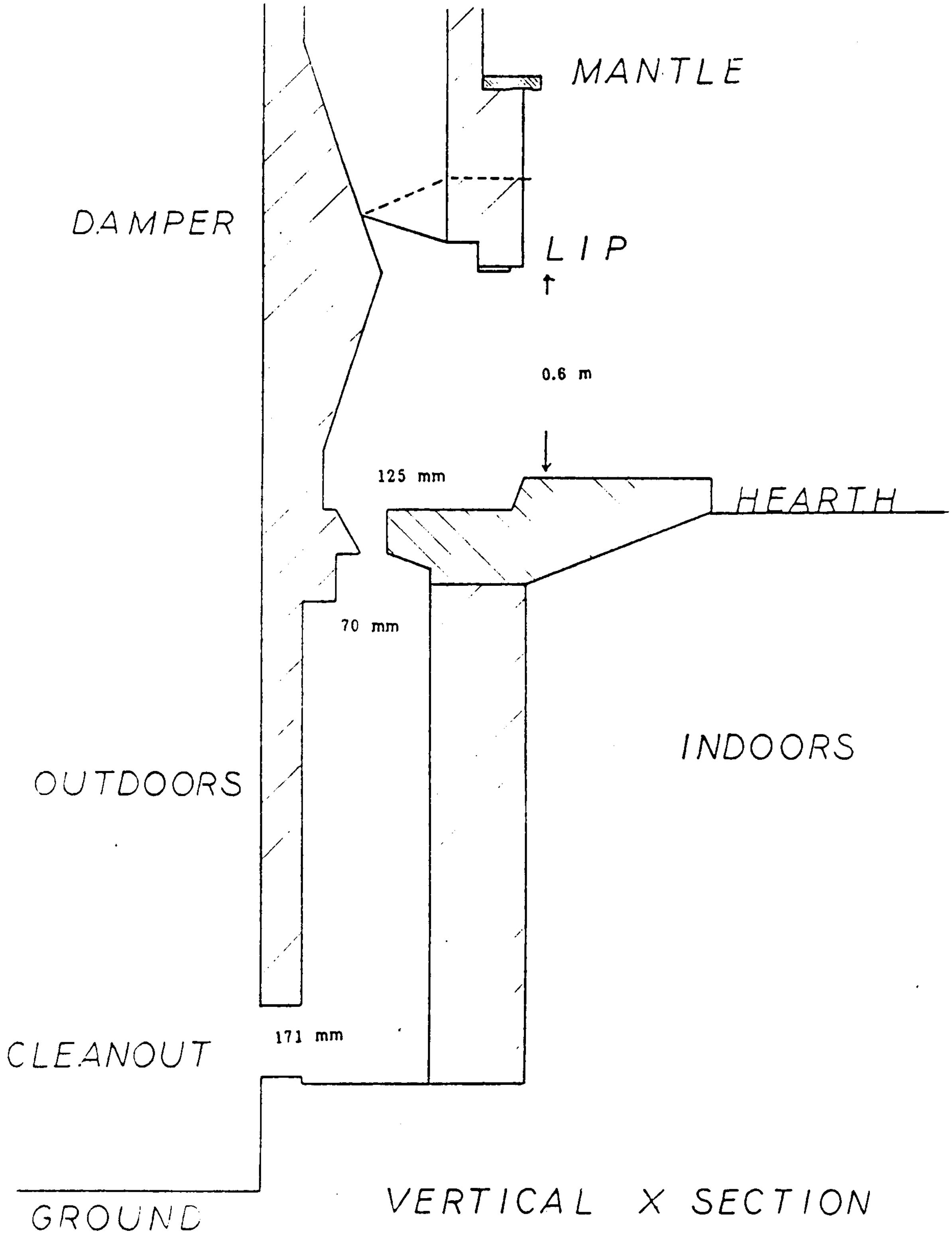


FIGURE 6: Schematic of Fireplace in Test House

Table 1

COST BREAKDOWN OF FIREPLACE DOORS

Item	Options	Retail Cost ($)* Low	Retail Cost ($)* High
Standard Glass Doors	Decorative Finish Heat Exchanger Fan	150	450
Ceramic Doors	Decorative Finish	400	550
	Heat Exchanger	150	150
	Outdoor Air Supply	50	50
	Fan	150	150
	Insulated Face	25	25
Installation of Doors		50	125
Installation of Outdoor Air Supply		100	200

* Approximates based on discussions with local suppliers.

4.0 RESULTS: FIREPLACE SAFETY

4.1 Fire Hazard

Airtight doors trap heat in the fire box, while at the same time slowing down the movement of heat out the chimney. The combined effect is to raise throat temperatures dramatically, creating a potential fire hazard if clearance to combustibles is inadequate.

4.2 House Fires Caused by Glass Doors

Data has been collected from the Fire Commissioner's Office of B.C., and is included as Appendix 3: Origin and Cause of Fires Due to Burning Solid Fuel in B.C. (for the year 1985). These statistics clearly document the problem. The Fire Commissioner's Office estimates their are 600 fires related to burning solid fuel in B.C. each year. This figure is on the rise in B.C., a province with an abundance of fireplaces and fire wood. (The number of fireplaces in B.C. is twice the national average.) The use of B.C. data was convenient for this project, although it may not be representative of other regions in Canada. Requests for data on fires in other provinces has produced data on Alberta and N.W.T., as well as Canadian Government buildings. (This data is summarized in Appendix 1, but is not as specific as B.C. data for cause of fire.)

The data supplied to Sheltair described 109 fires in B.C. reported by insurance companies. The insurance companies had been requested by the Fire Commissioner's Office to submit copies of damage reports on house fires attributed to burning solid fuels during 1985. Fourteen (14) of those house fires were caused by masonry fireplaces with glass doors. Eight (8) of the fourteen fires were due to inadequate clearance to combustibles. As an example, Reference 37 lists the origin and cause of the fire as "Behind masonry on face of F.P. just above throat. Heat conducted through masonry units to the header which had inadequate clearances."

4.3 Code Requirements for Clearance to Combustibles

The Fire Commissioner's Office describes what it considers to be adequate clearance as 'The shortest distance from the combustible 2 x 6 inch double header to a heated unlined surface should be not less than 7 1/2 inches of solid masonry with all joints and voids completely mortar filled, plus the clearance' (Appendix 2, In Fire Mation). However, individuals who we consulted with at the Fire Commissioner's Office, Param-jit Seran and Bob Thompson, were of the opinion that no EXISTING fireplaces could meet the requirement.

The contradiction lies in the fact that glass doors and exchangers can be installed without a permit or inspection, unlike fireplace inserts, even though they present an equal fire hazard. At present glass doors and exchangers are not required to meet any codes of performance.

In Fire Mation gave us a clear grasp of the problem, but did not describe how to determine whether an existing fireplace had adequate clearance. Without a workable procedure for locating combustible materials above the fire box, the recommendations and standards for existing houses become an academic issue.

It is now apparent that the first part of a procedure for properly installing airtight doors, should be precise determination of the fireplace header location and frame walls, where they exist.

Ostensibly the existing building codes and the latest draft of CSA A405 Draft Standard, Design and Construction of Masonry Chimneys and Fireplaces, prevent new fireplaces from being built with inadequate clearance. (The above Standard can be found in Appendix 2). However, there have been both inspection and interpretation problems in B.C. that are documented in In Fire Mation and suggest that there are still fireplaces being built with inadequate clearances.

4.4 Reducing Fire Hazard in Test House

The test fireplace was a typical existing fireplace,and consequently had only 5 inches between the unlined chimney and the combustible header. This is usually the case for masonry flues, regardless of whether the flue is lined, since the lining typically begins above the header location.

Rather than reject the fireplace as a candidate for airtight doors, two strategies were adopted to reduce the fire hazard:

1. The first strategy was to undersize the combustion air, there by limiting the rate of burn, and limiting the maximum temperatures in the throat. (This strategy assumes that the unit would only be operated with the door closed.)

2. The second strategy was to rely to extract heat from the fireplace, and thereby reduce throat temperatures.

4.5 Determining Combustion Clearances in the Field

To determine the location of combustibles, the installers of the insert were asked to drill a number of probe holes into the front facing of the masonry fireplace. Some simple deductions helped to determine where the top of the fireplace header might be located.

Headers over the windows in the house were 10 inches, so it was assumed that the same size of header would exist over the fireplace.

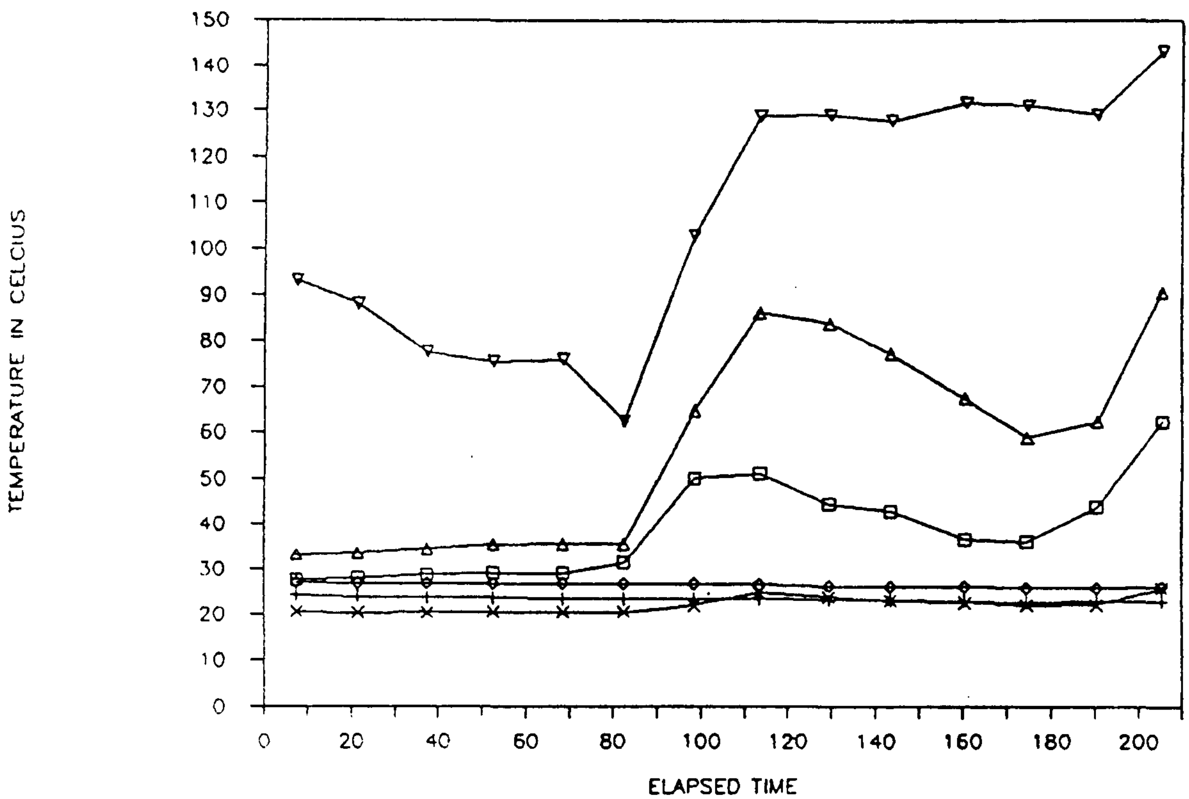
Drilling holes and noting the change of material that was being drilled through by feel and by examining the bore debris enabled the exact location of the bottom of the header to be found. Holes were drilled with an extended 9.5 mm masonry bit on a standard drill. The holes drilled diagonally, under the header, or directly through the mortar between bricks. The damage was slight and easily repaired, and the holes were completed quickly.

A careful examination of the inside of the chimney enough data to be able to draw an accurate schematic of the fireplace. Figure 7 is the result of this examination. It was considered a time-consuming and somewhat demanding task but well within the capabilities of the installers. Measuring from the back to the front of the fire box, and subtracting the width of the flue, provides a dimension from the face of the fireplace to the unlined flue.

4.6 Temperature Monitoring

The drill holes made it possible to insert thermocouples into the masonry to monitor temperatures during typical fires. Graph 2, shows a run during start-up of the fire. Graph 3, shows a run when the fire had time to reach peak temperatures. Both Graphs can be compared with temperature runs before the airtight doors were installed in Graph 1. After 3 hours of continuous burning, the temperature of the header nearest the unlined chimney had reached 30°C.

Monitoring of temperatures over the short term (2 to 3 hours) suggested that the potential for fire hazard was not increased by causing the fireplace to backdraft, or by plugging the combustion air intake. Graphs 4 and 5 present temperature profiles for each of the above conditions. In both cases temperatures at the throat of the fire box dropped off radically.

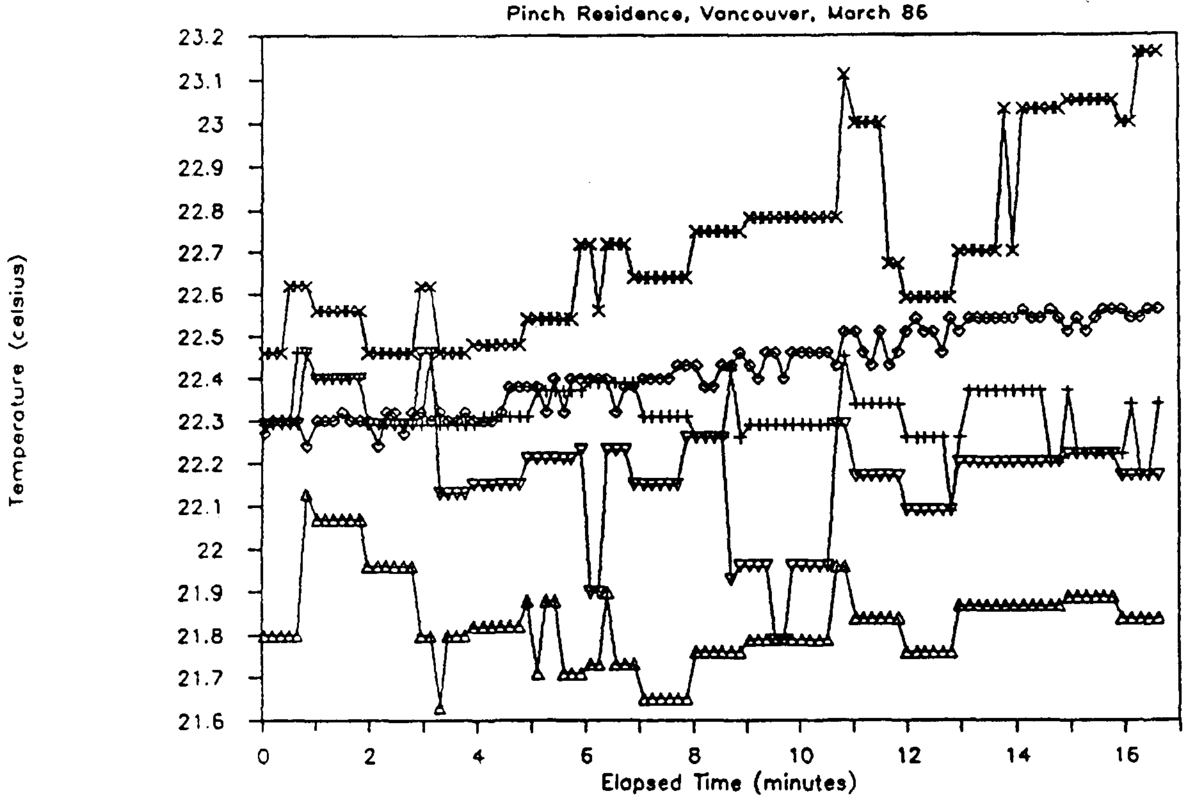


1. □ At upper lip of fireplace opening.
2. + 6 cm above hearth at fireplace opening.
3. ◇ 15 cm above hearth at fireplace opening.
4. △ Inside upper lip of fireplace brick.
5. X At centre of mantle.
6. ▽ In chimney at throat.

GRAPH 1: Temperature Monitoring Prior to Installation of Doors

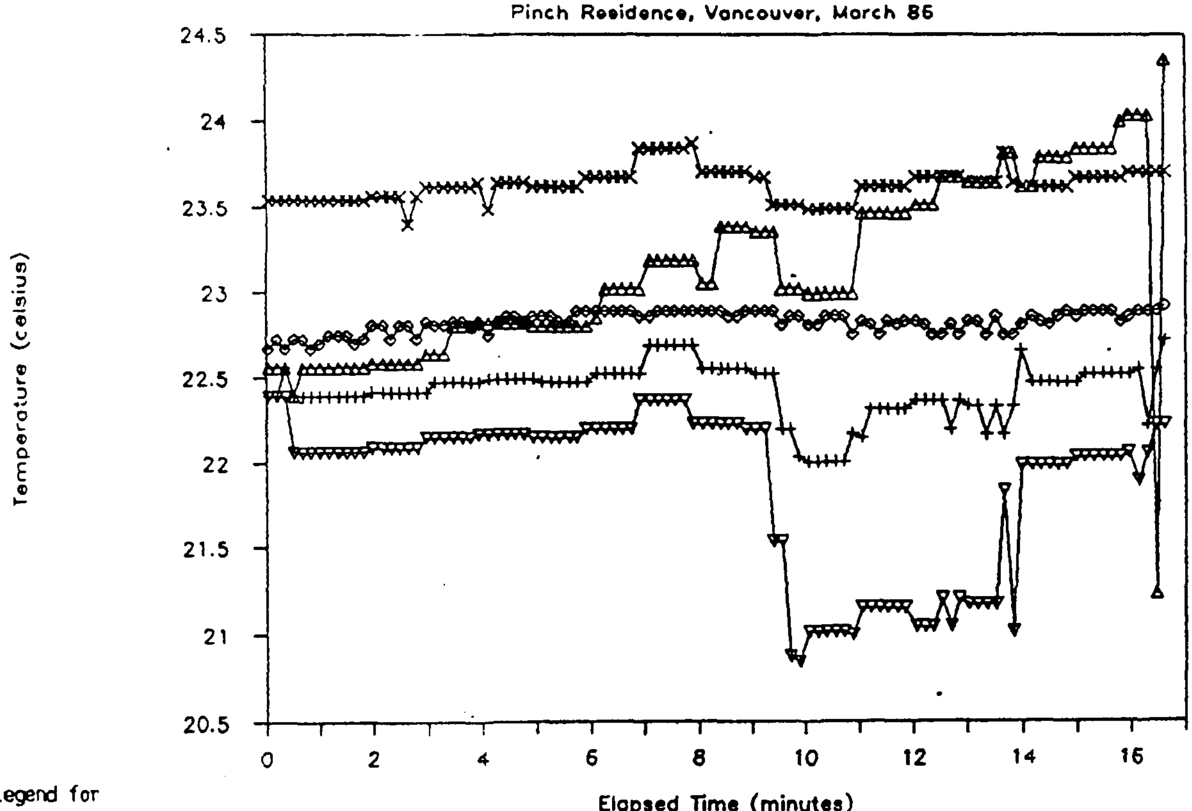
GRAPH 2 TEMPERATURE MONITORING AT START-UP

Pinch Residence, Vancouver, March 86



GRAPH 3 TEMPERATURE MONITORING ON HOT FIRE

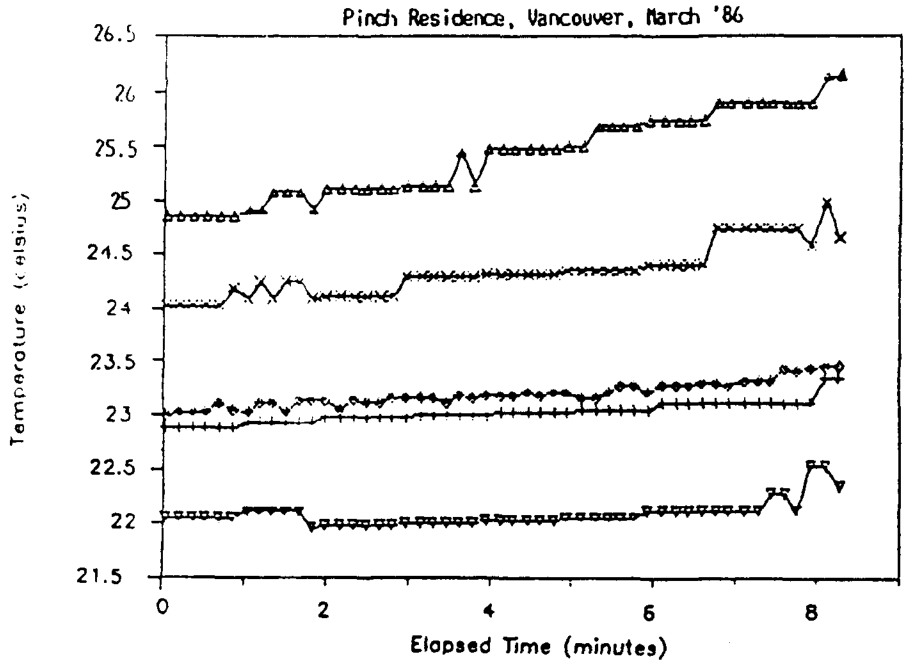
Pinch Residence, Vancouver, March 86



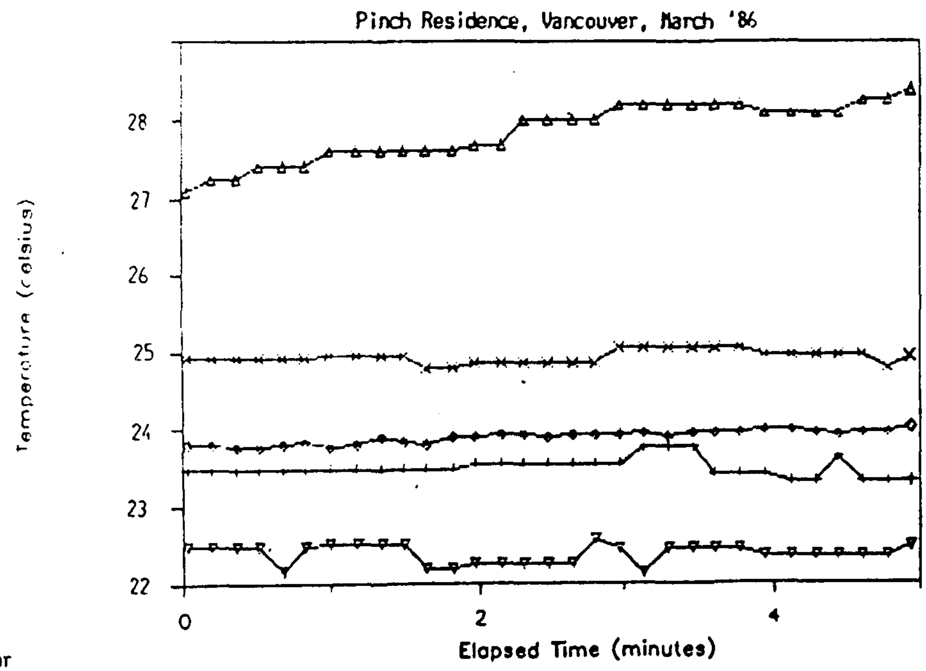
Legend for Graphs 2 + 3:

1. + 57 mm from face of plaster (back of header).
2. ◇ 108 mm from face of plaster (back of header).
3. △ Room
4. × 120 mm from face of plaster through brick base of mantle.
5. ▽ applied to face of header at base

GRAPH 4 TEMPERATURE MONITORING WITH BLOCKED COMBUSTION AIR



GRAPH 5 TEMPERATURE MONITORING DURING BACKDRAFT



Legend for Graphs 4 + 5:

1. + 57 mm from face of plaster (back of header).
2. ◇ 108 mm from face of plaster (back of header).
3. △ Room
4. ✕ 120 mm from face of plaster through brick base of mantle.
5. ▽ angled to face of header at base.

5.0 RESULTS: INSTALLATION

Installation of the fireplace doors and air supply was completed by two men in a period of approximate 3 hours. Time requirements would have been reduced (possibly by up to 50%) without the extra work required for recording the procedures, and checking for combustibles. The installation procedure is documented in stages with photographs in Appendix 4.

5.1 Damper Operation

The fireplace in the test house was particularly small, which meant that the location and installation of combustion air needed to be carefully planned. The installers commented that their usual practice is to permanently fit open the chimney damper as part of the installation. This, they felt necessary to prevent operation of the fireplace with damper closed. However, with very tight doors, the use of a chimney damper would not cause problems, other than causing the fire to burn less vigorously. Consequently it was decided to leave the damper operational. An operational damper offers the advantage of preventing convective currents from cooling the fire box and glass door in colder weather.

5.2 Heat Loss Concerns

Consultants to this project expressed concerns about heat loss from fireplaces and the problem with the door frosting up during very cold outdoor temperatures. The Hatzinikolas report included in Appendix 5 describes an airtight chimney top damper and a combustion air duct that has both an inside and an outside damper. The intention of these two items is to reduce heat loss from a fireplace and prevent frosting of the doors.

A double damper system for the combustion air intake was purchased from Mr Hatzinikolas for installation and testing with the airtight doors. This system was not used for the test fireplace, however, since it was felt that a double damper system is not warranted in Vancouver where the design heat loss is only -7°C.

Even if the test unit was installed in a much colder climate it is probable that the Hatzinikolas double dampers would not be required. The fireplace door used in the Hatzinikolas study was not airtight. The addition of the airtight door and the continued use of the damper made the dynamics of the system different. The single damper system employed in the test house is a tight fitting piston design and does not allow air entry when shut off, nor does it freeze shut in ways that would damage the components or restrict operation.

The combination of airtight doors and an operational chimney damper would presumably minimize convection currents in the chimney during standby conditions (although this is hypothetical at present).

5.3 Sealing the Door to the Masonry

The installers used R-20 fiberglass insulation to fill the space between the back of the door frame and the facing brick. This is common installation practice. However, the fiberglass was found to be extremely leaky when examined with a smoke pencil during house depressurization. Depressurization, of the house to 20 Pascals caused heavy smoke spillage around the doors, especially around the bricks and along the lower edge.

The door frame was sealed to the facing brick using a grey masonry silicone. It was impossible to seal a small portion of the door that was unaccessible because of the installation of a recirculating fan on the front of the doors. A better approach appeared to be to apply sealant just before final installation of the unit.

An attempt was made to measure the reduction in leakage area resulting from sealing the door frame, but the door fan was unable to detect a significant change.

Although the silicone produced a tight seal between steel and masonry, it is not certain that the seal will be maintained over the longer term. Some installers have reported problems with seals breaking due to thermal stress and movements, and have even claimed that a durable seal around fireplace doors is impossible.

6.0 RESULTS: BACKDRAFT AND SPILLAGE SAFETY

6.1 HD Limits

The effect of airtight doors on HD Limits for fireplaces is directly related to the leakage area of the doors. It was originally thought that the ELA for the door would only determine the quantity of spillage into the house, and not the pressures at which the fireplace spilled. However, the effect of placing doors on the fireplace opening, and limiting the combustion air supply, was to greatly increase draft in the chimney.

Table 2 lists the pressures measured in the fire box with the airtight door both closed and open. The effect of airtight doors was to increase the HD Limit for the fireplace from 8 Pascals to 22 Pascals at a high burn rate. HD Limits were not tested at lower burn rates.

Table 2
MEASURED PRESSURED IN TEST HOUSE FIREPLACE

	Measured Draft	HD Limit
DOOR CLOSED Combustion Air Open	25 Pa	22 Pa
DOOR OPEN Combustion Air Open	8 - 10 Pa	8 Pa

* Pressure at which spillage was observed

6.2 Dilution Air

Introducing an outdoor dilution air inlet in the fireplace may eliminate the gains in chimney draft achieved by closing off the fireplace opening. It may then be appropriate to specify a maximum ELA for airtight doors that would represent the allowable quantity of spillage into the house under worse case house depressurization.

6.3 ELA's of Conventional Doors

Table 3 gives a range of ELA's for typical semi-airtight doors. The test door unit No.1 was tested with depressurization apparatus. Test unit No. 1 was a new, tight set of doors in an R2000 house. The remaining units were measured with a micrometer (using a flexible gap filler for overlapping cracks). These measurements required over one hour per set of doors. Although the ELA's vary, it is obvious why most of these doors - especially older, used doors - do not give any degree of protection, either in terms of HD Limits or in terms of quantity of spillage. Further work is still required to specify maximum ELA's for airtight doors.

Table 3

RANGE OF ELA'S FOR TYPICAL AIRTIGHT DOORS

Description	Measured ELA	Estimated Spillage Flow in to House @ 3 Pa (L/s)***
New Bifold	84.0 cm^2*	9
Used Bifold	123.8 cm^2*	14
Used 2-Door	95.7 cm^2*	11
New Extra Tight Energy Efficient Doors	14.0 cm^2**	2

* Measured with a micrometer
** Measured with a door fan
*** 3 Pa = Indoor Pressure minus chimney draft

NOTE: Refer to Appendix 6, for description and schematic of fireplace doors measured with a micrometer.

As doors become tighter, two phenomenon occur which are likely to contribute to improved performance. Firstly, the reduced flow of draft air keeps the chimney warmer, prolonging the period during which the chimney can withstand house depressurization. Thus the tighter doors help to minimize spillage duration at the end of the burn cycle.

Secondly, the tighter doors offer less area for combustion gas flow, and thereby reduce the quantity of spillage that will occur for a given level of house depressurization. Further analysis of the ELA values that affect fireplace door performance will be conducted when the FLUE SIMULATOR fireplace module is available to account for the dynamic features of fireplace operation.

6.4 Operating Against a Backdraft

Graph 5, shows the effect on fireplace throat temperatures when the fireplace is operated as the house is depressurized. The effect is to slow down the exhaust of combustion gases to the point where it restricts the burning efficiency of the fireplace. As the fire cools, the draft in the chimney is reduced causing the fireplace to spill at lower house pressures. The pressures required to create a stall condition were extremely high (22 Pascals). A similar effect to the stall was caused by plugging the combustion air inlet which can be seen in Graph 4.

7.0 CONCLUSIONS

The airtight door with direct air supply remedial measure was effective at isolating the fire from house depressurization. The effective HD Limit increased from 3 to over 20 Pascals.

It is too early to say whether the installation does not increase the fire hazard. If the data of an evenings monitoring had not been lost the results might have been conclusive. After 3 hours of hot burn, temperatures at the header only increased 10 Celsius.

The tightness of the installation was not adequate until the frame was sealed with silicone to the brick facing. The durability of this type of seal has been questioned, and longer-term evaluations are required before the effectiveness of the doors is known.

For the test house, an outlay of $600 to transform the fireplace into a useful, safe, aesthetically pleasing heating system seemed to be a good investment for those who are determined to use a fireplace. The homeowners are enjoying the installation. Although the unit may result in overheating of some houses on warmer days, this was not the case in the test house.

The combustion air duct and damper control worked well at controlling the burn rate of the fire. It appeared to be an easy installation , adding one half hour to the total installation time.

The issue of fire safety remains paramount. Fire safety concerns will need to be resolved before recommending the installation of airtight or (even semi-airtight) doors on to an existing masonry fireplaces. A number of questions have be raised by this research:

Is it possible to reach a consensus on more lenient (and practical) clearance requirements for existing fireplaces?

Is there a need for codes and inspection requirements for the installation of glass doors on existing fireplaces?

Who should be responsible for developing and promoting improved procedures for checking combustibles and flue liners prior to installation of fireplace doors?

Is controlling the rate of burn, by carefully sizing the combustion air supply, a safe strategy for avoiding higher temperatures?

Would the installation of a permanent temperature or smoke alarm give occupants an appropriate warning system or significantly add to fire safety?

Do airtight doors and reductions in combustion air supply produce much additional creosote? And does the creosote significantly increase potential for dangerous chimney fires?

RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 1

ORIGIN AND CAUSE OF FIRES DUE TO BURNING
SOLID FUEL IN B.C. (FOR THE YEAR OF 1985)

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PER MIT	INSP	CLR OK?	FTD AVL	ORIGIN + CAUSE
1	Insert in mas Fplace No flue con Lined msnry chimney	Appliance Sidney Fireplace	Nil		850101	0	0	8000	n	n	y	y	In wall behind facing brick Heat radiated from chimney to wood in fascia wall.
2	Mas FP w/o Gls Drs Sole wall flue con Lined msnry chimney	Flue Conn	nil			0	0	1500			n		In wall above fireplace. Previous occupant left unconnected flue pipe sticking thru wall above fireplace. Fp heated pipe which ignited 1x8 sheathing.
3	Stove Sole wall flue con S604 chimney	Chimney Projet	ULC	CJO	841226	0	0	200	y	y	y	n	Horizontal chimney connected to Tee. Build up of creosote.
4	Hearth mtd Stove Sole wall flue con Lined msnry chimney	Appliance Pinehill Innovators Phoenix	Nil			0	0	0	y	y	y		Unit would not draw properly - Smoke filled room. Combustion air inlet obstructed. This problem has occurred before.
5	Stove No flue con S604 chimney	Chimney Selkirk Metalbestos Class A	ULC	DSQ	850103	0	0	2000	y	y	y	n	3' above stove. Fire broke out of chimney at 1st joint. Severe chimney fire.
6	Free-stdg mtl Fplace Sole wall flue con S629 chimney	Chimney More Heat	Nil	DKE	850106	0	0	300	y	y	y	n	Creosote build up.
7	Stove Sole wall flue con S604 chimney	Appliance C021 125	ULC	FKC	850108	0	0	1000	n	n	y	n	Chimney Air tight heater's thermostat was stuck open, causing the metal chimney to overheat and framework to smolder.
8	Stove Sole wall flue con Lined msnry chimney	Appliance Fisher Fisher		TCR	850111	0	0	20	n	n	y	n	Chimney Creosote build up. Fire started following an inadequate attempt to clean chimney.
9	Fct-blt metal Fplace Othr flue-see Cause S604 chimney	Chimney Oliver McLeod Projet 8"	ULC	CPG	850112	0	0	0	y	y	y	y	2nd floor bedroom where chimney was boxed in. Suspect overheated section of metal chimney.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PER MIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
10	Free-stdg mtl Fplace Dble wall flue con S604 chimney	Appliance Homemade	Nil	DSY	850119	0	0	1000	n	n	n	n	Wall behind appliance. Unit installed too close to combustible wall.
11	Stove Sgle wall flue con S604 chimney	Appliance Great West Metal Tip Top	Nil	DSQ	850120	0	0	4000	n	n	n	n	In wall beside stove. Stove installed too close to combustibles.
12	Mas FP w Gls Drs - Lined msnry chimney	Appliance U/K		DSQ	850107	0	0	2000	n	n	n	n	Plywood sheating above mantle. Plywood installed against smoke chamber of chimney.
13	Mas FP w/o Gls Drs No flue con Unlined msnry chmny	Appliance	nil	DSL	850116	-0	0	1000			n	y	Between back of fireplace and wall. Brick fell out at back of fireplace (had only one layer of brick) causing wall on fire.
14	Free-stdg mtl Fplace No flue con Appl-compnt chimney	Chimney Ent.Foundary Co. 66B FFCJ2530		DBA	850118	0	0	1200	n	n	n	n	Where chimney came through front room ceiling. Overheated 2"x3" brace in '0' clearance proximity to chimney.
15	Stove Sgle wall flue con S604 chimney	Chimney Oliver-MacLeod F.D. Chimney	ULC	CNA	850105	0	0	3000	n	y	y	y	Chimney chase. Hot embers/ashes falling onto wooden base of chase. Cleanout for Base T had come off.
16	Hearth mtd Stove Sgle wall flue con S604 chimney	Chimney Oliver McLeod Projet	ULC	RCO	850117	0	0	0			y		Roof space. Breakdown of insulated chimney during chimney fire.
17	Free-stdg mtl Fplace Sgle wall flue con Unlined msnry chmny	Chimney		TCR	850123	0	0	50	n	n	n	n	Base of chimney. No maintenance. 8" Chimney constricted by 2" vent for propane heater running in it.
18	Stove Sgle wall flue con Lined msnry chimney	Chimney	nil	CNA	850111	0	0	25	n	y	y		Kitchen wall (covering chimney). No thimble in hole. Chimney fire started wall on fire.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTD AVL	ORIGIN + CAUSE
19	Stove Sgle wall flue con Appl-compnt chimney	Appliance Frontier				0	0	1000			n	y	Heater too close to wall.
20	Stove Sgle wall flue con Unlined msnry chmny	Chimney		DLA	850128	0	0	5000			n	y	Chimney. Chimney fire caused masonry to fail igniting combustible framing.
21	Stove Sgle wall flue con	Flue Conn Home Made.	nil	RCB	850124	0	0	56556	n	n	y	n	Ceiling. Fire burned through flue and started ceiling on fire.
22	Stove Sgle wall flue con Lined msnry chimney	Chimney	nil	CKE	85127	0	0	0			n	n	Chimney fire caused c. vent damage.
23	Stove Sgle wall flue con Othr chmny-see Cause	Chimney Home Made. 45 gal. drum		CWI	85130	0	0	50	n	n	n		At roof in gable end where c. vent chimney exited. Possible fire in horizontal c. vent going thru gable or result of pyrolysis.
24	Stove Sgle wall flue con Othr chmny-see Cause	Appliance	nil			0	0	350	n	n	n	y	Right behind stove. Stove pipe goes thru roof. Stove was installed with very little clearances to combustibles.
25	-	Flue Conn		RCL	851204	0	0	35000	n	n	y	y	Pelieved to be in the flue. Unknown.
26	Stove Othr chmny-see Cause	Chimney		RCL	850126	0	0	102000	x	n	y	n	Metal dble wall chimney in the attic area. Chimney fire.
27	Stove Sgle wall flue con Appl-compnt chimney	Chimney		DSQ	850130	0	0	100	n	n	n	n	Where flue connector joins chimney. Chimney fire ignited combustibles touching flue pipe.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
28	Stove Sgle wall flue con S604 chimney	Flue Conn	nil	DLA	850204	0	0	11000	n	n	n	n	At point where flue pipe penetrated wall. Flue connector too close to combustible.
29	Stove Sgle wall flue con S604 chimney	Chimney		RCL	850129	0	0	26000	n	n	n	y	Living room. Fire believed to have been caused by chimney. Valley Comfort stove (CSA)
30	Stove Sgle wall flue con S604 chimney	Chimney Selkirk cc and ss	ULC	CPA	850203	0	0	15000	y	y	y	y	Attic void at roof level. Suspect failure and over heating of section of factory built chimney(ULC-S604).
31	Mas FP w/o Gls Drs No flue con Unlined msnry chmny	Chimney				0	0	20000	n	n	n	n	On second floor in chimney chase. Clearance to combustibles was nil.
32	Stand-alone Furnace Sgle wall flue con S604 chimney	Chimney			85-011	0	0	800	y	n		y	Chimney. Burning paper in stove when lit. Calvert Model C stove (CSA)
33	Stove Sgle wall flue con Lined msnry chimney	Flue Conn		DSQ	850201	0	0	100	y	y	n	y	Exterior sheathing. Single wall flue connector (thimble) run unprotected through combustible wall with half inch clearance to sheating.
34	Insert in mas Fplace No flue con Unlined msnry chmny	Appliance Earthstove (Insert)	nil	DSL	850126	0	0	1500	n	n	n	y	Header above fireolace. Insert in masonry fireplace caused bricks to heat up and caught wall on fire.
35	Hearth mtd Stove No flue con Lined msnry chimney	Appliance Black Pines Hearth Heater	WHI	CKA	850131	0	0	1200	y	y	n	n	Chimney. Creosote.
36	Add-on Furnace Dble wall flue con S604 chimney	Chimney Selkirk	ULC	DMI	850128	0	0	300	n	n	n	y	In the insulated chimney. Creosote fire.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PER MIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
37	Mas FP w Gls Drs No flue con Lined msnry chimney	Appliance G. Stein Masonry	nil	CVE	84 12	0	0	0	n	y	n	y	Behind masonry on face of F.P. just above throat. Heat conducted through masonry units to the header which had inadequate clearances.
38	Insert in mas Fplace No flue con Lined msnry chimney	Appliance Fisher		DNV	850205	0	0	500	n	n		n	In paper back insulation behind fireplace mantle. Lack of flue connector on insert allow hot gases to radiate through top of firebox.
39	Stove S604 chimney	Chimney Home made	nil			0	0	4000	n	n	n	n	Roof. Spark from chimney igniting roof shakes.
40	Fct-blt metal Fplace No flue con S604 chimney	Chimney Selkirk Metalbestos	ULC	DSY	851113	0	0	8000	y	y		y	Where chimney passes through ceiling. Blown in insulation against chimney caused framing to ignite.
41	Mas FP w Gls Drs No flue con Lined msnry chimney	Appliance				0	0	2000	n	n	y	n	Masonry chimney (flue). Starting up of fireplace, causing chimney to ignite.
42	Free-stdg mtl Fplace	Appliance Home built	nil	DSY	851110	0	0	1000	n	n	n	n	Wall behind free standing fireplace. Wall protection not adequate.
43	Free-stdg mtl Fplace Sole wall flue con S604 chimney	Appliance		DSY	851110	0	0	0	n	n	n	n	Behind free standing fireplace. Rear of unit rusted out, radiated heat ignited wood veneer wall paneling.
44	Stove Sole wall flue con S604 chimney	Chimney		DSY	851107	0	0	0				n	Ceiling space. Undetermined. Two possibilities. 1) Class A chimney ignited ceiling joist. 2) Chimney ignited cellulose insulation.
45	Stove Sole wall flue con Unlined msnry chmny	Flue Conn		CPA	851012	1	1	15000	n		n	y	Wall and ceiling by smoke pipe. Improper clearance to combustibles and flue pipe.

SOLID FUEL INCIDENT REPORTS

F	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTD AVL	ORIGIN + CAUSE
6	Mas FP w/o Gls Drs Sgle wall flue con Lined msnry chimney	Chimney		DTE	851118	0	0	2000			y	n	Just above damper. Occupant burnt egg cartons just prior to chimney fire.
7	Fct-blt metal Fplace	Appliance Fresh Air Fireplace WHI 265356	WHI		851101	0	0	0	y	y	y	n	Glass door broke - hot glass scorched carpet.
8	Mas FP w Gls Drs Lined msnry chimney	Appliance	nil	RGS	851025	0	0	1500	n	n	n	y	Heat transfer through inadequate fire box to wooden sub floor below.
9	Stove S604 chimney	Chimney	ULC	DPE	850227	0	0	8000	n	n	y	y	In ceiling between roof and ceiling tile. Too much heat in attic space ignited combustible materials.
0	Mas FP w/o Gls Drs	Appliance		CCO	850517	0	0	6500	y	y	y		Roof. Dirty fireplace, chimney fire, ember on cedar shingle roof.
1	Stove Sgle wall flue con S604 chimney	Flue Conn		RGS	850623	0	0	150	n	n	n	n	On wall panel behind asbestos mill board. Inadequate clearance behind and between flue connector and combustible.
2	Stove Dble wall flue con Unlined msnry chmny	Chimney				0	0	1000	n	n	n		In chimney. Dirty chimney.
3	Insert in mas Fplace No flue con Lined msnry chimney	Appliance Home made.	nil		85425	0	0	1000	n	n	n		Feature wall above fireplace mantle. 2x4's installed directly against masonry chimney. Heat eventually ignited 2x4's and feature wall.
4	Stove Sgle wall flue con Appl-comont chimney	Chimney	nil	RPR	850411	0	0	43033	n	n	n	y	At ceiling where chimney went through the roof. Chimney was a tight fit to a combustible material with no air space.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
55	Fct-blt metal Fplace Lined msnry chimney	Chimney		CDU	850324	0	0	1000			n		15' from chimney base. 2x4's up against masonry chimney overheated and caught fire.
56	Stove Sole wall flue con S604 chimney	Chimney				0	0	7000		n	y		Chimney at ceiling. Possibly overheated chimney.
57	Othr appl-See Cause Dble wall flue con S604 chimney	Chimney Selkirk	ULC	DPR	850402	0	0	7000	y	y	n	y	Chimney area between ceiling and attic. Overheated chimney.
58	Stove Sole wall flue con S604 chimney	Oliver MacLeod SSG	ULC			0	0	2000	y	y	y		Top of chimney. Sparks igniting creosote and the roof shingles.
59	Stove Sole wall flue con Unlined msnry chmny	Appliance Home made.	nil	CNA	850323	0	0	50	n	n	n	n	Wooden floor adjoining fireplace hearth. Wood-burning stove installed partially on a wood floor.
60	- Lined msnry chimney	Chimney	nil	VSA	841221	0	0	0	n	n	n	n	Fireplace. No fire took place. Smoke backed up into living room as a result of snowcap over chimney.
61	Fct-blt metal Fplace Sole wall flue con S604 chimney	Appliance		CJO	850327	0	0	3500	y	n	n	y	Behind fireplace. Resident had installed different doors on fireplace.
62	Insert in mas Fplace Sole wall flue con Lined msnry chimney	Appliance Fresh Air Fireplace	nil	RFC	850321	0	0	0	n	n	n		Between cement chimney chimney and combustible. Creosote burning in chimney which ignited inside wall.
63	Free-stdg mtl Fplace No flue con Appl-compnt chimney					0	0	5000	y	y	y		Sparks from chimney falling on shake roof. Sparks given off from the chimney.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PER MIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
64	Stove	Appliance Valley Comfort 266 (92752)	WHI			0	0	22500	n	n	n	y	No clearance from combustible materials and dry out over 4 - 5 year period.
65	Stove No flue con S604 chimney	Chimney Selkirk Metalbestos	ULC	CKA	850322	0	0	2500	y	y	n	y	Ceiling rafter against metal chimney. Void in insulation of metal A vent.
66	- Lined msnry chimney	Chimney		DSD	850213	0	0	1000	y	y	y	n	In chimney. Build-up of creosote.
67	Mas FP w Gls Drs Sole wall flue con Lined msnry chimney	Appliance		RFC	850222	0	0	700	n	n	y	n	In fireplace. Pitch on wood.
68	Stove Sole wall flue con Lined msnry chimney	Flue Conn		DSL	850217	0	0	200	n	n	n	y	Where the stovepipe passes through the wall. Stove pipe that passes through the wall caught the wood panelling on fire.
69	Mas FP w/o Gls Drs Unlined msnry chmny	Appliance Home made.	nil	DSL	850225	0	0	1000	y		n	y	Exterior wall right behind fireplace. Wood wall tight against fireplace.
70	Mas FP/HtEx/Gls Drs Lined msnry chimney	Appliance	nil			0	0	8000	n	n			In wall above mantle. Pyrolysis.
71	Mas FP w/o Gls Drs No flue con Lined msnry chimney	Appliance	nil	DSY	850226	0	0	3500				n	Behind brick fireplace face in wooden header. Appears to be gap at top of firebox between brick of firebox and brick of fireplace facing.
72	Stove Sole wall flue con S604 chimney	Acorn Voyager				0	0	500	y	n	n		Where chimney passes through roof. Improper clearances - insulation packed around chimney.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PER MIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
73	Hearth mtd Stove Sgle wall flue con S604 chimney	Chimney Selkirk Metalbestos SS	ULC	DKI	850108	0	0	15194	y	y	n	y	Fire at attic. Cellulose fibre insulation in direct contact with metal chimney in attic.
74	Stove Sgle wall flue con Unlined msnry chmny	Chimney	nil	DSY	850201	0	0	3300	n	n	n	n	Base of chimney in wooden timbers. Appears to be construction deficiency.
75	Insert in mas Fplace No flue con Unlined msnry chmny	Appliance Unknown	nil	DOB	850207	0	0	100				n	In the fireplace insert. Possible over abundance of creosote in insert and chimney.
76	Insert in mas Fplace No flue con Lined msnry chimney	Appliance Fisher	WHI	DSO	850112	0	0	3000	y	y	y	n	Masonry chimney. Excessive creosote ignited causing severe chimney fire to damage chimney.
77	Mas FP w Gls Drs No flue con Lined msnry chimney	Appliance	nil	CJO	851020	0	0	2200	n		n		Above and behind fireplace facing. Combustible material too close to chimney.
78	Fct-blt metal Fplace Appl-compnt chimney	Chimney		DWH	851121	0	0	147000	y			n	3 ft. above mantel on living room side of chase. Possibly radiant heat from flue pipe igniting the wooden chase.
79	Stove Sgle wall flue con S604 chimney	Appliance		DSY	851119	0	0	0	n	n	n	n	Behind stove under artificial brick. Minor damage. Stove installed too close to unprotected combustible wall.
80	Mas FP w Gls Drs			CKE	851121	0	0	0			n	n	In the wall behind fascia bricks. Minor damage. Improper clearance. Plywood and 2x4s too close to firebox.
81	Mas FP/HtEx/Gls Drs No flue con Lined msnry chimney	Chimney Welenco Wh500297	WHI	DDE	851122	0	0	0	n	n		n	Framing against chimney above fireplace. Minor damage. Suspect heat was conducted through the brick directly onto the framing.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
82	Insert in mas Fplace	Appliance Welenco, Langley WH500265	WHI	DSY	851112	0	0	5000	n	n	n		Behind masonry fireplace. Clearance of brick work to combustibles not in accordance with the "Code".
83	Mas FP/HtEx/Gls Drs No flue con Lined msnry chimney	Appliance Welenco 464848	WHI	CJO	850210	0	0	9000	n	n	n	y	Between the fireplace dand chimney. Hot gases escaping between chimney and fireplace ignited header. Unit installed January 1985.
84	Hearth mtd Stove Sgle wall flue con Lined msnry chimney	Osburn, Victoria.	nil		851120	0	0	1000	y	y		n	In the masonry chimney. Build-up of creosote.
85	Stove No flue con S604 chimney	Chimney Black Pine 752851	WHI	ULL	851124	0	0	2500	n	n			In chimney chase. Mechanical failure, corrosion, buckling of inner casing of chimney.
86	Mas FP/HtEx/Gls Drs No flue con S629 msnry chimney	Chimney		CKA	85	0	0	3000	y	y	y	n	Above smoke shelf upper fireplace. Paper ash ignited creosote - chimney fire.
87	Stove Sgle wall flue con Lined msnry chimney	Flue Conn		RCO	851113	0	0	30000	n	n	n	n	Flue connector. Single wall flue connector passing through a combustible wall. Inadequate clearance.
88	Stove Sgle wall flue con S604 chimney	Chimney Security/Selkirk ULC S604	ULC	CWI	851213	0	0	65000	n	n	y	y	Exterior wall studs. Suspect ignition of creosote leaking at connector of base "T" and pipe section through exterior wall.
89	Stand-alone Furnace Sgle wall flue con S604 chimney		CSA			0	0	70000	n	n		n	
90	Stove Sgle wall flue con Lined msnry chimney	Chimney			851127	0	0	50			y	n	Chimney fire.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
91	Free-stdg mtl Fplace Sgle wall flue con S629 chimney	Appliance Fisher		RFG	851121	0	0	500			n	n	Behind wood heater. Installation too close to combustibles. 8" clearance on stove. 12"on vent.
92	Stove Sgle wall flue con S604 chimney	Chimney Selkirk Metalbestos	ULC	RCL	851129	0	0	5000	n	n	n	n	Directly beside chimney at the roof truss. Chimney was in contact with paper type ceiling board.
93	Free-stdg mtl Fplace Sgle wall flue con S604 chimney	Chimney Selkirk	ULC	DSD	851207	0	0	1000	y	y	y	n	In base of chimney around flue connector. Extensive buildup of creosote in chimney.
94	Stove Sgle wall flue con Lined msnry chimney	Chimney		CPA	851121	0	0	200	y	y			Fire wood stacked next to chimney. Fire wood stacked against metal clean out.
95	Add-on Furnace Sgle wall flue con Lined msnry chimney	Chimney	nil	CPA	851109	0	0	2000	y	y	y	n	Fire wood box next to chimney. Fire wood stacked against clean-out.
96	Stove Sgle wall flue con S604 chimney	Appliance		CPA	851122	0	0	75000	n	y	y	y	Side wall approx. 30" from stove. It is believed installation radiated heat to cedarwall or upholstered sofa.
97	Insert in mas Fplace - Lined msnry chimney	Appliance		RCK	851201	0	0	2000	y	y	n		Above mantle on fireplace. Conduction.
98	Stove S604 chimney	Chimney		DSY	851202	0	0	100	n	n		n	Rafters and roof sheathing. Loose chimney pipe - heat escaped, causing fire damage very slight.
93	Stove Sgle wall flue con Unlined msnry chmny	Chimney		DMT	851121	0	0	8000					In chimney flue. Extreme buildup of creosote.

SOLID FUEL INCIDENT REPORTS

REF	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
30	Stove No flue con Unlined msnry chmny	Appliance Homemade		DBU	851126	0	0	100	n	n	n	n	On floor below heater. Heater directly on hardwood flooring.
31	Insert in mas Fplace No flue con Lined msnry chimney	Flue Conn	nil	DSD	851121	0	0	2500	y	y	y	n	At the back of insert in fire box. Creosote buildup at back of insert as it only emptied into fire chamber of original fireplace.
32	Mas FP/HtEx/Gls Drs No flue con Lined msnry chimney	Chimney		DSQ	851122	0	0	5000			y	n	Chimney. Chimney fire of unknown cause - sparks landed on shake roof burning roof, attic and behind facing stone.
33	Stove Sgle wall flue con Lined msnry chimney	Chimney		DSQ	851125	0	0	2000	n	n		n	In chimney. Overfired unit caused chimney fire that damaged chimney liner.
34	Stove Sgle wall flue con Lined msnry chimney	Chimney		DSQ	851127	0	0	3000	n	n		n	In chimney. Overfired unit caused chimney fire that damaged liner.
5	Insert in mas Fplace Sgle wall flue con Lined msnry chimney	Chimney		DSQ	851118	0	0	1500	y	y	y	n	In chimney. Overfire condition.
6	Stove Sgle wall flue con Lined msnry chimney	Appliance Hillside Welding	nil	CWI	851127	0	0	500	y	y	y	n	Directly above flue pipe where flue enters chimney. Combustibles too close to flue connector (6").
7	Stove Sgle wall flue con Lined msnry chimney	Chimney		CPA	851122	0	0	2500	y	y	y	n	Second floor. Creosote leaked out between seams of stainless steel liner causing fire between chimney and liner.
8	Stove Sgle wall flue con Lined msnry chimney	Chimney	nil	CPA	851130	0	0	1500	n	n	n	y	Back side of kitchen cupboards. Metal plate covering old unused chimney opening transferred heat to back of cupboards in kitchen.

SOLID FUEL INCIDENT REPORTS

F	SYSTEM COMPONENTS Appliance, Flue Connector, Chimney.	PROBLEM PART Part, Manufacturer, Model.	TEST LAB	LOC	DATE	INJ	DEAD	LOSS	PERMIT	INSP	CLR OK?	FTO AVL	ORIGIN + CAUSE
1	Mas FP/HtEx/Gls Drs No flue con Lined msnry chimney	Appliance	nil	CPA	851227	0	0	2100					Mantle level. Glass doors installed in fireplace opening caused build-up of heat at mantle level.
1	Fct-blt metal Fplace No flue con Appl-comont chimney	Appliance Oliver McLeod BI-36ES 243591C	ULC	RCB	851225	0	0	6000	n	n	y	y	Rafters in attic. "Cellufibre insulation" too close to chimney conducted heat to rafters causing ignition.
Total						1	1	937234					

Labour Canada / Travail Canada
Ottawa, Ontario / Ottawa (Ontario)
K1A 0J2 / K1A 0J2

SEP 9 1986

29 August 1986

Our File
D862-2

Mr. Sebastian Moffatt
Sheltair Scientific Ltd.
3661 West 4th Avenue
VANCOUVER, British Columbia
V6R 1P1

Dear Mr. Moffatt:

This is in response to your letter of July 31, 1986 requesting information in regard to fires involving the use of solid fuel appliances in houses, particularly fires related to the operation of a fireplace with fireplace doors.

This office does collate statistics from the various provincial fire marshals and fire commissioners. The statistics received at this office, however are very general and are not usually cross-referenced. For example, we would have listings on how many fires had occurred in residences and how many fires had occurred in solid fuel appliances, but we would not have a record of fires occurring in solid fuel burning appliances in residences. For this reason, the information that we can provide to you is limited. If you were to contact one or more of the provinces in regards to more specific statistics, they may be able to provide you with the detail you require. Attached please find a list of the mailing addresses of the provincial fire marshals/fire commissioners.

Also attached are copies of Table 5 - Source or Ignition in Relation to Fuel or Energy, extracted from the "Supplement to Report of Fire Losses in Government of Canada Properties" for the years 1981 through to 1984. This publication relates to Federal government properties only. In Table 5, you will note the cross-reference made between such categories as fireplaces (item 15) and type of fuel.

. . . 2

In response to your question regarding safe, practical guidelines for installing airtight doors in fireplaces, it would be best if you directed this question to the various fire and safety councils in Canada, namely Underwriter's Laboratories of Canada, Canadian Standards Association, and Warnock Hersey. Their mailing addresses are attached.

I hope that this reply has been satisfactory. Should you have a requirement for further information in regards to this project or any other, please do not hesitate to contact this office again.

Yours truly,

Ronald M. Horrocks
Director General, Fire Prevention and
Fire Commissioner of Canada

Attach.

1984

Table 5 - Source of Ignition in Relation to Fuel or Energy

The major fuel or energy categories with the greatest number of fires were coal, wood, paper, waste (85 fires), electricity (48 fires) and smokers materials (34 fires). They accounted for 167 of the 288 fires. Unclassified or unknown fires numbered 87.

TABLE 5 - SOURCE OF IGNITION IN RELATION TO FUEL OR ENERGY

SOURCE OF IGNITION	COAL, WOOD PAPER, WASTE		FUEL OIL		GASOLINE		NATURAL GAS		PROPANE		SMOKERS' MATERIALS		ELECTRICITY		LIGHTNING		MISCELLANEOUS		TOTAL	
	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS	NO.	$ LOSS
0. HEATING EQUIPMENT -																				
1. CENTRAL HEATING UNITS	1	800	2	5,100	0	0	0	0	0	0	0	0	1	1	0	0	0	0	4	5,901
2. SERVICE WATER HEATERS	0	0	2	2,001	0	0	1	1,500	0	0	0	0	0	0	0	0	0	0	3	3,501
3. SPACE HEATERS: STATIONARY	2	11,155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11,155
4. SPACE HEATERS: PORTABLE	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	2
5. FIREPLACES	2	3,561	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3,561
6. CHIMNEYS, GAS VENTS	1	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	255
7. FLUE PIPES, VENT CONNECTORS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. STEAM, HOT WATER PIPES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. UNCLASSIFIED OR UNKNOWN	0	0	1	15,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15,000
SUB-TOTAL	6	15,771	5	22,101	0	0	1	1,500	0	0	0	0	3	3	0	0	0	0	15	39,375
0. COOKING EQUIPMENT -																				
1. STOVES, RANGES	1	2,900	0	0	0	0	0	0	0	0	0	0	5	24,395	0	0	1	1	7	27,296
2. OVENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. FOOD WARMING APPLIANCES	0	0	0	0	0	0	0	0	0	0	0	0	2	226	0	0	0	0	2	226
4. DEEP FAT FRYERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. COOKING UNITS, PORTABLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7,000	1	7,000
7. OPEN FIRED BROILERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. UNCLASSIFIED OR UNKNOWN	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
SUB-TOTAL	2	2,901	0	0	0	0	0	0	0	0	0	0	7	24,621	0	0	2	7,001	11	34,523
0. SMOKERS' MATERIALS -																				
1. CIGARETTES	17	33,851	0	0	0	0	0	0	2	10	29	167,497	0	0	0	0	6	343	54	201,701
2. PIPES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. CIGARS	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1
9. UNCLASSIFIED OR UNKNOWN	7	805	0	0	0	0	0	0	0	0	2	301	0	0	0	0	5	584	14	1,690
SUB-TOTAL	24	34,656	0	0	0	0	0	0	2	10	32	167,799	0	0	0	0	11	927	69	203,392
0. ELECTRICAL DISTRIBUTION EQUIPMENT -																				
1. WIRING, CABLE	1	4,000	0	0	0	0	0	0	0	0	0	0	3	353,203	0	0	1	200	5	357,403
2. TRANSFORMERS	0	0	0	0	0	0	0	0	0	0	0	0	3	100,601	0	0	1	1	4	100,602
3. SWITCHGEAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. PANELBOARDS, SWITCHBOARDS	0	0	0	0	0	0	0	0	0	0	0	0	1	200	0	0	0	0	1	200
5. SWITCHES, OUTLETS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. CORDS, PLUGS	0	0	1	4,062	0	0	0	0	0	0	0	0	4	1,514	0	0	0	0	5	5,576
7. SIGNAL, TELEPHONE EQUIPMENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. BATTERIES, RECTIFIERS	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0	0	1	10
9. UNCLASSIFIED OR UNKNOWN	1	10,000	0	0	0	0	0	0	0	0	0	0	7	7,502	0	0	1	225	9	17,727
SUB-TOTAL	2	14,000	1	4,062	0	0	0	0	0	0	0	0	19	463,030	0	0	3	426	25	481,518
0. ELECTRICAL APPLIANCES AND EQUIPMENT -																				
1. TELEVISIONS, RADIOS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
2. MOTORS: 1 HP AND OVER	1	1	2	2	0	0	0	0	0	0	0	0	3	1,701	0	0	0	0	6	1,704
3. MOTORS: UNDER 1 HP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	200	1	200
4. ELECTRONIC EQUIPMENT: COMMUNICATIONS	0	0	0	0	0	0	0	0	0	0	0	0	1	300	0	0	0	0	1	300
5. ELECTRONIC EQUIPMENT: DATA PROCESSING	0	0	0	0	0	0	0	0	0	0	0	0	1	500	0	0	0	0	1	500
6. ELECTRIC BLANKETS, PADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. INCANDESCENT LAMPS	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	1	100
8. FLUORESCENT LAMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. UNCLASSIFIED OR UNKNOWN	0	0	2	113	0	0	0	0	0	0	0	0	4	36,101	0	0	0	0	6	36,214
SUB-TOTAL	1	1	4	115	0	0	0	0	0	0	0	0	11	38,703	0	0	1	200	17	39,019

FILE: 82-33-2

AUG 2 1 1986

Northwest
Territories Justice
Safety Division
Office of the Fire Marshal

August 14, 1986

Mr. Sebastian Moffatt
Sheltair Scientific Ltd.
3661 West 4th Avenue
Vancouver, B. C.
V6R 1P1

Dear Mr. Moffat:

Regarding your letter of July 21, 1986 concerning venting failures. To this date, this has not been a problem in the Northwest Territories (NWT) and cannot relate to any fires involving fire places. All of the fires which have occurred involving solid fuel fired appliances have been caused by lack of maintenance or improper installation.

Yours truly,

L. D. MCPHEE
FIRE MARSHAL

LDM/leb

Alberta
LABOUR
General Safety Services Division
Fire Prevention Branch

7th Floor, 10808 - 99 Avenue, Edmonton, Alberta, Canada T5K 0G2 403/427-8392

5788-18

1986.08.28

Sheltair Scientific Ltd.,
Suite 2, 3661 West 4th Avenue
Vancouver, B.C.
V6R 1P7

Attn: Sebastian Moffatt

Dear Mr. Moffatt:

In response to your letter of July 31, 1986, we are pleased to provide you with information on fireplaces and chimneys. You will note from the attached list of fires from 1983, 1984 and 1985, that there appear to be a number of causes related to fireplace fires. Unfortunately, our fire loss statistical system does not indicate those fireplaces that may be equipped with doors although it is obvious from some of the causes that doors were not provided or they'were open at the time of the incident.

If you feel we can assist you further, please let me know.

Sincerely,

W.D. MacKay
Fire Commissioner

WDM/gg/23

TOTAL

No. of Fires	186
$ Loss	1,382,510

1984

	Glass Doors Exploded	Log rolled out	Sparks came out	Chimney fire	Over-heated F.P.	Paper flew out	Child playing	Material too close	Contact cement by pilot light	Cleaning	Damper closed	Over fuelling
No. of Fires	3	30	7	1	3	2	0	2	0	1	3	3
$ Loss	5,486	110,314	9,449	2,400	245,539	1,866	Nil	2,760	Nil	2,702	6,945	17,285

	Dirty Chimney	Burning Xmas Tree	Using Barbeque Starter	Aerosol can Exploded	Unknown	Lighter thrown in	Screen melted	Cracks in F.P.	Design	Construc.	Install.	Unclassified Unknown
No. of Fires	35	0	1	0	4	0	0	2	11	13	32	13
$ Loss	51,711	Nil	1,098	Nil	3,049	Nil	Nil	1,090	96,090	42,81[illegible]	[illegible]70,815	520,350

TOTAL

No. of Fires	147
$ Loss	1,255,832

1985

	Glass Doors Exploded	Log rolled out	Sparks came out	Chimney fire	Over-heated F.P.	Paper flew out	Child playing	Material too close	Contact cement by pilot light	Cleaning	Damper closed	Over fuelling
No. of Fires	4	21	8	2	5	2	1	4	1	0	2	5
$ Loss	5,492	45,763	5,316	1,082	30,128	1,212	160	126,528	42,000	Nil	3,934	128,654

	Dirty Chimney	Burning Xmas Tree	Using Barbeque Starter	Aerosol can Exploded	Unknown	Lighter thrown in	Screen melted	Cracks in F.P.	Design	Construc.	Install.	Unclassified Unknown
No. of Fires	37	0	0	2	0	1	1	4	4	10	31	2
$ Loss	282,153	Nil	Nil	6,990	Nil	781	5,011	18,202	23,481	61,734	456,161	10,250

RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 2

IN FIRE MATION
OFFICIAL BULLETIN OF THE FIRE COMMISSIONER,
BRITISH COLUMBIA

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

APPENDIX 2

IN FIRE MATION

OFFICIAL BULLETIN OF THE FIRE COMMISSIONER, BRITISH COLUMBIA

GORDON R. ANDERSON – FIRE COMMISSIONER

Province of British Columbia

VOL 5-84

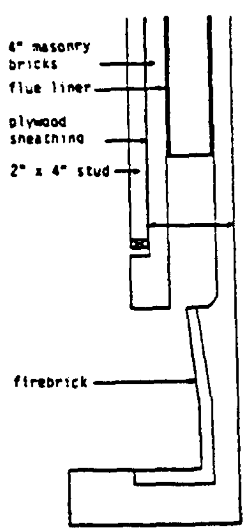
SEPTEMBER/OCTOBER 1984

Better Fireplace Inspections Required

Too many masonry fireplaces are constructed in an unsafe manner, and all too often building inspectors are approving them even though they do not conform to the building code. We touched on this subject in our January/February 1984 issue but we believe the problem is severe enough to warrant elaboration.

Last winter, we were investigating the frequency of fires originating just above the "openings" of masonry fireplaces which had been closed off by the installation of fireplace inserts, heat exchanger units or simply, glass doors alone. The common denominator in those fires was the point of origin - combustibles (plywood sheathing and studs) that were in contact with the masonry of the fireplace/chimney. The age of the fireplaces involved varied from 15 years to 5 years.

That prompted inspections of about 10 fireplaces under construction in various locations. The general construction was very similar in most of them. They were all fireplaces on an external wall and the typical construction was as shown in Figure 1.



← Figure 1

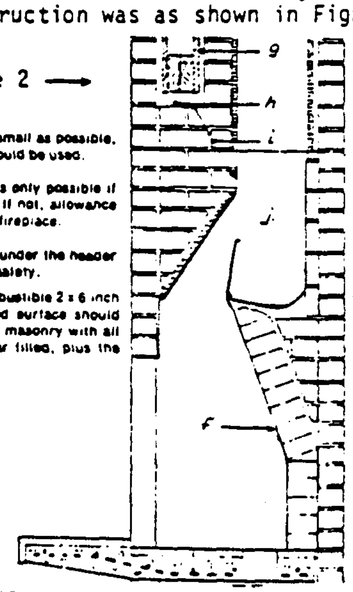
Figure 2 →

f) All joints in firebricks should be as small as possible, and air setting refractory mortar should be used.

g) Minimum clearance ½ inch. This is only possible if the framework is perfectly plumb. If not, allowance must be made during lay-out of the fireplace.

h) Two inch space should be provided under the header for frame settlement and extra fire safety.

i) The shortest distance from the combustible 2 x 6 inch double header to a heated unlined surface should be not less than 7½ inches of solid masonry with all joints and voids completely mortar filled, plus the clearance.



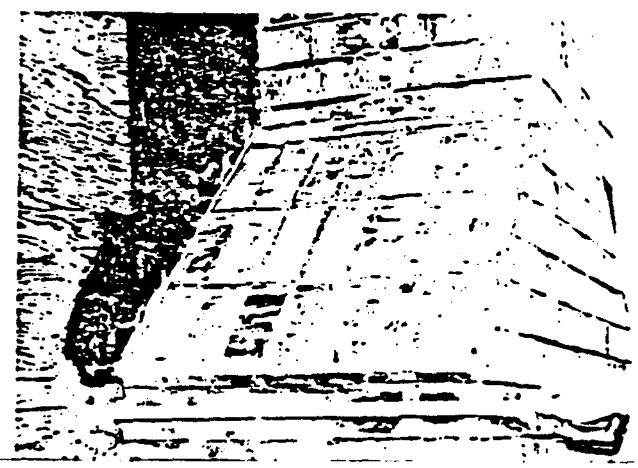
Compare Figure 1 with Figure 2 which is taken from "Fireplace Report", an industry guide for the design and construction of fireplaces and chimneys published by the Alberta Masonry Institute. Note the differences between Figures 1 and 2. The major shortcomings in Figure 1 are:

(con't)

Published by the Office of the Fire Commissioner, Ministry of Attorney General, Suite 1 2780 East Broadway, Vancouver British Columbia V5M 1Y8 – Telephone 251 3131

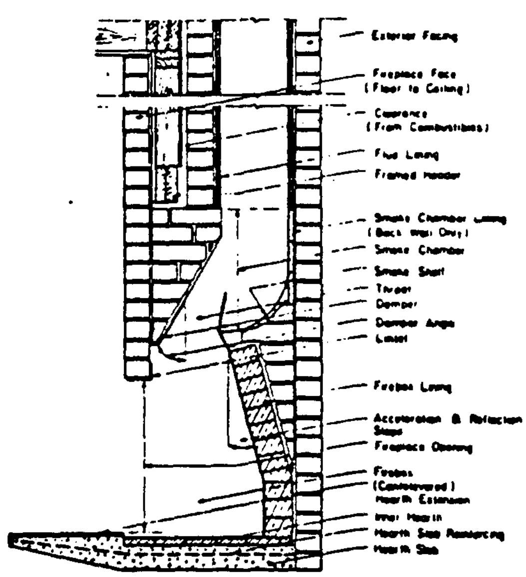
(1) Plywood sheathing which forms part of the outside wall, is in direct contact with the chimney's masonry blocks. Building code requires a minimum of 1/2" clearance.

(2) The thickness of masonry in the smoke chamber (the portion above the throat up to the beginning of the tile liner) is only 4". The building code requires 7-1/2" of solid masonry.



Solid Fuel Problems

The cold spell that we had in December brought to light more fires related to the use of solid-fuel burning appliances. The nature of these fires, although not new, does support what we have believed and publicized over the last few years, i.e. if you close off the front of your masonry fireplace, temperature in the fireplace and the lower portion of the chimney can get high enough to ignite combustibles located above the fireplace opening. In most instances these combustibles - usually the header, framing members and plywood sheathing - are concealed by a decorative brick wall or panelling.



Let's take a closer look at three specific fires, all of which occurred in December 1983. The point of origin in all three cases was concealed combustibles above the fireplace, and in all instances there did not appear to be any clearance between the sheathing and the chimney. These are only three incidents. There were several other similar incidents that occurred in December.

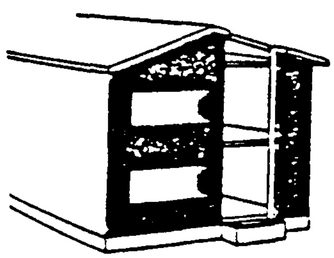
Various methods are then discussed in the book to avoid the guesswork. These deficiencies may not create fires immediately, but as creosote accumulates in the smoke chamber and eventually ignites, all we have between the combustible framing and a chimney fire, producing temperatures up to 2200°F, is 4 inches of masonry!

The problem is magnified several times when a fireplace insert or other device, which closes off the fireplace opening, is installed.

In the interest of fire safety, the Fire Commissioner's Office is making the following recommendations:

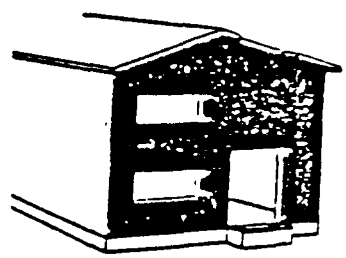
(1) Building inspectors inspect new masonry fireplace installations very closely to ensure they comply with the building code.

(2) Masons and bricklayers who build fireplaces should be informed of these problems by local building or fire officials, so that they can improve their work. For a nominal extra expense a person is better off eliminating combustibles for the full width of the fireplace. The combustible framing will then be as shown in Figure 4 as opposed to the more traditional Figure 5 where the firebox backs through the wall.



← Figure 4

Figure 5 →

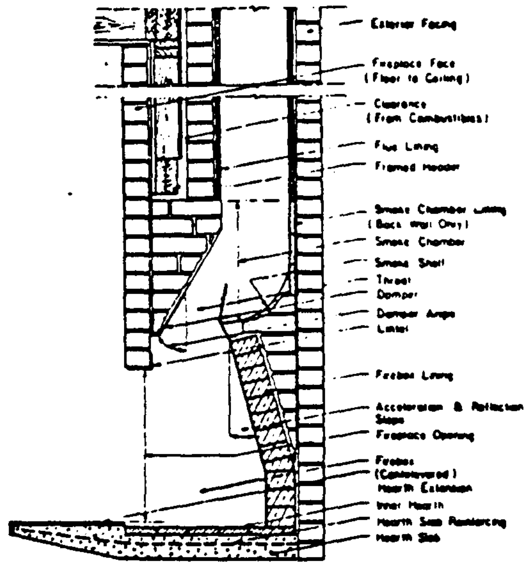


(3) Dealers and distributors of fireplace inserts, heat exchangers with glass doors, or other such devices should be advised so that they could inform prospective customers. Installation of a fireplace insert or other similar appliance is only safe if it is installed in a fireplace that conforms to the building code, because the test structures used by the testing laboratories for such appliances conform to the building code. At one stage, it was suggested to ULC to modify the test structure to reflect field conditions (i.e. fireplaces constructed like Figure 1) but the response of the ULC-S600 standards writing committee was that nothing will pass in a fireplace constructed as in Figure 1. Several committee members were highly critical of "the sloppy fireplace inspections in British Columbia". The criticism was difficult to accept but they did have a point - you can't go on making the standard for fireplace inserts more and more restrictive to compensate for poor fireplace construction.

(4) People who have existing installations of fireplace inserts, heat exchangers and tight fitting glass doors in their fireplaces should inspect their fireplaces and make the necessary modifications if they find that their fireplaces are similar to our Figure 1. If modifications to the masonry fireplace is not a viable alternative, they should remove the fireplace insert or at least refrain from using it.

* * * * *

Solid Fuel Problems

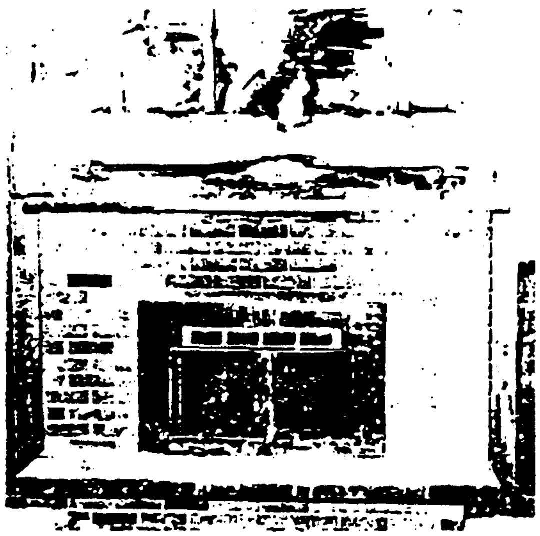


The cold spell that we had in December brought to light more fires related to the use of solid-fuel burning appliances. The nature of these fires, although not new, does support what we have believed and publicized over the last few years, i.e. if you close off the front of your masonry fireplace, temperature in the fireplace and the lower portion of the chimney can get high enough to ignite combustibles located above the fireplace opening. In most instances these combustibles - usually the header, framing members and plywood sheathing - are concealed by a decorative brick wall or panelling.

Let's take a closer look at three specific fires, all of which occurred in December 1983. The point of origin in all three cases was concealed combustibles above the fireplace, and in all instances there did not appear to be any clearance between the sheathing and the chimney. These are only three incidents. There were several other similar incidents that occurred in December.

Photo 1 This incident took place in Richmond on December 7, 1983. The fireplace insert had been installed approximately 4 years ago. The unit was purchased second hand and therefore no installation instructions were available to the present owner. The unit was listed by ULI (American) and required 33 inches clearance between the top of the insert and any combustibles - visible or concealed. This clearance apparently was not met. In addition, the unit was modified by the addition of a baffle plate which according to the owner brought the heat forward. The unit did not use a flue connector but the ULI standard did not require one anyway. The Underwriters' Laboratories of Canada standard for fireplace inserts presently requires a flue connector to direct flue gases into the chimney.

(con't)



← Photo 2 This case occurred in Prince George on December 18, 1983. A heat exchanger unit with glass doors (manufacturer calls it a converter furnace) was installed a year ago into a masonry fireplace that was built 15 years ago. The unit was listed by Warnock Hersey Professional Services Ltd. Clearance between the sheathing and the chimney appeared to be almost nil and insulation between the sheathing and panelling might have compounded the problem by restricting the dissipation of heat.

Photo 3 This incident involved glass doors fitted to a heat circulating masonry fireplace. The fireplace was built 5 years ago and the glass doors were fitted 2 years ago when the present owner bought the house. Here again, it didn't appear as if there was any clearance between the chimney and the sheathing. →

The following building code references have relevance to this problem:

9.21.6.1. The clearance between *masonry or concrete chimneys* and *combustible* framing shall be not less than 50 mm for interior *chimneys* and 12 mm for exterior *chimneys*.

9.21.6.4. Flooring shall have not less than a 12 mm clearance from *masonry or concrete chimneys*.

9.22.7.2. The thickness of masonry walls surrounding the smoke chamber shall be at least 190 mm at the sides, front and back, except that the portions of the back exposed to the outside may be 140 mm thick.

9.22.9.4. At least a 50 mm clearance shall be provided between the back and sides of the smoke chamber of a fireplace and *combustible* framing, except that a 25 mm clearance is permitted where the fireplace is located in an exterior wall.

The problem may stem from the use of the words "combustible framing" in 9.21.6.1. Jim Currie, Director of the Building Standards Branch, has reviewed the requirements and interprets sheathing to be part of the "framing" as used in the code. He points out that 9.21.6.4. implies that 12 mm clearance to be a bare minimum between any combustibles and a chimney.

(con't)

In some instances the framing comes too far down. In many others, the flue liner does not come down far enough, resulting in a smoke chamber that may be as high as 3 feet. This type of construction usually leaves only 4" of masonry between the flue gases and the sheathing. Sentence 9.22.7.2. requires masonry at least 190 mm (7-1/2") thick in the front of the smoke shelf, in addition to the 1/2" clearance discussed earlier. Sentence 9.22.9.4. might imply the necessity for more than the 1/2" clearance.

The problem does require further study but in the meantime it is quite clear that the area above the fireplace is very vulnerable and building inspectors should pay particular attention to this area.

These potential problems were pointed out in 1980 in our Guideline No. 80-4 "An Update on Chimneys, Airtight Stoves, Fireplace Inserts and Glass Doors". It seems that the fire service is quite aware of these potential problems but homeowners still need to be educated. Building officials should be warned about the potential dangers of insufficient clearances mentioned earlier. It may be noted that as long as a fireplace is used as such, i.e. without inserts or glass doors, there may be sufficient latitude in safety. That probably explains why some of these problems don't show up earlier, eg. in Photo 2 the fireplace was constructed 15 years ago but the problem didn't show up until the glass doors came into place.

There is a serious need for initiative at a local (municipal) level. A recent good example comes to mind. When Prince George's Director of Fire Services, Harold Dornbierer, had four similar fires between December 17 and 25 (two of which were discussed earlier) he raised the alarm. He had a meeting with building officials, local contractors, bricklayers, masonry suppliers, insurance people, fireplace insert and other related companies. The result was a public awareness program in Prince George and the media provided full co-operation. In addition, the municipality has also initiated improved inspections of retrofit and new installations. In Prince George, for now at least, no installation will be approved unless it is clear that there is no wood above the fireplace, if an insert or glass doors are installed.

The Fire Commissioner's Office is presently reviewing all available data before deciding on any action on a provincial level. In spite of any provincial action, there is still a need for local initiatives in this regard.

We are trying to include every building official in B.C. on our mailing list. We would like to request local assistants to check with their building officials to see if they are presently receiving In Fire Mation. If they are not, we would appreciate it if you send us their names and mailing addresses.

* * * * *

Editor: Param-jit S. Seran

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RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 3

CSA DRAFT STANDARD A405
DESIGN AND CONSTRUCTION OF MASONRY CHIMNEYS AND FIREPLACES

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

5. Chimneys and Fireplaces, Design and Construction

5.1 General

5.1.1
Unless otherwise specified in this Standard, masonry construction shall be in accordance with CSA Standard CAN3-A371.

5.1.2 Footings and Foundations for Chimneys and Fireplaces

5.1.2.1
Plain concrete chimney footings shall be designed, mixed, placed, cured and tested in accordance with CSA Standard CAN3-A438.

5.1.2.2
Reinforced concrete footings and foundations shall conform to CSA Standard CAN3-A23.3.

5.1.2.3
Interior masonry foundations shall be provided with a dampproof course (DPC) where the masonry extends through a floor slab and is not otherwise protected against ground moisture.

5.1.2.4
Where a chimney or fireplace is added to the outside of the exterior wall of an existing structure the following shall apply:
(a) except where prevailing local soil conditions or design criteria permit an alternative level, the new footing shall be installed at the same level or below the existing footing provided the level is below the frost line and the new footing is placed on undisturbed soil with adequate bearing capacity;
(b) the existing drainage provision shall not be blocked, interrupted or bridged; and
(c) where an existing exterior foundation wall is pierced to provide a passage for a below grade flue or fireplace, the new foundation wall shall be damp-proofed or waterproofed in accordance with CSA Standard CAN3-A371-M.

5.2 Chimneys

5.2.1 Flues and Flue Liners for Chimneys

5.2.1.1
Masonry or concrete chimneys shall have a clay, concrete or metal flue lining or fire-brick lining.

5.2.1.2
Every flue liner shall extend upward from the flue base to a point not less than 50 mm and not more than 100 mm above the chimney cap.

5.2.1.3
A chimney shall extend not less than 900 mm above the highest point at which the chimney comes in contact with the roof and no less than 600 mm above the highest roof surface or structure within 3000 mm of the chimney top.

5.2.1.4
Except for flues constructed to serve fireplaces or wood burning stoves, every flue shall be equipped with a clean-out door near the bottom. In the case of stoves a clean-out door is optional. Clean-out openings must be furnished with a tight fitting metal frame and door.
Note: *Where a clean-out door is not provided, cleaning may be done through the flue pipe thimble.*

5.2.1.5
Except for fireplaces every flue shall extend downward 200 ± 20 mm below the lowest opening (thimble or clean-out). The horizontal base of the flue shall be sealed with concrete or cement mortar.
Note: *The lower portion of the flue is intended to act as a receptacle for falling debris. Regular removal of debris is recommended.*

5.2.1.6
All joints of flue linings shall be sealed airtight and struck flush on the inside so as to produce a straight, smooth, fully aligned flue.

5.2.1.7
Flue liners inclined to the vertical shall have a manufactured mitre or be cut with a masonry saw to maintain full alignment of flue walls. All adjustments of liner length shall be made with a masonry saw to produce square bedjoints. Equal cuts should be made to both liners.

5.2.1.8
Cracked or broken liners or liners with broken edges shall not be used.

5.2.1.9
The opening in the flue liner for a flue pipe connection shall be manufactured or machine cut.

5.2.1.10
Flue liners shall be surrounded and stabilized on all four sides.

5.2.1.11
Chimney liners shall be installed when the surrounding masonry or concrete is placed. Spaces (collar joint) between the liner and the surrounding masonry shall not be filled with mortar when the chimney walls are less than 190 mm in thickness.

5.2.1.12
The space between the liner and the surrounding masonry shall be a minimum of 10 mm and a maximum of 25 mm.

5.2.1.13
The last (top) flue liner shall not be less than 300 mm in length.

5.2.1.14
Liners shall not be placed in such a manner as to cause ledges or steps within the flue passage.

5.3.7.1
The free damper area, normally taken to be the area of the throat, shall be at least equal to 90% of the area of the flue.

5.3.8 Smoke Chamber

5.3.8.1
The sides of the smoke chamber connecting a fireplace throat with a flue shall not be sloped at an angle greater than 45° from the vertical and shall be smooth and offer no impediment to smoke clearance.

5.3.8.2
The thickness of masonry walls surrounding the smoke chamber shall be at least 190 mm at the sides, front and back, except that the portions of the brick exposed to the outside may be 140 mm thick.
Note: *It is recommended that outside walls of smoke chamber be composed of two wythes of masonry in order to reduce drafts through joints.*

5.3.8.3
When a fireplace is constructed in a structure in 2 stages whereby the chimney and roughed-in fireplace recess preceed the construction of the finished fireplace, the base of the chimney must extend at least 200 mm below any wood headers or combustible framing members.

5.3.8.4
Sufficient space must be left to allow the uninterrupted alignment of the smoke chamber to the base of the chimney when any portion of the required smoke chamber wall thickness is to be constructed during the completion of the finished fireplace stage.

5.3.9 Clearance of Combustible Material

5.3.9.1
Combustible material shall not be placed on or near the face of a fireplace within 150 mm of the fireplace opening, except that where the combustible material projects more than 38 mm out from the face of the fireplace above the opening, such material shall be at least 300 mm above the top of the opening. Material below the opening shall conform to Clause 5.3.6.

5.3.9.2
Metal exposed to the heated interior of a fireplace, such as the damper control mechanism or a built-in glass door, shall have at least a 50 mm clearance from any combustible material on the face of the fireplace where such metal penetrates through the face of the fireplace.

5.3.9.3
When a fireplace is equipped with heat circulating outlet ducts above the fireplace opening, the distance from such a duct or metal duct grill to the combustible material above shall be at least 300 mm where such projections are more than 38 mm from the face. Where the combustible material projects less than 38 mm,

the distance shall be not less than 150 mm to the combustible material.

5.3.9.4
At least a 100 mm clearance shall be provided between the back and sides of a fireplace and combustible framing, except that a 50 mm clearance is permitted where the fireplace is located on an exterior wall.

5.3.9.5
At least a 50 mm clearance shall be provided between the back and sides of a smoke chamber of a fireplace and combustible framing, except that a 25 mm clearance is permitted where a fireplace is located on an exterior wall.

5.3.10 Fireplace Hoods
Hoods used as part of a fireplace or barbecue shall be not less than No. 18 gauge copper, galvanized steel or other equivalent corrosion-resistant metal with all seams and connections of smokeproof unsoldered construction. The hood shall be sloped at an angle of 45° or less from the vertical and shall extend horizontally at least 160 mm beyond the limits of the fire chamber. Metal hoods shall be kept a minimum of 450 mm from combustible materials unless approved for reduced clearance.

5.3.11 Combustion Air Intake

5.3.11.1 General
All fireplaces shall have provision for a supply of combustion air from the outside.

5.3.11.2
The minimum inside clear diameter of the intake duct shall be 100 mm or equivalent area.

5.3.11.3
The outlet port shall be positioned as close to the fireplace opening as possible.

5.3.11.4
The outlet port, if positioned inside the fire chamber shall be located at the front centre of the chamber hearth and shall be equipped with a noncombustible ~~retractable~~ hood which ~~when open~~ points away from the fire and shall be designed to prevent embers from entering the duct.

5.3.11.5
All air inlets shall be fitted with two dampers, one at the outlet port and one at the inlet port, which are operable from inside the dwelling.

5.3.11.6
The exterior duct intake shall have an insect screen.

5.3.11.7
The ducts shall be noncombustible, corrosion resistant and insulated (WHEN NECESSARY) to prevent condensation.

5.3.11.8
The duct shall be kept at least 50 mm clear of combustible construction for the first 1000 mm of its length from the outlet in the fire chamber.

5.3.11.9
The inlet for combustion air shall be located to avoid being blocked by snow.

RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 4

INSTALLATION OF AIRTIGHT FIREPLACE DOORS STEP-BY-STEP

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

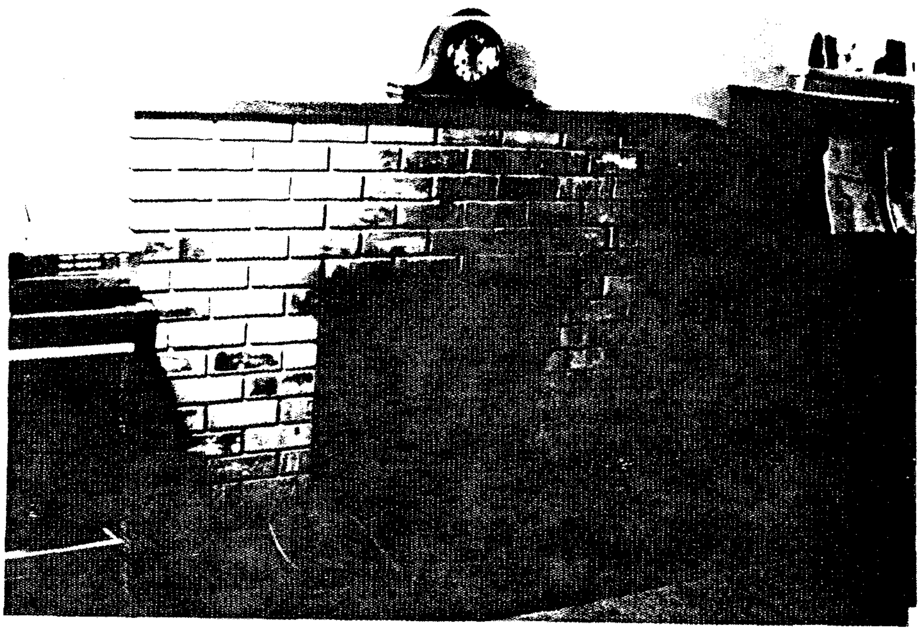
January, 1987

INSTALLATION OF AIRTIGHT FIREPLACE DOORS
STEP BY STEP

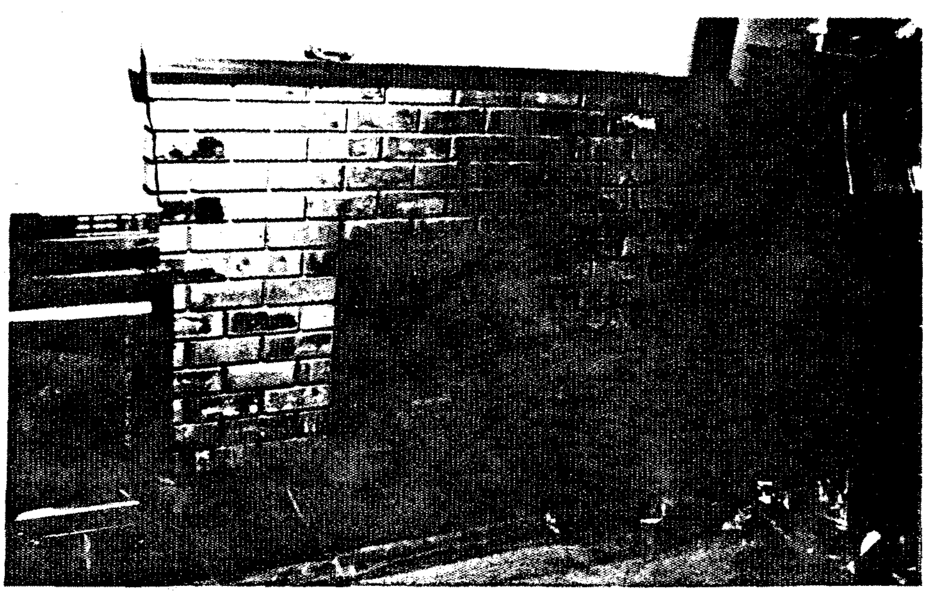
PHOTOGRAPHS:

1. House exterior with masonry fireplace chimney.
2. Fireplace as found.
3. Screens and valance are removed and ashes cleaned out.
4. Ash clean-out and masonry inspected for damage or fire hazards.
5. Observations made to determine condition of flue, location of flue liner, and construction of smoke chamber.
6. Estimating best locations for drill holes to locate (nearest combustible material next to unlined flue, e.g. header).
7. Drilling probe holes below mantle with extended masonry bit.
8. Examining bore debris to identify wooden components.
9. Sealing the ash clean-out with masonry silicone.
10. Front view of airtight door unit, prior to installing.
11. Rear view of door unit, showing insulcast cement behind frame to reduce surface temperatures.
12. Profile of heat exchanger, with 75 mm air supply duct along lower edge.
13. Preliminary fitting of door unit to locate air supply inlet and support brackets.
14. Drilling pilot holes through fire brick for air supply.
15. Reaming the hole in back of fireplace to fit the 75 mm iron pipe.
16. Chisel work on stucco veneer behind fireplace to permit insertion of 75 mm air inlet pipe.
17. Fitting door unit into opening for permanent installation.
18. Connecting air supply pipe from outdoors to supply duct along side of unit so that outdoor air is supplied along lower front of fire.
19. Supporting brackets are tightly bolted to brick flange of fireplace.
20. Exterior of air inlet is being patched with mortar and fitted with insect screen.
21. Frame of the door unit is sealed to the masonry using masonry silicone along sides, top and bottom.

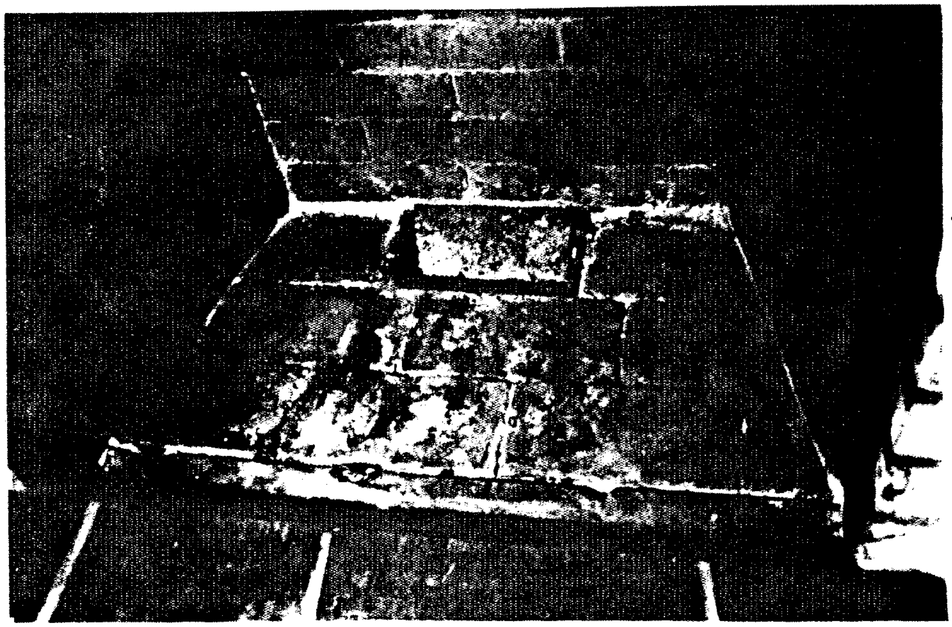
1. House exterior with masonry fireplace chimney.



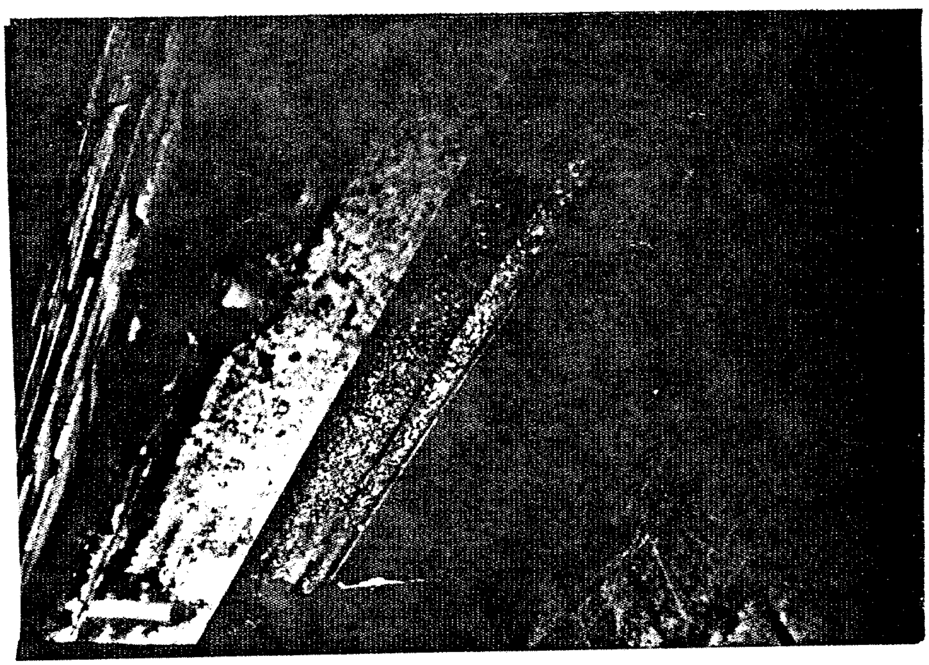
2. Fireplace as found.



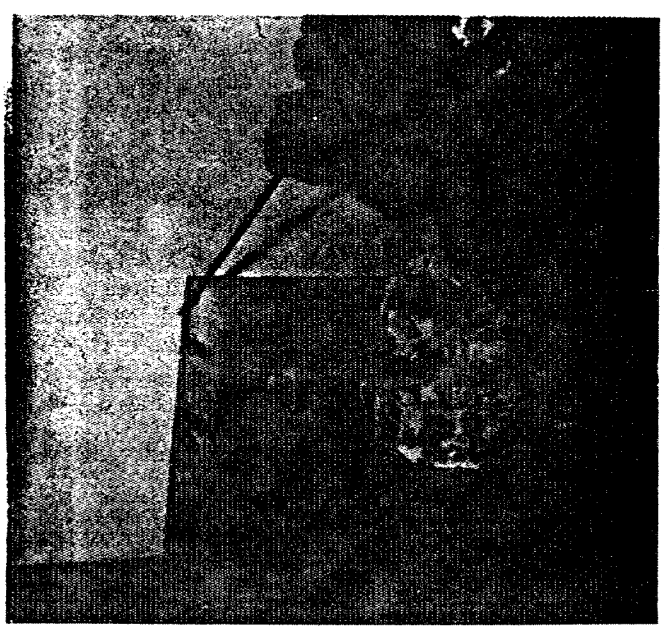
3. Screens and valance are removed and ashes cleaned out.



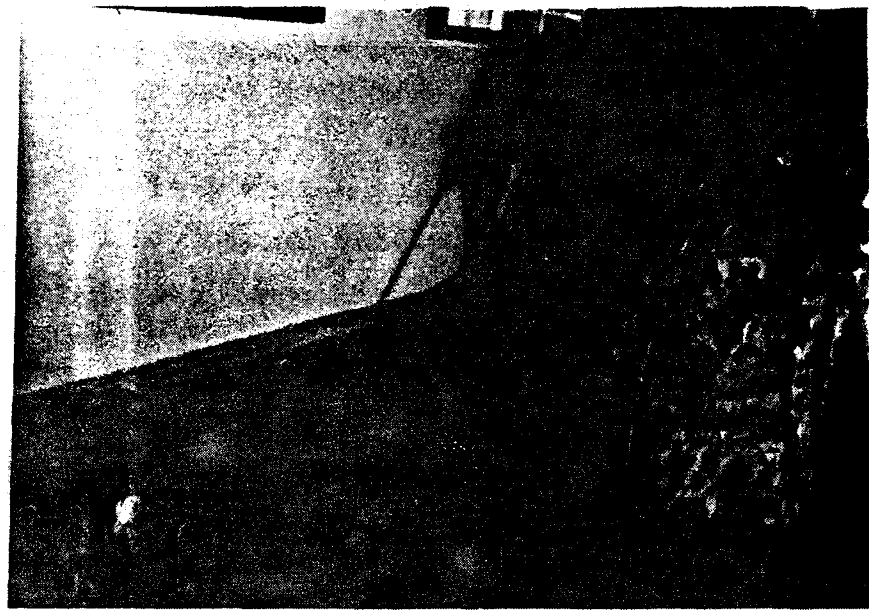
4. Ash clean-out and masonry inspected for damage or fire hazards.



5. Observations made to determine condition of flue, location of flue liner, and construction of smoke chamber.

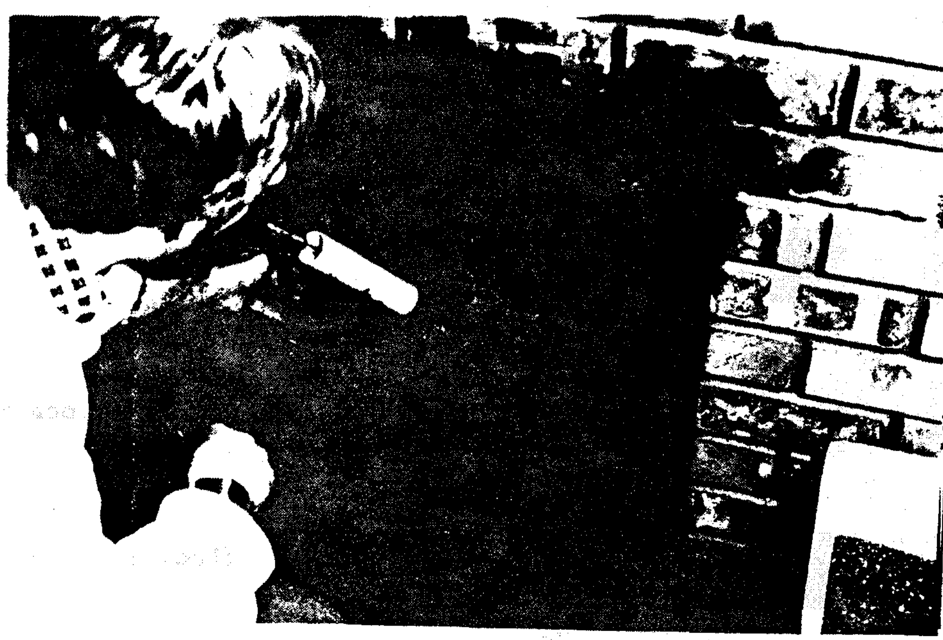


6. Estimating best locations for drill holes to locate (nearest combustible material next to unlined flue, e.g. header).

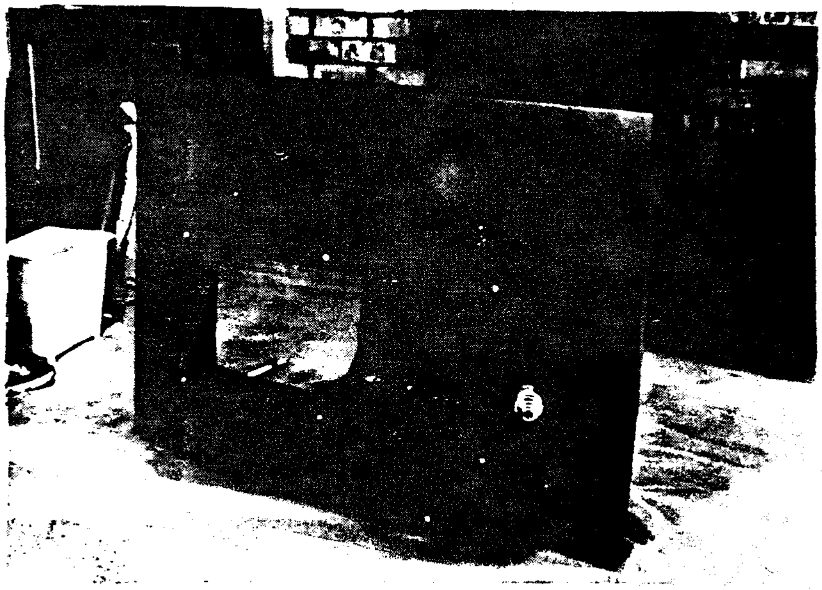


7. Drilling probe holes below mantle with extended masonry bit.

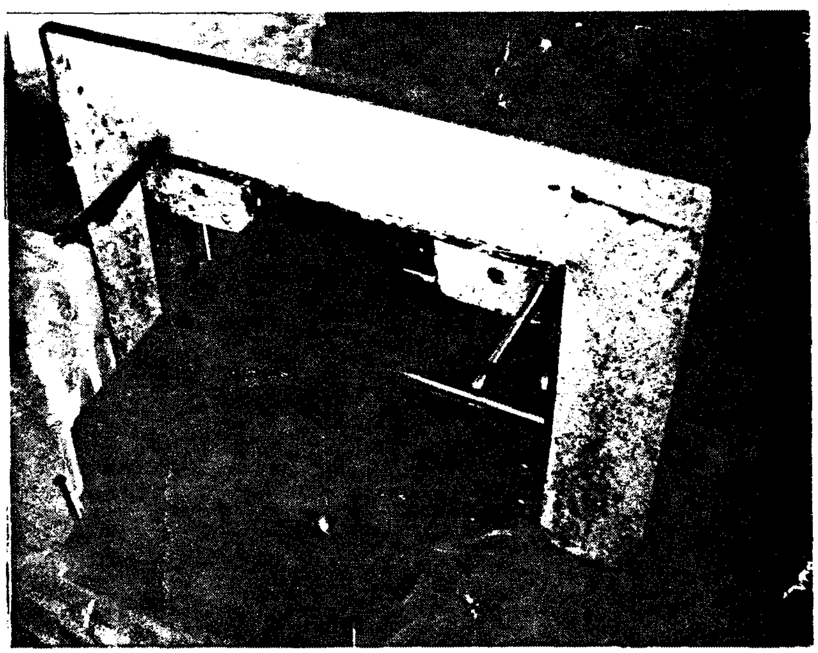
8. Examining bore debris to identify wooden components.



9. Sealing the ash clean-out with masonry silicone.

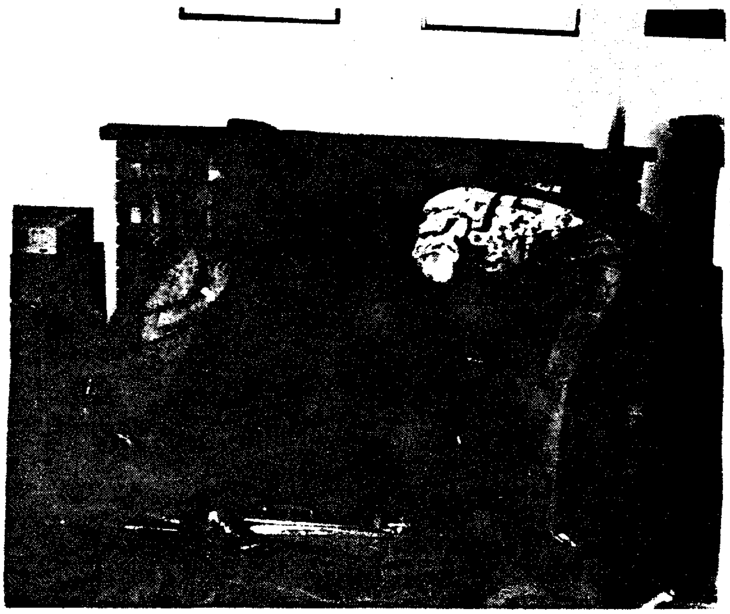


10. Front view of airtight door unit, prior to installing.



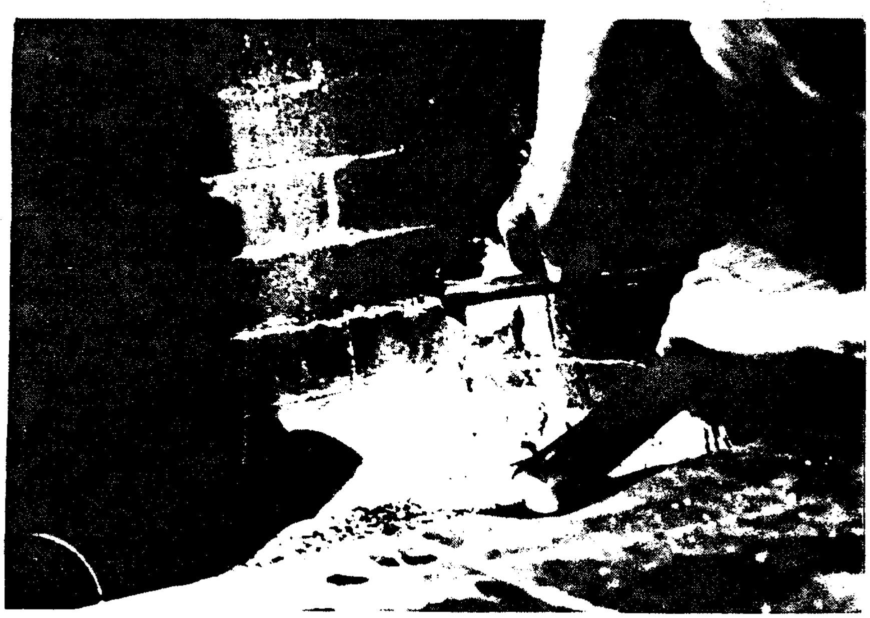
11. Rear view of door unit, showing insulcast cement behind frame to reduce surface temperatures.

12. Profile of heat exchanger, with 75 mm air supply duct along lower edge.



13. Preliminary fitting of door unit to locate air supply inlet and support brackets.

14. Drilling pilot holes through fire brick for air supply.



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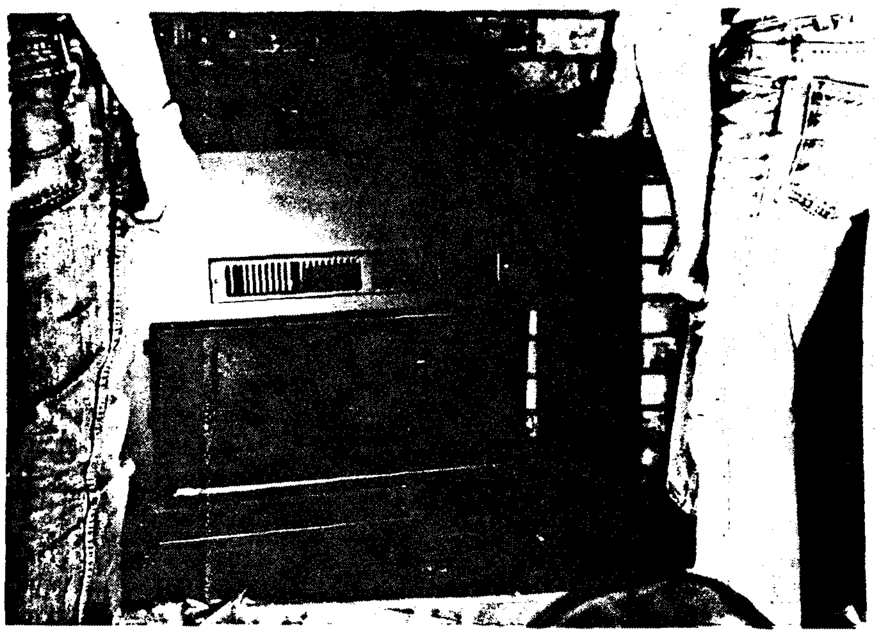
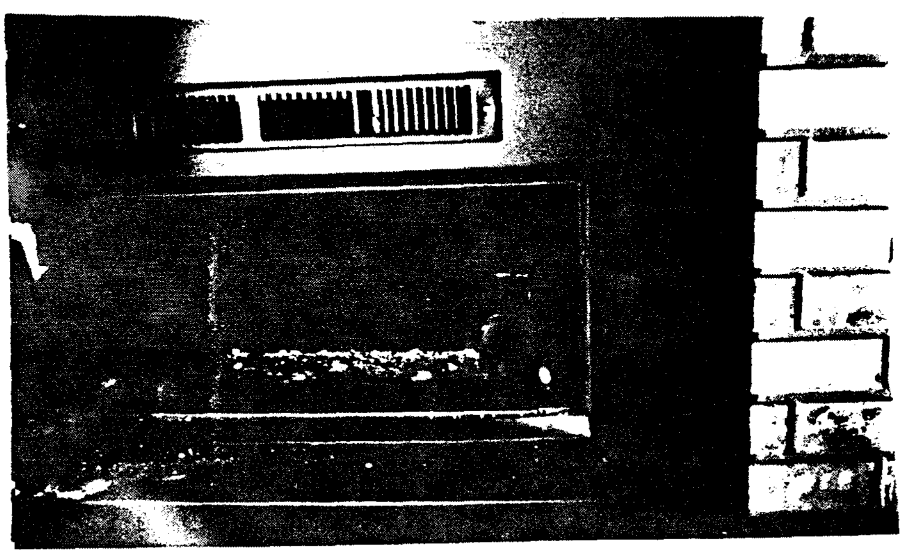
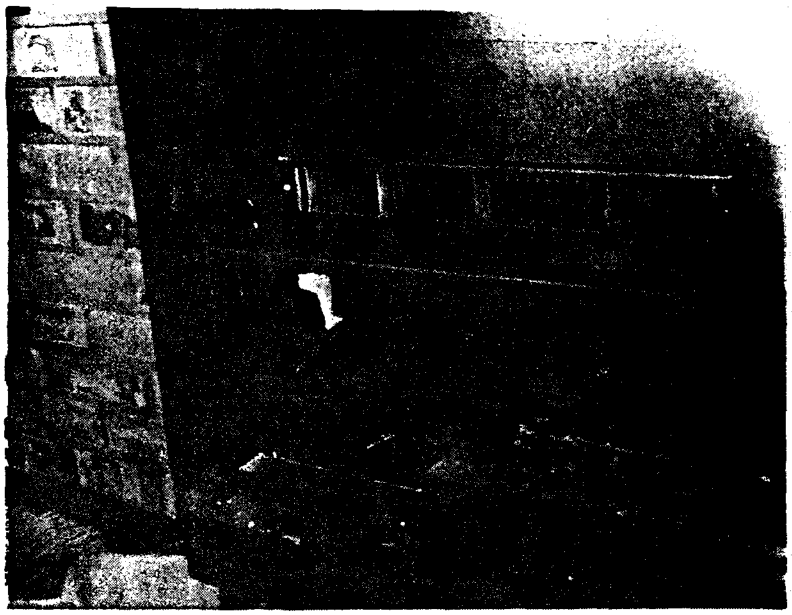
16. Chisel work on stucco veneer behind fireplace to permit insertion of 75 mm air inlet pipe.



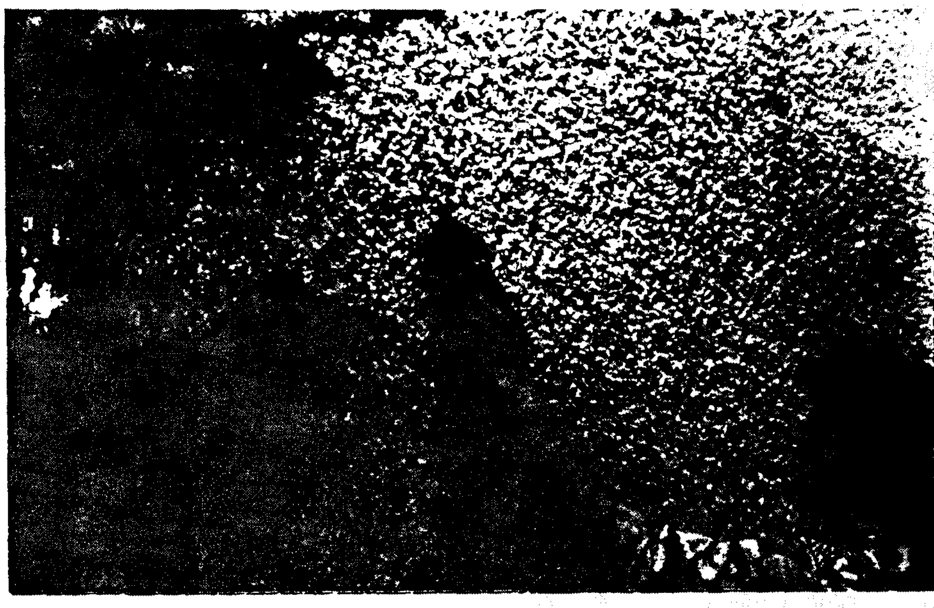
17. Fitting door unit into opening for permanent installation.



18. Connecting air supply pipe from outdoors to supply duct along side of unit so that outdoor air is supplied along lower front of fire.



19. Supporting brackets are tightly bolted to brick flange of fireplace.



20. Exterior of air inlet is being patched with mortar and fitted with insect screen.

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RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 5

FRESH AIR INTAKE FOR FIREPLACES
A REPORT BY DR. M. A. HATZINIKOLAS, P. ENG.
APRIL, 1984

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

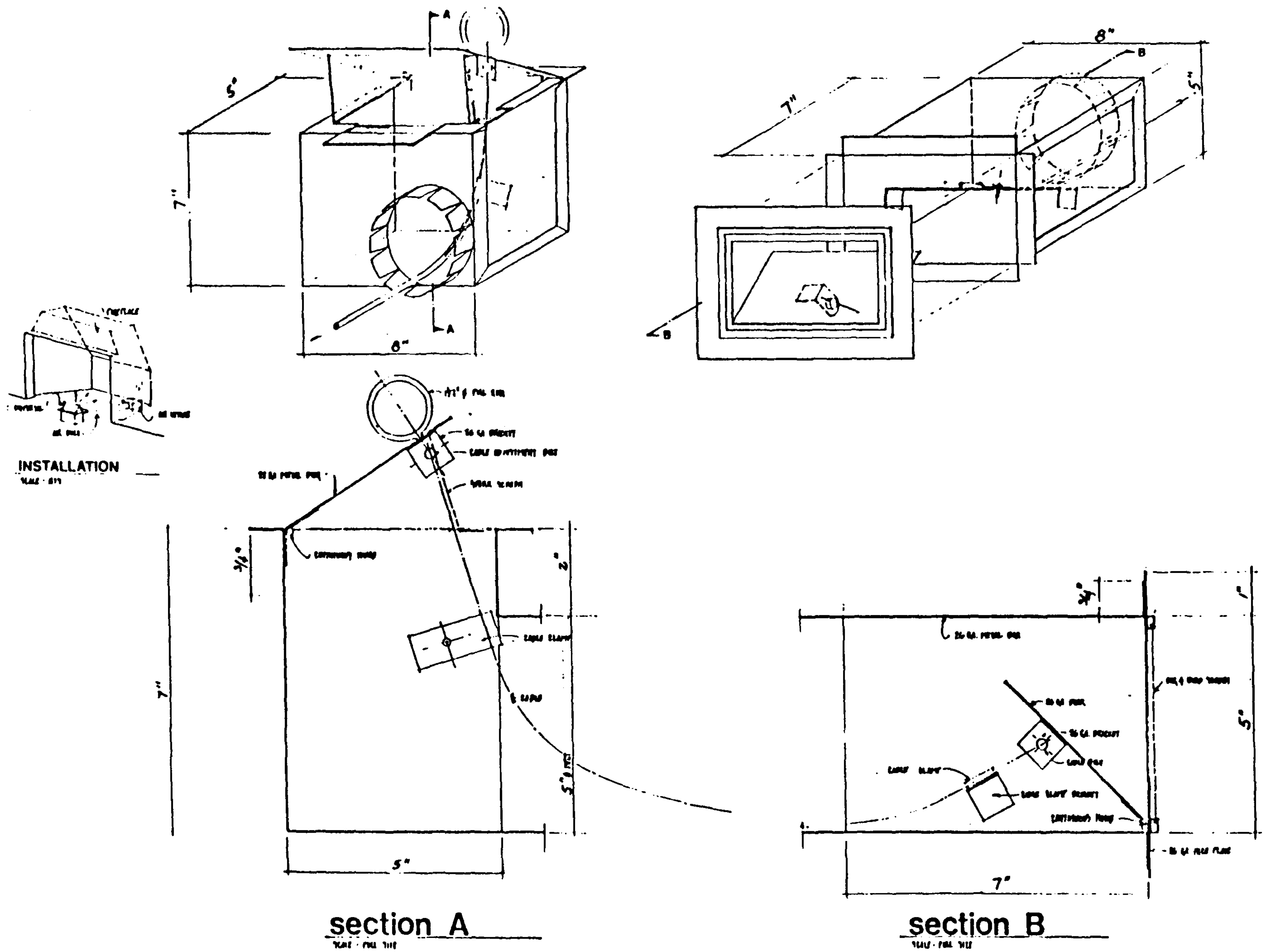
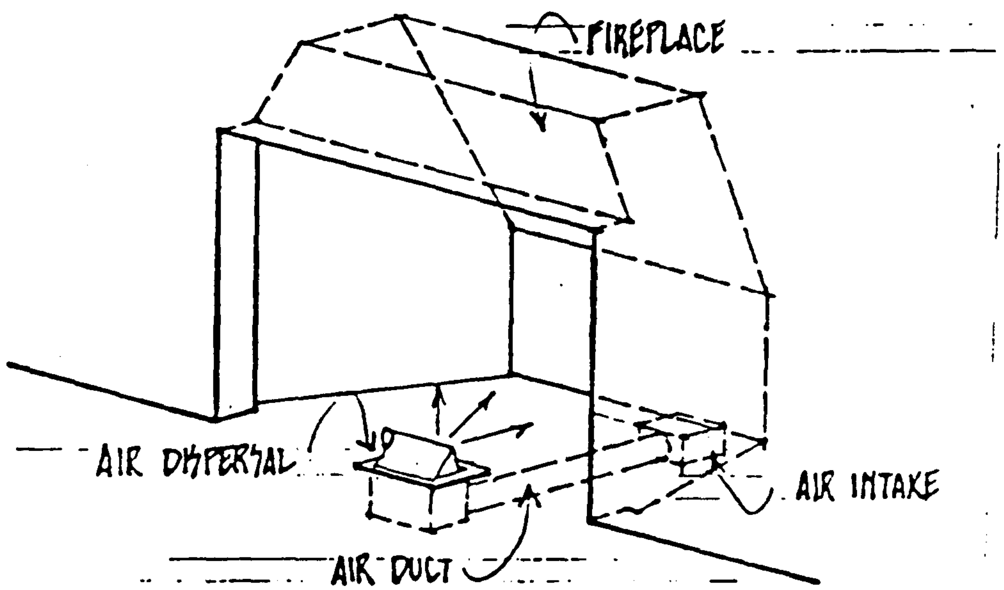


Fig. 1 - Main Elements of Fresh Air Intake



INSTALLATION

SCALE · NTS

Fig. 6 - INSTALLATION OF DEVICE SHOWING POSITION OF CONNECTING DUCT.

RESIDENTIAL COMBUSTION VENTING FAILURES

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES: AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 6

DIMENSIONS AND STYLE OF AIRTIGHT DOORS MEASURED LEAKAGE AREA

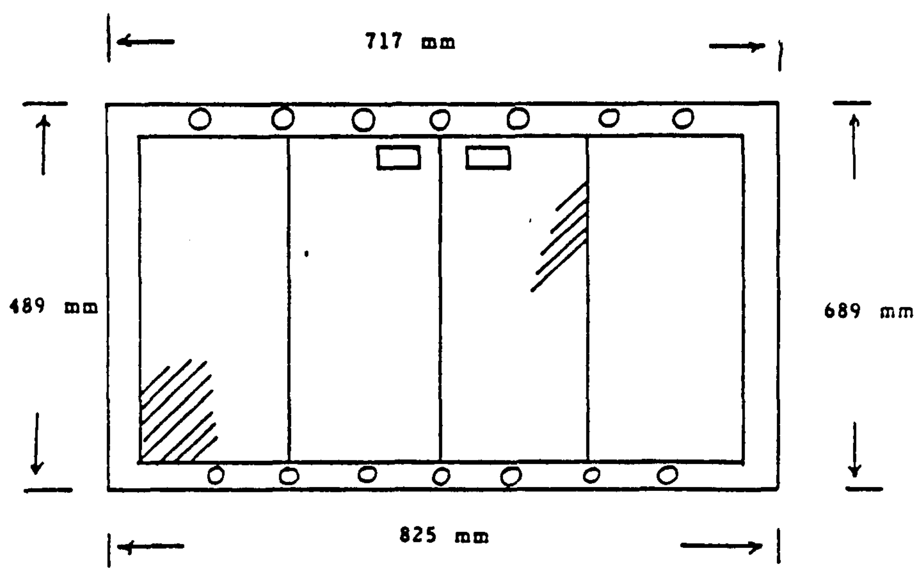
Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

#1 FIRE PLACE GLASS DOOR

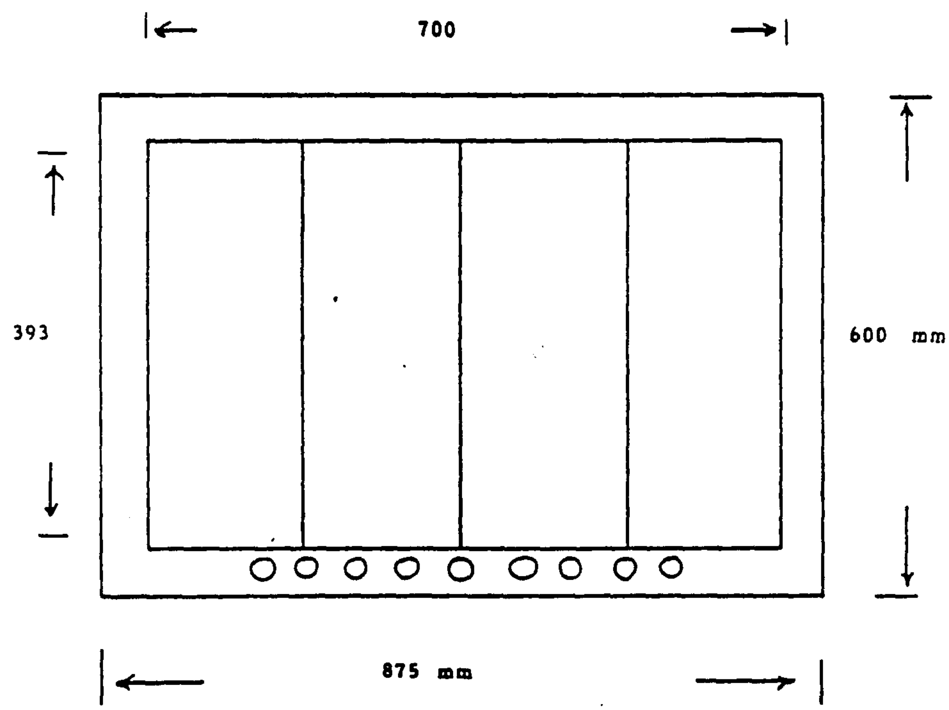
- BIFOLD DOORS
- DOUBLE VENTS
- U.S. MADE - PORTLAND - WILLAMETT
  A DIVISION OF THOMAS INDUSTRIES



TOTAL LEAKAGE AREA: 123.8 mm

2 FIRE PLACE GLASS DOOR

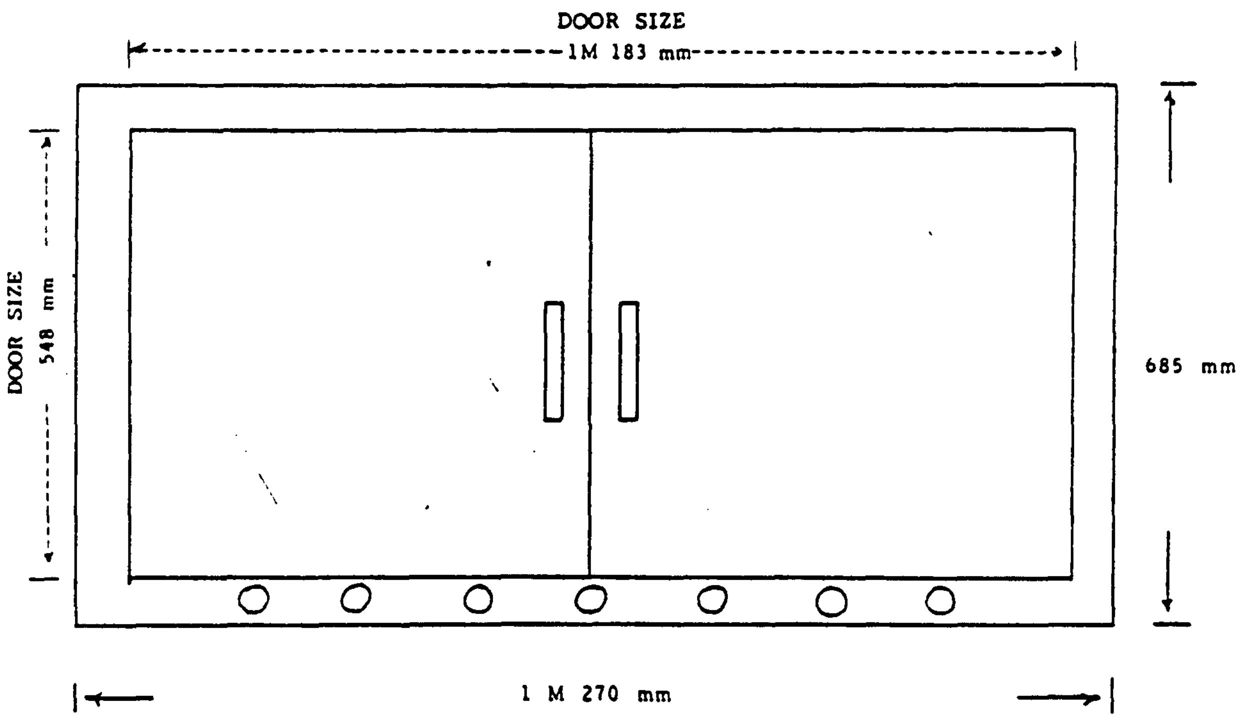
- BIFOLD
- SINGLE ROW OF VENTS
- MADE BY JUSTESEN (LANGLEY) PRODUCTS CORP.



TOTAL LEAKAGE AREA: 84.0 cm^2

#3 FIRE PLACE GLASS DOOR

- 2-DOOR CUSTOM MADE
- USED
- AVERAGE INEXPENSIVE MODEL GENERALLY FOUND OF THIS SORT
- ACTUAL MANUFACTURER NOT KNOWN
- ONE ROW VENTS
- LEAKAGE BETWEEN GLASS TO METAL SEAL AS WELL AS METAL TO METAL



TOTAL LEAKAGE AREA: 95.7 cm^2

RESIDENTIAL COMBUSTION VENTING FAILURE

A SYSTEMS APPROACH

PROJECT 5:

REMEDIAL MEASURES FOR WOOD-BURNING FIREPLACES:
AIRTIGHT DOORS WITH DIRECT AIR SUPPLY

APPENDIX 7

OVERALL PROJECT SUMMARY

Prepared for:
The Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

Prepared by:
Scanada Sheltair Consortium

January, 1987

The project reported on here was designed to expand on previous studies of the problem of incomplete venting of combustion products from heating appliances in order to approach a more nearly comprehensive understanding of the extent and nature of the problem in the Canadian housing stock. This project, which was carried out for Canada Mortgage and Housing Corporation by the Scanada Sheltair Consortium Inc., consisted of the seven sub-projects described below.

PROJECT 1 COUNTRY-WIDE SURVEY

Spillage detectors were installed on the draft hoods or barometric dampers of gas and oil furnaces and water heaters in 937 houses spread throughout the Vancouver, Winnipeg, Toronto, Ottawa and Charlottetown regions. The detectors were left in place for approximately 2 months in late winter.

Of the gas heated houses surveyed, 10% had experienced prolonged and unusual amounts of combustion gas spillage and 65% had experienced either short duration start-up spillage or prolonged spillage of small amounts of combustion gas. Of the oil heated houses, 55% had experienced significant spillage of high temperature combustion gas, but some of these spillage events may have been of only short duration.

Preliminary analysis indicates that spillage problems seem to be related to the following house or heating system characteristics:

- Winnipeg houses (believed to be more nearly airtight due to extensive use of stucco)
- pre-1945 houses
- post-1975 houses
- one storey houses
- exterior chimneys
- masonry chimneys with under-sized metal liners
- houses with three or more exhaust fans
- houses with two open masonry fireplaces
- poorly maintained heating appliances

PROJECT 2 MODIFICATIONS AND REFINEMENTS TO THE FLUE SIMULATOR MODEL

FLUE SIMULATOR, a detailed theoretical computer-based model of the combustion venting process had been developed for CMHC prior to this project. It is intended for use as an aid in understanding the mechanisms of combustion venting failure and the circumstances that give rise to them. The modifications undertaken in this project were intended to make the program easier to use and to allow it to model a wider variety of furnace/flue/house systems. The modifications included -

- refinements to algorithms
- more efficient operation of the program
- modelling additional features and system types
- user-friendly input and output

The modified model was validated against field test data and used to investigate a number of issues.

A separate developmental version of the program, called "WOODSIM", was successfully developed to model the combustion and combustion venting process in wood stoves and fireplaces.

PROJECT 3 REFINEMENT OF THE CHECKLISTS

A procedure for identifying and diagnosing combustion venting failures had previously been developed for CMHC - the Residential Combustion Safety Checklist. This project provided an opportunity to refine the checklist and develop variations of it suitable for a variety of possible users such as furnace service personnel, air sealing contractors, homeowners, etc. Early in the project, it was decided to separate the identification procedures from the diagnostic procedures. This allowed the process of identifying houses with potential for combustion venting problems to remain relative simple and allowed the diagnostic process to become more complex since it would only be used on houses where the extra effort would likely be worthwhile. Thus the original backdraft checklist has grown into five separate tests/procedures -

Venting Systems Pre-test
- a quick, visual inspection procedure which identifies a house as either unlikely to experience pressure-induced spillage or requiring further investigation

Venting Systems Test
- a detailed test procedure for determining to what extent the combustion venting system of a house is affected by the envelope airtightness and operation of exhaust equipment, perhaps the clearest descendent of the old backdraft checklist.

Chimney Performance Test
- a simple method of determining whether a chimney is capable of providing adequate draft

Heat Exchanger Leakage Test

- a quick method of determining if the heat exchanger of a furnace has a major leak

Chimney Safety Inspection

- a visual check for maintenance problems in the chimney system

These tests/procedures are all presented in a manual entitled "Chimney Safety Tests". Full trials of the procedures were carried out on the case study houses investigated in Project 6.

PROJECT 4 HAZARD ASSESSMENT

Although little was known at the outset of this project about the frequency of combustion spillage, even less was known about how much of a health hazard such spillage represents. Therefore this sub-project was included to investigate the real nature of the health and safety risk associated with venting failures. The work was divided into five tasks -

1. Review of current knowledge on pollutant generation due to improper venting of combustion appliances (literature review).
2. Development of a computer program to predict levels of various pollutants under various combustion venting failure scenarios.
3. Acquisition and calibration of a set of instruments required to measure the various pollutants at the levels predicted by the computer model.
4. Monitoring pollutant levels in problem houses identified in the Country-wide Survey (Project 1) using the instruments acquired in Task 3.
5. Analysis of the results of Task 4 to arrive at an overall assessment of the health hazard represented by combustion venting failures in Canadian houses.

The results indicate that, in most houses, one would rarely encounter acute, immediately life-threatening concentrations of pollutants as a result of combustion spillage from furnaces or water heaters. However, chronic health risk due to low level, long term exposure to pollutants , particularly NO_2, may be a more significant problem which requires further investigation. High levels of CO do not seem to be caused by the problems which cause spillage and thus occur in spillage events only as a result of coincidence.

PROJECT 5 REMEDIAL MEASURES

Remedial measures for pressure-induced combustion venting problems were identified and researched for a number of different types of combustion appliances.

The remedial measures identified for FIREPLACES were:

Spillage Advisor

- This is an adjustable volume alarm triggered by a combination of particulate and CO detectors and intended to be mounted on the front of the mantle or on the wall just above the fireplace.

Airtight Glass Doors Combined With An Exterior Combustion Air Supply Duct

- The research indicated that conventional glass doors are not nearly airtight and do little to separate the fireplace from the house's pressure regime. Prototype doors using special glass, heavier than normal steel frames and special sealing techniques were fabricated and installed and tested. It was found that these doors increased the level of house depressurization required to cause prolonged spillage from the fireplace from 3 Pa to 22 Pa. It is estimated that the installed cost would be $600. Further research on the effect of airtight doors on temperatures within the fireplace and flue and the possible hazard to surrounding combustible materials is required.

The remedial measures identified for GAS-FIRED APPLIANCES were:

Spillage Advisor

- This could be similar to the fireplace spillage advisor but would be triggered by a heat probe mounted in the dilution port of the appliance. The heat probes investigated could also be used to trigger other remedial measures discussed below.

Draft-inducing Fan

- A paddle-wheel-type fan mounted in the vent connector was found to increase the level of house depressurization required to cause irreversible spillage from a naturally aspirating gas furnace from 7 Pa to more than 20 Pa.

Draft-assisting Chamber

- A chamber surrounding the appliance's dilution port and extending downwards contains combustion products flowing out of the dilution port and prolongs the period before they are actually spilled into the room. It was expected that the chamber would also use the buoyancy of the contained combustion products to assist the flue in developing upward flow and thus would increase its resistance to house depressurization; however, the results obtained with the prototype tested did not live up to expectations. It is expected that modification of the design and testing with a furnace/flue/house combination more prone to pressure-induced spillage will improve this aspect of the chamber's performance.

The research on remedial measures for OIL-FIRED APPLIANCES indicated that stable backdrafting is unlikely to be a problem with oil-fired appliances since the pressure generated by the burner blowers is able to rapidly overcome backdrafting due to house depressurization and initiate upward flue flow. However, this pressurization of the flue system is what accounts for the start-up spillage associated with oil appliances and it is the duration of this spillage that remedial measures must address. The measures identified were:

Solenoid Valve
- By delaying the start of combustion until the burner has had a chance to overcome backdrafting and initiate upward flue flow, the solenoid valve reduces the duration of spillage but does not eliminate it altogether.

Draft-inducing Fan
- A fan, similar to that described above under gas appliances, mounted in the flue pipe downstream of the barometric damper is not needed to overcome backdrafting since the burner blower can do this. However, it does relieve pressurization of that portion of the flue pipe upstream of itself and hence reduces spillage from that portion. There can still be spillage from the downstream portion; but, since that portion does not include the barometric damper, it is easier to seal.

Elimination of the Barometric Damper
- Provision of a well-sealed flue pipe without a barometric damper is one obvious way to reduce spillage. However, elimination of the barometric damper exposes the burner to the full chimney draft and disturbs the combustion process of conventional burners. Therefore this procedure must include replacement of the conventional burner with a high pressure burner which is less influenced by flue pressure. Provision of an insulated flue liner is often included as part of this measure.

The work on MAKE-UP AIR SUPPLY remedial measures was less directed towards specific measures but served to clarify a number of general air supply issues. It indicated that the provision of additional supply air is not likely to be effective as a remedy for pressure-induced spillage of combustion products if the supply air is introduced unaided through an envelope opening of any size likely to considered practical. It is only likely to be effective if a supply air fan is used and if that fan has a capacity at least equal to the total capacity of all exhaust equipment it is attempting to counteract. The discharge from such a supply air fan can be introduced essentially anywhere in the house, but is likely to create fewer thermal comfort problems if introduced in a normally unoccupied area such as the furnace room.

The knowledge generated in the remedial measures research and already available to Consortium members was synthesized into the draft Remedial Measures Guide, a manual intended to be a decision-making guide for tradesmen and contractors who have identified pressure-induced spillage problems in houses with vented fuel-fired appliances and want to know how best to remedy these problems. It is designed to accompany the Venting Systems Test. Although the draft Guide is not yet comprehensive and in some cases describes procedures which have not been thoroughly field tested and/or approved by regulatory authorities, it is hoped it will stimulate thought and discussion and improve current trade practices.

PROJECT 6 PROBLEM HOUSE FOLLOW-UP

Twenty of the houses identified in the country-wide survey as experiencing the worst combustion spillage problems were visited with the following objectives:

- to categorize and quantify the nature of venting failures
- to isolate contributing factors
- to collect field data on venting failures for use in the flue simulator model validation
- to measure the frequency and quantity of spillage in problem houses
- to measure the approximate impact on air quality of venting failures in houses
- to evaluate the effectiveness of the chimney safety tests in diagnosis of failures and identification of remedial measures
- to evaluate communications techniques
- to evaluate remedial measures under field conditions

In most of the houses, there were several factors that were assessed as contributing causes of the combustion spillage problem - thus confirming the "systems" nature of the problem. It is also worth noting that, in many houses, although the spillage observed was indeed pressure-induced, it occurred at quite low levels of house depressurization because the chimneys were only able to generate very weak draft due to some problem such as a blocked or leaky flue. The main problem in these cases, therefore, was not depressurization but weak chimneys.

PROJECT 7 COMMUNICATIONS STRATEGY

As the survey revealed that the problem, while substantial, is not epidemic in proportion, there is no need to create widespread alarm in the general public. A communication strategy has been drafted with this in mind. It places emphasis on motivating the heating and housing industries to be aware of the combustion venting problem and its causes and to make effective use of the diagnostic tools and preventive and remedial measures developed in this project.

OVERALL PROJECT SUMMARY AND CONCLUSIONS

The project has gone a long way towards meeting its original objectives and has significantly advanced the state-of-the-art in this field.

It has led to improved understanding of the combustion venting process and confirmed the "systems" nature of the failures that lead to combustion venting problems.

It appears that a significant portion of the Canadian housing stock has potential for combustion venting failure to occur on a regular basis. In most cases, this is unlikely to lead to immediate life-threatening pollution levels, but long term chronic health hazards could be a problem; however this latter concern requires further investigation before any definite conclusion can be reached.

A number of techniques are available for identifying houses prone to combustion venting failure and for diagnosing the causes of such failure. There are also available a number of measures for preventing combustion venting failure in new houses and for remedying it in existing houses. A communication strategy has been drafted for conveying these techniques and measures to relevant people in the housing and heating industries and for encouraging them to make use these tools.