RESEARCH REPORT

Chimney Safety Tests User's Manual Second Edition

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CHIMNEY SAFETY TESTS
USERS' MANUAL
(Second Edition)

PROCEDURES FOR DETERMINING
THE SAFETY OF RESIDENTIAL CHIMNEYS

Prepared for:
Research Division
Canada Mortgage and Housing Corporation

Prepared by:

Scanada-Sheltair Consortium Inc.

January 12, 1988

NOTICE

Canada Mortgage and Housing Corporation (CMHC) commissioned the Scanada Sheltair Consortium Inc. to develop a series of procedures for testing the performance of residential combustion venting systems. Theses procedures are intended to be used by qualified and experienced housing and heating industry technicians to assist and improve their ability to detect and diagnose combustion venting problems. **The responsibility for the detection and diagnosis of combustion venting problems remains with the qualified technician.** While CMHC and the Consortium have conducted a significant amount of research in the development of these procedures and strived to make them accurate and relevant, the procedures have not been extensively tested in the industry. Neither CMHC nor Scanada Sheltair Consortium Inc. can accept any responsibility for any consequences resulting from the use of these procedures.

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1. INTRODUCTION

This manual describes a series of procedures for testing the performance of residential chimney systems.

The tests are used to identify houses in which spillage of combustion gases into the living area may occur due to a failure of the chimney venting system. The tests are structured so that the cause of the failure can be diagnosed and appropriate remedies pinpointed. The tests are applicable to residential chimneys serving naturally-aspirated oil and gas furnaces and hot water heaters. Methods to test chimneys serving fireplaces are also included.

The current requirement for chimney performance tests is a result of a variety of recent developments affecting the Canadian housing stock. One of these developments is the widespread practice of upgrading residential combustion appliances by means of fuel changes, downsizing, and efficiency improvements. Inadequate provision for the substantially altered operating conditions created by such modifications can lead to serious chimney deterioration and eventual venting failure.

At the same time, there is a growing trend in Canadian housing toward tighter envelopes and greater use of exhaust fans. This trend tends to reduce the available supply of combustion air and increase house depressurization, which make it harder for chimneys to do their job. In such an environment, there is greater risk that natural chimney draft will be overpowered by the depressurizing action of exhaust devices, resulting in flow reversal or "backdrafting" and the spillage of combustion gases.

As a result of these developments, safe chimney operation can no longer be taken for granted. As houses have become more finely tuned in terms of airtightness and energy-efficiency, they are much more sensitive to changes in structure and operation. Consequently, any modifications which affect combustion air supply, furnace performance, or chimney operating conditions must be carefully considered to ensure that such modifications do not adversely affect chimney safety.

The tests described in this manual have been specifically designed for this purpose. They provide insulation and sealing contractors, fan installers, and heating tradesmen with a simple way to ensure that the changes in the chimney operating environment resulting from their work will not result in unsafe conditions.

In addition, the tests provide a convenient method for diagnosing and correcting problems in houses where a chimney venting failure is suspected or where a failure has already been identified.

The tests are applicable to all standard houses with conventional heating and ventilation systems . This includes houses heated with gas, oil, or wood, and houses equipped with any variety of exhaust equipment or two-way fan systems.

The test procedures were developed by Sheltair Scientific Ltd under a series of contracts with the Research Division, Canada Mortgage and Housing Corporation. They have been extensively field tested and evaluated in a variety of centres across Canada.

2. SUMMARY OF THE SAFETY TESTS

2.1 INTRODUCTION

This manual presents five test procedures. These procedures break into the following two groups:

(1) House and venting system tests - These tests can be competently administered by any member of the building service trades and do not require special expertise in heating systems. The tests are designed to detect the susceptibility of the chimney system to combustion gas spillage events caused by the combined operation of fans, fireplaces and any other device which exhausts air from the house.

(2) Furnace/flue tests - These tests are designed to be conducted exclusively by members of the heating trades. They are intended to permit detection of combustion gas spillage problems which could be caused by:
   (a) a leaky heat exchanger
   (b) weak chimney draft due to leaks or constrictions within the flue or
   (c) various maintenance problems which can be determined by careful inspection of the chimney, flue, flue connector, furnace system and furnace room.

Each of the five tests is described in detail in this manual, which provides step-by-step instructions on how to perform each test. The manual also provides special checklists and report forms to facilitate the delivery of each test.

The following discussion provides a brief overview of each of the tests described in this manual.

2.2 HOUSE AND VENTING SYSTEM TESTS

2.2.1 THE VENTING SYSTEM PRE-TEST

Many houses may not require the more detailed tests described in this manual because they are so leaky or have so few exhaust devices that there is no possibility that exhaust device operation will adversely affect chimney performance. The Venting Systems Pre-test provides a simple technique by which such "venting-safe" houses can be accurately identified on the basis of a brief inspection. The Venting System Pre-test involves a visual inspection of the house, some simple measurements and the use of reference tables. It takes about 10-15 minutes. Houses which pass the pre-test can be excused from the more rigorous and time-consuming Venting Systems Test.

2.2.2 THE VENTING SYSTEM TEST

The Venting System Test is a detailed test procedure designed to ensure that the operation of household exhaust devices does not adversely affect chimney operation. The procedure can be used to test:

(a) the impact of fans and fireplace operation on the chimney serving the furnace and hot water appliances and

(b) the impact of fans and furnace operation on the chimney serving a fireplace.

In both cases, a manometer is used to determine if the maximum depressurization which can be produced by the combined operation of all exhaust devices, exclusive of the test chimney itself, exceeds the maximum safe level prescribed for that type of chimney.

In addition, both the furnace and fireplace are operated at the maximum level of depressurization to determine if excessive combustion gas spillage can be observed. The test requires 40-80 minutes to complete and requires no special expertise in heating systems. Tools required for the test cost approximately $170.

2.3 FURNACE/FLUE TESTS

2.3.1 The Heat Exchanger Leakage Test

The heat exchanger leakage test provides a quick and accurate method for determining if the heat exchanger in an oil or gas forced-air furnace has a major leak which is capable of permitting excessive combustion gas spillage from the combustion chamber into the living area.

Combustion gas spillage from heat exchangers in forced air furnaces can occur in two ways. The first form occurs before the furnace blower starts to operate. Combustion gases may leak from the combustion chamber into the forced air plenum since the chamber is pressurized with respect to the plenum. When the blower fan turns on, the leaked gases are blown throughout the houses. Occupants may notice this leakage as a sudden blast of smelly or dirty air when the blower operates.

The second form of heat exchanger leakage occurs when the blower fan starts to operate. If leaks are present in the heat exchanger, the fan may force circulating air through the leaks into the heat exchanger. This stream of forced air may cause the combustion flame to be distorted and cooled, leading to sooting and carbon monoxide production.

If the leak is very large, larger amounts of air can enter the combustion chamber, which pressurizes the chamber. This leads to further problems such as rumbling and back-puffing in an oil furnace or continuous spillage through the dilution air inlet of a gas furnace.

The heat exchanger leakage test can detect furnaces which may be experiencing these kinds of problems. Furthermore, since spillage caused by the heat exchanger is very similar to spillage caused by venting-induced depressurization, poor draft, or a flue blockage, the test is a useful diagnostic method for pinpointing whether or not the heat exchanger is at fault in a house in which spillage events have been reported.

The heat exchanger leakage test can be completed in about 15 minutes. An air current tester is required.

2.3.2 The Chimney Safety Inspection

The Chimney Safety Inspection is a visual check for maintenance problems in the chimney system. A thorough inspection is often the quickest way to identify the source of chimney venting problems or the potential for chimney problems. In addition, the inspection can be helpful in deciding what other chimney venting tests may be required, if evidence of spillage has been detected during the inspection.

A Chimney Safety Inspection Checklist is used to guide the inspection and to pinpoint possible repairs or improvements which may be required to improve the performance and safety of the chimney system. The checklist sets out possible maintenance actions which should be considered for each part of the heating system, including the chimney, liner, flue connector, furnace, and furnace room. The hot water chimney system and the fireplace are also inspected if applicable.

No special certificates or licenses are required to carry out the Chimney Safety Inspection; however, it should be carried out by individuals with a working knowledge of heating systems and an awareness of the applicable codes or regulations.

The Chimney Safety Inspection can be completed in about 20 minutes. No special equipment is required.

2.3.3 The Chimney Performance Test

This test provides a simple way to determine if an oil- or gas-fired chimney is capable of providing adequate draft. The test involves using a thermometer to measure flue gas temperature, and a manometer to measure the draft pressure in the flue after the furnace has had time to warm-up. If the measured flue pressure is too low, a problem with leaks or constrictions in the chimney flue is indicated. Temperature of the gases may indicate fire safety or condensation problems.

Chimneys with low draft should be diagnosed and repaired immediately since they are particularly susceptible to serious combustion gas spillage events caused by the operation of competing exhaust devices. An effort should be made to determine if the flue is blocked or broken or performing poorly due to poor design.

The Chimney Performance Test requires about 10 minutes to complete. A manometer and a thermometer are required.

SECTION 1

VENTING SYSTEM PRE-TEST

1. INTRODUCTION

General

The Venting System Pre-Test is a procedure which can be used to quickly distinguish between houses in which the combined operation of household exhaust systems MAY cause combustion gas spillage from naturally-aspirated heating appliances and those in which this is unlikely to occur. The household exhaust systems considered by this procedure include fans, fireplaces, ventilators, and all other devices which move air out of the house.

The purpose of the procedure is to permit tradesmen and technicians to accurately identify houses which do not require the detailed and more time-consuming Venting System Test described in Section 2 of this manual.

If the house passes the Venting System Pre-test, the tradesman or technician may safely omit the Venting System Test since there is little possibility that venting systems operation will adversely affect chimney operation. If the house fails the Pre-test it may still be safe since the Pre-test is very conservative. However this can only be confirmed by application of the full Venting System Test.

Overview of the procedure

The assessment involves a brief inspection of the house in order to determine the flow capacity of each exhaust system, what provisions, if any, have been made to bring air into the house to replace that removed by exhaust systems, and the basic characteristics of the chimney system. Using this information and a set of reference tables, it becomes possible to determine if the depressurization induced by the combined operation of the exhaust systems could potentially reach unsafe levels. No tools or testing are required. Therefore, no special qualifications are necessary.

Intended Users

The procedure is intended for use by residential tradesmen who are making modifications which could affect the operation of household ventilation systems and hence the potential for these systems to cause combustion gas spillage. More specifically, the procedure should be used by the following groups:

(a) Retrofit contractors whose work will affect the level of airtightness in the house. This includes all work involving weatherstripping, caulking, adding insulation or storm windows.

(b) Heating and ventilating contractors whose work involves ventilation alterations. This includes modifications to the chimney flue system, furnace ductwork, air supply inlets, and household ventilation systems.

(c) Contractors who are installing new exhaust fans in the kitchen, bathroom, or other areas of the house.

2. GENERAL PRINCIPLES AND PROCEDURES

When certain household systems, such as exhaust fans, exterior dryer vents and fireplaces, operate, they suck air out of the house. This lowers indoor pressure relative to the outside. The amount of this negative pressure or "depressurization" varies directly with the number and capacity of the exhaust devices in the house and the tightness of the building envelope. It is possible that unsafe levels of depressurization may be produced if the house is sufficiently tight or if enough exhaust devices are installed and operated simultaneously.

Unsafe depressurization occurs when the suction created by the exhaust devices is sufficient to overcome the natural chimney draft in a chimney serving a combustion appliance such as a furnace, hot water heater or fireplace.

The purpose of the Venting System Pre-test is to provide a quick way to estimate if unsafe depressurization levels could occur in a given house. The assessment is based on estimating the minimum draft pressure which the chimney will deliver and comparing it to an estimate of the maximum amount of house depressurization which the exhaust devices could jointly achieve. If the maximum house depressurization is less than the minimum chimney draft pressure, the venting systems can be assumed to be safe from pressure-induced venting problems.

Since the minimum chimney draft pressure establishes an upper bound for safe depressurization, it is referred to in this manual as the "House Depressurization Limit" or H.D.L.

The assessment procedure provides simple methods for estimating the maximum depressurization which the household venting devices can achieve. It also includes a table of House Depressurization Limits for different classes of chimneys based on their height, location, liner type and the type of combustion appliance they serve.

To estimate maximum depressurization, the tradesman or technician uses additional reference tables to estimate (1) the total exhaust flow which can be delivered by all venting devices in the house and (2) the overall leakage area of the house. With these two values, a further reference table can be used to obtain the required estimate of maximum depressurization.

As mentioned above, if the maximum house depressurization estimate is less than the H.D.L., the chimney can be considered safe from pressure-induced spillage problems and a Venting System Test will not be necessary.

3. THE VENTING SYSTEM PRE-TEST, STEP-BY-STEP

The Venting System Pre-test is conducted in 5 steps. The tradesman or technician works through the calculation and report form shown at the end of this section, completing each step in the procedure as outlined below.

Step 1 - Estimate the TOTAL EXHAUST flow for all venting systems

1. The first step is to estimate the TOTAL EXHAUST flow for all vents and flues, except the furnace and water heater. You do this by estimating the flow for each venting device and then adding these flows together. The flow for each device can be determined in one of several ways:

   (a) Use the "effective" flow values provided in Table 1.1. The table lists the flow which can be expected from a variety of exhaust appliances. For example, a bathroom fan exhausting through a 75 mm duct (or with a 75 mm blade size) would have an effective flow of 20 litres/sec.

   (b) If you can obtain the manufacturer's flow specifications for a venting device, use it. However, if the manufacturer's specification is for "free flow", you will should divide the flow in half to account for typical restrictions, like ducts, screens, and louvres.

   (c) If you or others have actually measured the fan flow, then use the measured flow data.

   Record the estimated flow for each device on the report form. Then sum the flows and enter the total. If the reference you used to estimate an exhaust flow was other than Table 1.1 below, note your reference source on the form (e.g. manufacturer's specs.).

Step 2 - Estimate the equivalent leakage area of the house

The next step is to estimate the equivalent leakage area for the building. The equivalent leakage area (ELA) is the size of hole you would get if all the leaks and cracks in a house could be gathered in one place.

All houses have some amount of unintentional leakage area because, without a lot of extra work, it is hard to construct houses that are perfectly airtight. For simplicity, you should assume that all houses have a minimum of 350 cm^2 of unintentional leakage area. An ELA of 350 cm^2 is roughly equivalent to that found in a large low energy house. Of course, most houses will have a much greater UNINTENTIONAL ELA; but, since there is no easy way of recognizing leakier houses, we must assume the house construction in quite tight. This is a very conservative assumption but is adequate for a screening process such as this. However this should be kept in mind in interpreting the results of this Pre-test.

In addition to the UNINTENTIONAL ELA, you can assume that any installed make-up air ducts will increase the ELA of the house. Table 1.2 provides a list of ELA values for various sizes of make-up ducts. These values are referred to as the INSTALLED ELA for the house.

Table 1.1

ESTIMATED AIR FLOW FOR TYPICAL EXHAUST DEVICES

	Duct or Flue Size (mm)	Default Flow for Use in Calculations (L/S)	Typical Flows Specified by Manufacturer (L/S)	* Percentage Reduction Due to Restrictions
Bathroom and Range Hood Fans	75	25	40	40%
	80 X 250	25	40	40%
	100	30	50	40%
	175	60	100	40%
	200	105	150	30%
Exterior Mounted Kitchen Fan	250	140	200	30%
	250	210	300	30%
Clothes Dryer	100	50	40 - 60	15%
Barbecue Fan	250	115	165	30%
Central Vacuum Cleaner with Exterior Exhaust	---	55	---	---
CHIMNEY SERVING HEATING APPLIANCES				
Wood Burning Fireplaces	---	80	---	---
Open Wood Stove	---	30	---	---
Airtight Wood Stove	---	---	---	---
Operating Gas, Oil, or Propane Appliances	75	10	---	---
	100	18	---	---
	125	22	---	---
	150	34	---	---

* Typical restrictions are screens and louvres and an equivalent duct length of 10 meters.

By adding the INSTALLED ELA to the UNINTENTIONAL ELA (350 cm^2), you can determine the TOTAL ELA for the house. For example, a house with an INSTALLED ELA of 170 cm^2 would have a TOTAL ELA of 170 + 350 = 520 cm^2.

Table 1.2

INSTALLED ELA VALUES

Size of Make-Up Air Duct		INSTALLED ELA Value (cm^2)
Round Duct Diameter	75 mm (3 inch)	40
	100 mm (4 inch)	70
	125 mm (5 inch)	120
	150 mm (6 inch)	170
	175 mm (7 inch)	240
	200 mm (8 inch)	310
Rectangular Duct Dimensions	87 X 250 mm (3.5 X 10 inch)	210
	87 X 300 mm (3.5 X 12 inch)	260
	150 X 250 mm (6 X 10 inch)	375

Step 3 - Estimate Maximum Depressurization Level

The Maximum House Depressurization Estimate can now be obtained from Table 1.3 using the TOTAL EXHAUST FLOW estimated in Step 1 and the TOTAL ELA estimated in Step 2.

For example, if the TOTAL EXHAUST is 100 litres/sec and the TOTAL

ELA is 520 sq.cm., Table 1.3 indicates that the Maximum House Depressurization Estimate would be 7.5 pascals.

Record the Maximum House Depressurization Estimate obtained from Table 1.3 on the report form.

Step 4 - Determine House Depressurization Limit

Table 1.4 provides the House Depressurization Limits (HDLs) for various chimney configurations.

To use Table 1.4, it is necessary to note the following chimney characteristics:

(a) the height of the chimney to the closest meter (from the top of the combustion chamber to the top of the chimney)

(b) the location of the chimney (mostly in the house interior or mostly on an exterior wall)

(c) the type of chimney lining (unlined or lined)

(d) the type of appliance the chimney serves (furnace, boiler, water heater, fireplace, woodstove)

Note these chimney characteristics during your house inspection. Then obtain the House Depressurization Limit for the chimney from Table 1.4. For example, Table 1.4 shows that if the house has a gas furnace served by a 5 meter chimney which is unlined and in an exterior wall, the House Depressurization Limit (HDL) would be 5 pascals.

Record the House Depressurization Limit on the report form.

Table 1.3

MAXIMUM HOUSE DEPRESSURIZATION ESTIMATE IN PASCALS

TOTAL EXHAUST ESTIMATE (L/s)	TOTAL ELA ESTIMATE (cm^2) 250 to 299	300 to 349	350 to 399	400 to 449	450 to 499	500 to 599	600 to 699	700 to 799	800 to 899	900 to 999	1000 to 1199	1200 to 1399	1400 to 1599	1600 to 1799	1800 to 1999
20	1.8	1.4	1.1	0.9	0.7	0.6	0.5								
30	3.4	2.6	2.0	1.7	1.4	1.2	0.9	0.7	0.6	0.5					
40	5.3	4.0	3.2	2.6	2.2	1.8	1.4	1.1	0.9	0.7	0.6	0.5			
50	7.5	5.7	4.5	3.6	3.0	2.6	2.0	1.5	1.3	1.0	0.9	0.7	0.5		
60	10.0	7.5	5.9	4.8	4.0	3.4	2.6	2.0	1.7	1.4	1.2	0.9	0.7	0.6	0.5
70	12.6	9.5	7.5	6.1	5.1	4.3	3.3	2.6	2.1	1.8	1.5	1.1	0.9	0.7	0.6
80	15.5	11.7	9.2	7.5	6.3	5.3	4.0	3.2	2.6	2.2	1.8	1.4	1.1	0.9	0.7
90	18.6	14.0	11.1	9.0	7.5	6.4	4.8	3.8	3.1	2.6	2.2	1.7	1.3	1.1	0.9
100	21.8	16.5	13.0	10.6	8.8	7.5	5.7	4.5	3.6	3.0	2.6	2.0	1.5	1.3	1.0
110	25.3	19.1	15.1	12.3	10.2	8.7	6.6	5.2	4.2	3.5	3.0	2.3	1.8	1.5	1.2
120	28.9	21.8	17.2	14.0	11.7	10.0	7.5	5.9	4.8	4.0	3.4	2.6	2.0	1.7	1.4
130		24.7	19.5	15.9	13.2	11.3	8.5	6.7	5.5	4.6	3.9	2.9	2.3	1.9	1.6
140		27.7	21.8	17.8	14.8	12.6	9.5	7.5	6.1	5.1	4.3	3.3	2.6	2.1	1.8
150			24.3	19.8	16.5	14.0	10.6	8.4	6.8	5.7	4.8	3.6	2.9	2.3	2.0
160			26.8	21.8	18.2	15.5	11.7	9.2	7.5	6.3	5.3	4.0	3.2	2.6	2.2
170			29.5	24.0	20.0	17.0	12.9	10.1	8.3	6.9	5.9	4.4	3.5	2.8	2.4
180				26.2	21.8	18.6	14.0	11.1	9.0	7.5	6.4	4.8	3.8	3.1	2.6
190				28.5	23.7	20.2	15.3	12.0	9.8	8.2	7.0	5.3	4.1	3.4	2.8
200					25.7	21.8	16.5	13.0	10.6	8.8	7.5	5.7	4.5	3.6	3.0

Table 1.4

HOUSE DEPRESSURIZATION LIMITS (HDLs)

		H. D. Limit in Pascals	
Appliance	Chimney Height to closest metre	Unlined Chimneys on Exterior Walls	Metal-Lined Insulated or Interior Chimneys
Gas-Fired Furnace, Boiler, or Water Heater	4 or less	5	5
	5, 6	5	6
	7 or more	5	7
Oil-Fired Furnace or Water Heater	4 or less	4	4
	5, 6	4	5
	7 or more	4	6
Fireplace (wood or gas)	N/A	3	4
Airtight Wood-Stove or Fireplace	N/A	10	10
Appliances with Retrofitted Induced Draft Fans	N/A	15	15

Step 5 - Pass or Failure Assessment

If the Maximum House Depressurization Estimate from Step 3 is less than the H.D.L obtained from Table 1.4, then the house passes the test. No further testing is required. As long as the chimney is in reasonably good condition, the potential for pressure-induced spillage is low.

If the Maximum House Depressurization Estimate from Step 3 is equal to or greater than the H.D.L. obtained from Table 1.4, then chimney spillage MAY be a problem and the house will need to be tested by means of a full Venting System Test. (Refer to Section 2 of this manual for the Venting System Test procedure.)

The Venting System Pre-test is summarized in Figure 1.1.

VENTING SYSTEM PRE-TEST

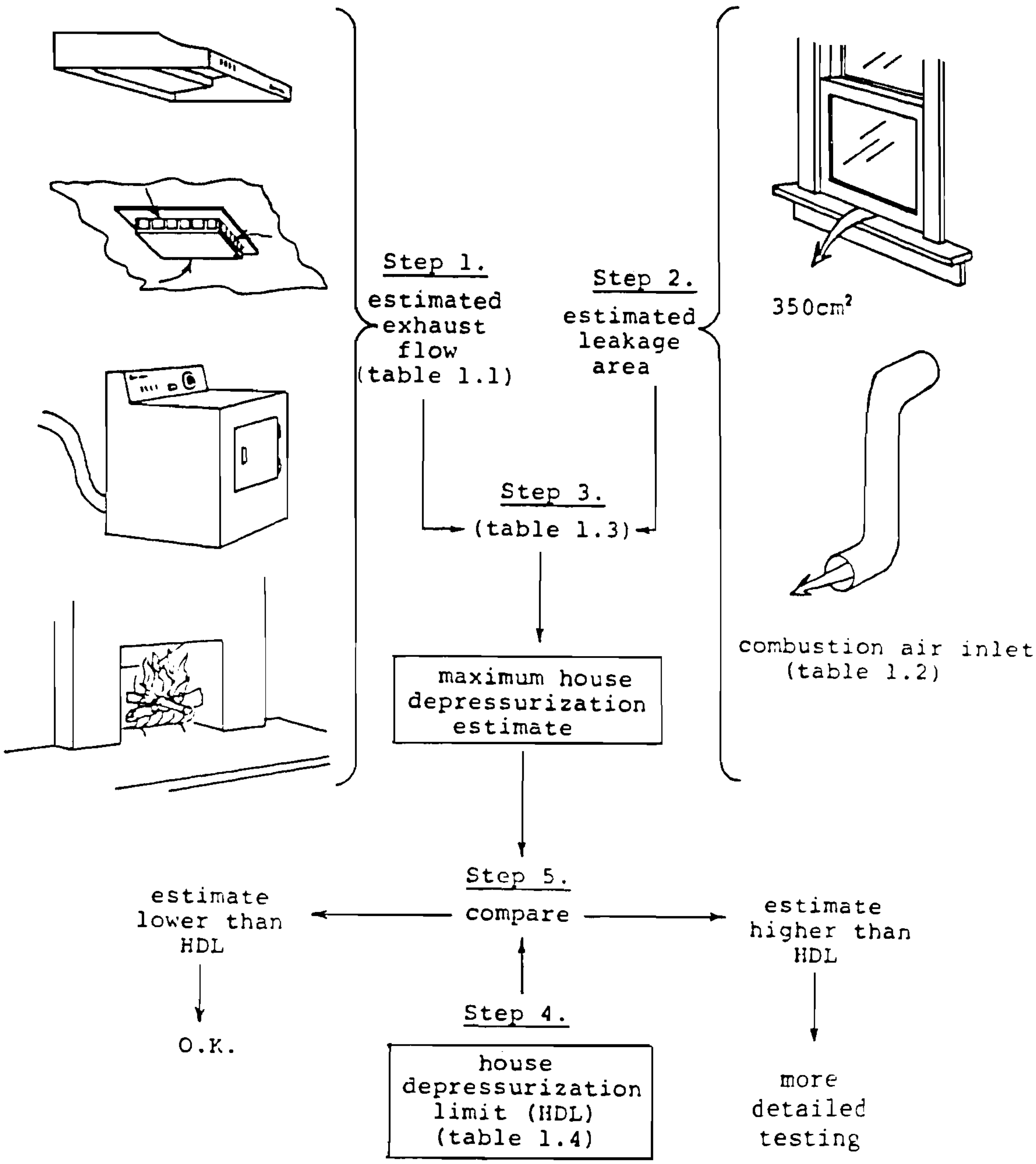


Figure 1.1

VENTING SYSTEM PRE-TEST REPORT FORM

COMPANY NAME:________________________ DATE:__________
COMPANY ADDRESS:________________________
NAME OF ASSESSOR:________________________
ADDRESS OF DWELLING:________________________

STEP:

1. Estimate of Total Exhaust Flow (Table 1.1):

DEVICE	FLOW (L/s)	REFERENCE (if not Table 1)
Bath fan #1	______	____________
Bath fan #2	______	____________
Bath fan #3	______	____________
Range hood	______	____________
Kitchen fan	______	____________
Barbeque fan	______	____________
Clothes dryer	______	____________
Whole house ventilator	______	____________
Vacuum fan	______	____________
Workshop fan	______	____________
Fireplace #1	______	____________
Fireplace #2	______	____________
Other ________	______	____________
TOTAL	______L/s	

2. Calculation of Equivalent Leakage Area (Table 1.2):

Unintentional ELA		Installed ELA		Total ELA
350	+	________cm^2	=	________cm^2

3. Maximum House Depressurization Estimate (Table 1.3): ________Pa

4. Determine the HDLs for each appliance/chimney system (Table 1.4):

	Appliance	HDL (Pa)
1.	Furnace	______
2.	Water heater	______
3.	Wood fireplace	______
4.	Other: ____________	______
5.	Other: ____________	______

5. Check-off the correct conclusion, and take appropriate steps.

____ HOUSE DEPRESSURIZATION (STEP 3) DOES NOT EXCEED THE HOUSE DEPRESSURIZATION LIMIT (STEP 4) - CHIMNEY SPILLAGE IS UNLIKELY

NO FURTHER TESTS OR REMEDIAL MEASURES ARE REQUIRED

____ HOUSE DEPRESSURIZATION (STEP 3) EXCEEDS THE HOUSE DEPRESSURIZATION LIMIT (STEP 4) - THE HOUSE REQUIRES A VENTING SYSTEM TEST OR SUITABLE REMEDIAL MEASURES

SECTION 2

VENTING SYSTEM TEST

1. INTRODUCTION

General

The Venting System Test is designed to determine whether the combined action of a house's exhaust equipment could cause failure of the venting systems serving naturally-aspirated combustion appliances. The household exhaust systems considered by this test include kitchen and bathroom fans, dryer exhausts, fireplaces, vented combustion appliances, and all other devices which can exhaust air from the house.

When chimney venting failures occur, excessive amounts of combustion gases are spilled from the chimney into the living area of the house. This creates a potential health and safety hazard. The purpose of the Venting System Test is to help identify houses in which this hazard may exist so that appropriate action can be taken to avoid or eliminate it.

Overview of the Procedure

The procedure can be used to test (a) the impact of fans and fireplace operation on the chimney serving the furnace and water heater and (b) the impact of fans and furnace operation on the chimney serving a fireplace. In both cases, a manometer is used to determine if the maximum depressurization which can be produced by the combined operation of all household exhaust systems, exclusive of the test chimney itself, exceeds the maximum level that is safe for that type of chimney.

In addition, both the furnace and fireplace are operated at the maximum level of depressurization to determine if excessive combustion gas spillage can be observed.

The test requires 40 to 80 minutes to complete and requires no special expertise in heating systems.

The test is suitable for all standard houses with naturally-aspirated heating equipment. This includes houses heated with gas, oil, or wood, and houses equipped with any variety of exhaust equipment or two-way fan systems.

No special certificate or licence for working with heating and ventilation equipment is necessary to do the test. However, the test does require careful attention to detail and must be conducted exactly according to the step-by-step procedure described in this manual. Consequently, some training and self-study will be required in order to adequately carry out the test procedure.

Intended Users and Applications

The procedure is intended for use by residential tradesmen who are making modifications which could affect the operation of household ventilation systems and hence the potential of these systems to adversely affect chimney performance. More specifically, the procedure should be used by the following trades in order to ensure that their work does not produce a potential combustion gas spillage hazard:

(a) Retrofit contractors whose work will affect the level of airtightness in the house. This includes all work involving weatherstripping, caulking, adding insulation or storm windows.

(b) Heating and ventilating contractors whose work involves venting or ventilation alterations. This includes modifications to the chimney flue system, furnace ductwork, air supply inlets, and household ventilation systems.

(c) Contractors who are installing new exhaust fans in the kitchen, bathroom, or other areas of the house.

In addition, the Venting System Test can also be used in houses where a chimney venting failure involving combustion gas spillage is known to occur, or is suspected to occur, but where the cause of the spillage is unknown. The Venting System Test is an effective way to identify the cause of spillage in such cases. Once the cause or causes have been identified, appropriate steps can be taken to eliminate the problem.

Venting System Pre-Test

In order to determine if the Venting System Test is warranted for a given house, the shorter Venting System Pre-test may be carried out before attempting the Venting System Test. If the house passes the Venting Pre-test it is unlikely that the house will experience pressure-induced chimney failure. Therefore, it is not necessary to do a full Venting System Test. The Venting System Pre-test is described in Section 1 of this Manual.

2. GENERAL PRINCIPLES AND PROCEDURES

To use the Venting System Test, it is necessary to have a general understanding of how household exhaust systems can cause spillage of combustion gases.

When household exhaust equipment, such as exhaust fans, clothes dryers, and fireplaces, operate, they blow air out of the house. This lowers indoor pressure relative to the outside. This lowering of indoor pressure is referred to as "house depressurization". The amount of house depressurization that occurs depends on the number and capacity of the exhaust devices in the house and the tightness of the building envelope. The greater the exhaust, and the tighter the building, the more a house will be depressurized.

As house depressurization increases, the chimney must increasingly compete against the suction exerted by the exhaust devices and hence becomes less and less capable of venting all of the combustion gases it was installed to vent. In some cases, house depressurization is great enough to cause the flow of combustion gases in the chimney to reverse. This results in a "backdraft" situation in which the combustion gases are all spilled into the house rather than being safely vented up the chimney. However, this is unlikely to occur when the heating appliance is actually operating since the chimney is warm and its draft is high. Reversal of chimneys during heating appliance operation is rare. Chimneys are least effective in combatting house depressurization when they are cool, since cool chimneys have weak draft. For this reason, it is most common for chimneys to backdraft when the heating appliance is not operating. When the appliance eventually begins to operate, it must fight against the backdrafting current of cold air. Often an appliance will spill for prolonged periods of time into the house before it manages to re-establish an upward draft in the chimney. Spillage produced in this manner can be referred to as "pressure-induced" spillage since it is the depressurization created by the operation of household exhaust devices which causes the spillage to occur.

The purpose of the Venting System Test is to determine whether such pressure-induced spillage could occur in a particular chimney in a given home. The determination involves three parts as outlined below. (In the following description of each part, the particular chimney under examination will be referred to as the "test" chimney.)

Part 1 - Worst-Case Depressurization Simulation and Measurement

To perform Part 1, an estimate of the minimum draft pressure which the test chimney will deliver is made using reference tables. The reference tables provide minimum draft values for various types of chimney. The minimum chimney draft pressure establishes an "upper bound" for safe house depressurization. For this reason, the minimum draft pressure is referred to in this manual as the House Depressurization Limit or HDL for short.

The HDL approximates the draft pressure likely to be achieved in chimneys of the same type as the test chimney on calm spring days when outdoor temperatures are relatively mild and natural draft is weakest. In other words, the HDL can be regarded as the worst-case draft pressure for a given chimney configuration.

If the house's exhaust devices can produce house depressurization levels GREATER than the HDL, there is an unacceptable risk that chimney draft will be reversed and prolonged combustion gas spillage will take place. Consequently, the house cannot be considered "venting-safe" unless it is certain that house depressurization will NEVER exceed the HDL.

To determine if the house meets this venting safety requirement, the tradesman or technician must create "worst-case" venting conditions in the house. Worst-case venting conditions are those in which the house is as tight as possible (all doors and windows closed) and in which all exhaust devices, except of the test chimney itself, are operated simultaneously.

The level of house depressurization created under these worst-case conditions is measured using a manometer. If the worst-case depressurization is LESS than HDL, the chimney passes the test.

If the worst-case house depressurization EQUALS OR EXCEEDS the HDL, the house fails the test. Remedial actions will have to be implemented until the house can pass the test. This may involve:

(1) reducing depressurization potential in the house by reductions in exhaust capacity or increases in make-up air provisions or
(2) increasing the HDL by adjusting the chimney system in ways which increase draft pressure.

Note: If the house has a separate chimney serving a fireplace, a second depressurization test will be required. In this test, a second worst-case depressurization measurement is to determine if operating all exhaust devices (except the fireplace) under worst-case conditions while the furnace and hot water heater are also operating produces a depressurization in excess of the HDL for the fireplace.

Part 2 - Spillage Test at Maximum Depressurization

Even if the measured house depressurization is below the H.D. limit for the chimney, there is still a possibility that prolonged combustion gas spillage may occur if the chimney draft is unusually weak; i.e. if some defect in the chimney, such as a blockage, prevents it from creating the amount of draft that would normally be expected of a chimney of its type. To check for spillage caused by unusually weak chimneys, the Venting System Test includes a spillage test.

In this procedure, the combustion appliances served by the test chimney are turned on when the house is experiencing the worst-case depressurization established in Part 1. An air current tester is then used to actually check for spillage at the dilution air inlet of a gas furnace or at the barometric damper of an oil furnace. Spillage lasting more than 30 seconds after furnace start-up is considered excessive and unacceptable.

If prolonged spillage occurs at house depressurization levels BELOW the HDL, it is an indication that the chimney draft is unusually weak for a chimney of its type. For instance it may be partially blocked. Appropriate remedial action will be required.

Part 3 - Spillage Test at Normal Depressurization

It is possible that excessive spillage observed in Part 2 may be due to blockages or other problems in the flue system. To determine this, the combustion appliances are allowed to cool, the depressurization level is reduced, and the appliances turned on once again.

If spillage still persists, the spillage is due to a problem in the chimney system and is not pressure-induced. The chimney problem will have to be identified and appropriate remedial measures implemented. (The three furnace/flue test procedures presented in Sections 3, 4 and 5 of this manual may be helpful in this respect.)

However, if no spillage occurs, the spillage at maximum depressurization observed in Part 2 was indeed pressure-induced and appropriate corrective action can be taken to eliminate the potential for excessive depressurization.

3. TOOLS AND TIME REQUIREMENTS

A Venting System Test requires about 40 to 60 minutes. Time can be less for experienced test users, and for tests done in simpler houses with fewer fans and chimneys, and for tests done in conjunction with airtightness testing. Tests tend to be longer in houses with lots of venting systems, and especially in houses where problems are encountered due to high levels of house depressurization.

The Venting System Test requires three pieces of equipment: a pressure measuring apparatus, an air current tester, and a wood fire simulator. All this equipment will fit in a standard tool box. The cost of purchasing this equipment will be approximately $200. The cost of materials used for each test will be about $5 (an air current tester and some propane fuel).

Each piece of equipment is described in more detail below.

Pressure Measuring Apparatus

This device must be capable of measuring pressure differences from 0 to at least 25 Pascals, with an accuracy of ± 0.5 Pascals. One common choice for the pressure measuring apparatus is an inclined, block manometer. Inclined manometers are relatively inexpensive gauges, and are very portable. A properly maintained manometer will not lose its accuracy with time, and does not need to be recalibrated.

Other types of pressure gauges can also be used, including electronic manometers and electronic pressure transducers. Magnahelic gauges are not sufficiently accurate for this type of test. Because manometers are the most commonly used pressure measuring apparatus, the remainder of this test will assume the tester is using a manometer.

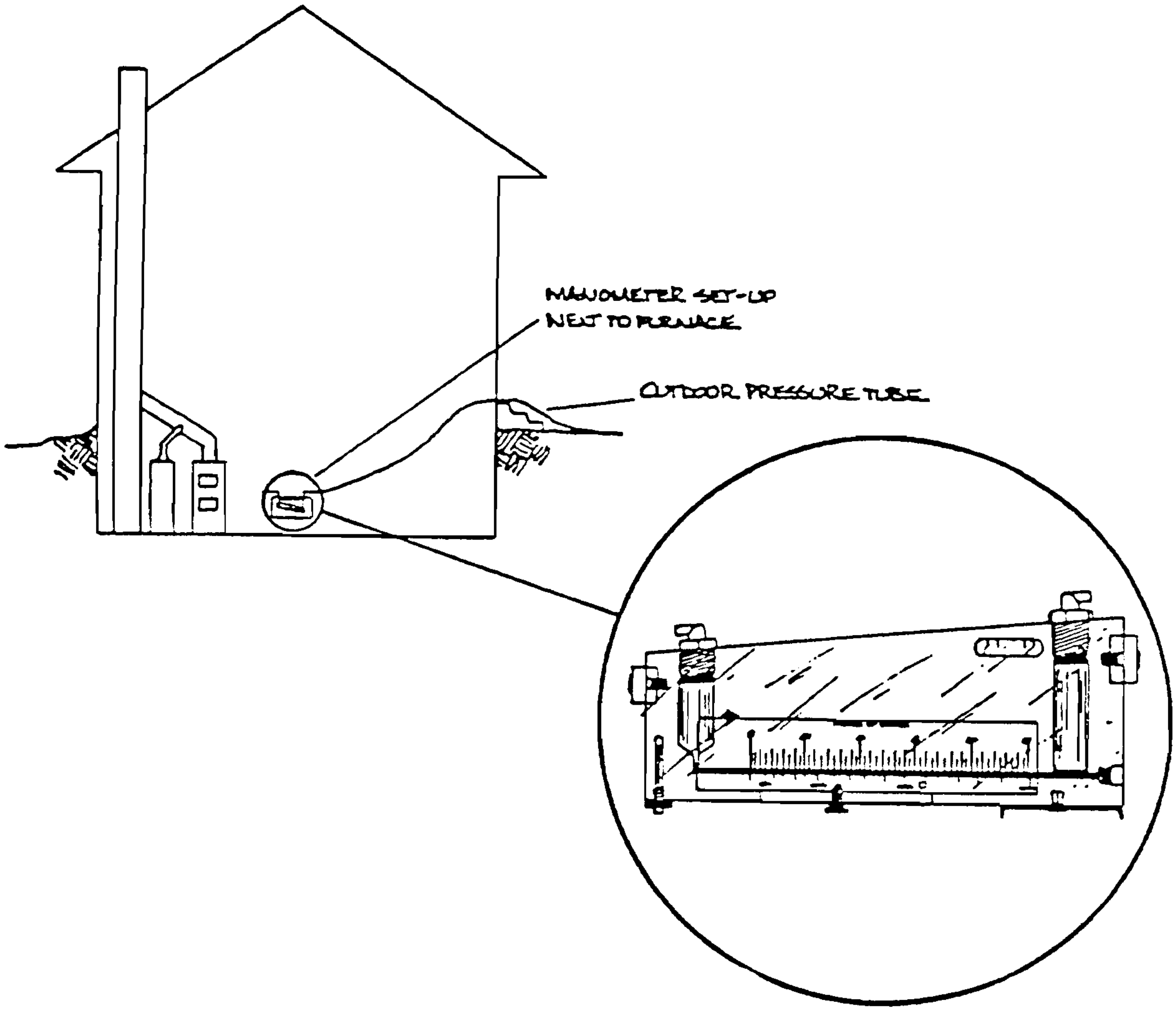
A pressure tube 10 metres or longer should be fitted to the lower side (or high pressure port) of the manometer for use as an outdoor pressure tube. Since the manometer will be set up in the furnace room of the house (in most cases), the tube must be long enough to reach an opening in the exterior wall and still reach beyond the house at least 8 metres. A good choice is polypropylene tubing, with an inside diameter of 4.76 mm (3/16 inches) and an outside diameter of 7.94 mm (5/16 inches).

A pressure averaging system will be needed on windy days. A pressure averaging system helps to reduce fluctuations in the pressure readings due to wind gusts, and is often necessary for accurate testing. A typical pressure averaging system is a one litre airtight can connected to four additional tubes that can be stretched to other locations around the house. It is recommended that the pressure averaging system be constructed in accordance with the instructions provided in Appendix A of the Canadian General Standards Board standard for fan depressurization testing (CAN/CGSB- 149.10-M86). If you have fan depressurization equipment, use the same pressure averaging equipment.

Air Current Testers

An air current tester is used to determine whether air and combustion gases are flowing up the chimney, or out of the chimney and into the house. It helps the test technician to determine whether a little or a lot of spillage is occurring, and to find leaks in the flue pipe and other parts of the chimney system.

Manometer and Tubing Set-up



The most common type of air current tester used for this purpose is a smoke pencil and a squeeze bulb. Butane lighters and matches can also be used, but they are much more difficult to interpret. Because smoke pencils are the most common tool used for detecting air currents, this manual will refer to the air current tester as a smoke pencil.

Wood Fire Simulators

A wood fire simulator is used to simulate a fire in a fireplace. The simulation is necessary so that the exhaust effect of fireplaces can be included in the "worst-case" depressurization measurement.

Without a wood fire simulator, the only alternative would be to use paper and wood, which would create additional clean-up work for the tester, and possible annoyance for the householder if wood smoke were to spill indoors during the test.

A wood fire simulator is a portable heater with a variable heat output, capable of generating a temperature of at least 150°C in the smoke chamber of the firebox of the fireplace. A lightweight camping stove that screws on to a propane canister meets the requirements for a wood fire simulator and is recommended for this purpose. Two stoves work better, especially for larger fireplaces. Two stoves are also useful in houses with two fireplaces. In the rest of this manual, we refer to the wood fire simulator as a propane stove.

4. THE VENTING SYSTEM TEST, STEP-BY-STEP

The Venting System Test is conducted in three stages: PREPARATION, TESTING, and CLEAN-UP. Each of these stages is described below. The descriptions will help you become familiar with what is to be done and why. You won't actually follow these descriptions when conducting a Venting System Test in a house. Instead, you will use a CHECKLIST to conduct the Venting System Test, and a REPORT FORM to record the results. Both the Checklist and the Report Form are presented at the end of Section 2.

The Checklist is a short convenient outline of how to do the Venting System Test. It is designed to be checked off step-by-step as you conduct the test. This will help you to avoid mistakes and omissions, since the procedure can get a bit complicated in some houses. The Checklist also helps to avoid return visits to houses because you forgot to turn off a furnace fan, pack up your propane stove, or complete some other important step. For these reasons, it is recommended that you NEVER CONDUCT A VENTING SYSTEM TEST WITHOUT USING THE CHECKLIST.

The Checklist should be easy to follow once you have read through the more detailed descriptions provided.

DETAILED DESCRIPTION ON THE VENTING SYSTEM TEST

STAGE 1 - PREPARATION:

1. Make sure the information is filled out completely on the forms at the time you do the test.

2. Record the wind speed, wind direction, and outdoor temperature on the report form. This information is just for reference and is not used in any calculations, so approximations are adequate.

3. Switch off all the exhaust devices in the house, including the furnace, water heater, and exhaust fans like range hoods, clothes dryers, and air conditioners.

4. Furnaces can be turned off by lowering the house thermostat setting. There is no need to extinguish pilot lights.

5. If water heaters are not operating at the moment, and no one is using hot water, it is probable that they will stay off. You can usually leave water heaters as is, and ask the occupants not to use hot water for a few minutes.

6. Close the doors, windows, chimney dampers, and other intentional openings in the house. The object is to make the house as tight as it would be under normal winter operating conditions and hence to simulate the conditions under which the depressurization induced by the operation of exhaust devices would be at a maximum. As a general rule, make the house as tight as possible, without doing things an occupant wouldn't do, like taping over an air inlet, or plugging a chimney.

7. While you are moving through the house closing doors, windows, and other openings, also close up interior doorways in the house to all rooms <u>except</u> rooms that contain either a chimney or an exhaust device like a bathroom or kitchen fan. The rooms without chimneys or exhaust devices do not contribute to house depressurization and are sometimes referred to as "passive" rooms. Bedrooms, for example, are usually passive

rooms. The doorways into these passive rooms will remain shut throughout the test.

8. Install a propane stove (the wood fire simulator) in each fireplace, but do not light it.

9. Make sure each fireplace is completely closed up. This includes closing the damper, air supply, and fireplace doors where applicable.

10. Set-up the pressure gauge (manometer) in the same room as the furnace and water heater. Level the manometer. This will allow several minutes for the manometer to be warm and stable so that it can be properly zeroed in Step 12.

11. Attach the exterior pressure tubing to the low end (high pressure side) of the manometer. Extend the tubing outdoors through a suitable location, such as a mail slot, keyhole, or door corner. The easiest place to use as an exit for the tubing is usually a doorway that is weatherstripped. The door must be pulled shut to ensure maximum tightness but it should be possible to squeeze the tubing into the corner with the biggest gap without causing the tube to be pinched too tightly by the closed door. If there is any doubt, disconnect the tubing and suck on the end to ensure that some air movement is still possible. The exterior tubing should terminate at least 8 meters away from the house.

12. Zero the manometer according to the manufacturer's instructions. Observe the pressure reading on the scale for about a minute, and record the maximum pressure fluctuation over this period. Major fluctuations in pressure readings are usually a result of wind gusting.

13. If the fluctuations exceed 0.5 Pascals, the wind is likely to affect the results of the test, and you will need to use your pressure averaging system. Go back outside the house and connect the pressure averaging system to the end of the exterior pressure tube.

14. If the pressure fluctuations continue to exceed 0.5 Pascals after attaching the averaging system, further testing is not recommended since it is possible that the pressure fluctuations may lead to inaccurate or misleading test results.

STAGE 2 - TEST PROCEDURE:

1. You should have closed the door to the furnace room, if there is a furnace room. Close the door to the basement if the furnace is located in the basement. Then operate the furnace circulating blower. If no manual furnace blower switch can be found, you will have to leave out this step of the test. Naturally, you will also skip this step if the house is heated with a hot water boiler, instead of a furnace.

   Most furnaces have a manual switch which allows operation of the blower even when the burner is not firing. This switch is often called the summer-switch. It is sometimes located at the side of the furnace. On other furnaces it is a white push button or metal switch located on a hand-sized fan control box behind the front cover of the furnace. If the furnace has a two-speed fan, operate the fan at the lower speed.

   After operating the furnace blower, read the manometer, and record the pressure on the Report Form. If the pressure you record exceeds zero, the furnace room is depressurized, and the furnace blower should remain operating for the remainder of the test. If, on the other hand, the recorded pressure is less than or equal to zero, the blower should be shut off.

2. Open the basement and furnace room doors.

3. If the house has two-way fan systems, then operate these fans at their highest speed. If there are no two-way fan systems, then skip this step and proceed with the next step.

   Two-way fan systems blow air into and out of the house at the same time. Two-way fan systems are rare, except for the newer energy-efficient houses that have heat recovery ventilators (also known as air-to-air exchangers). If there is a heat recovery ventilator (HRV), it should be operated at high speed. Some HRVs have a defrost mode in which they shut off the supply fan and operate like an exhaust fan. In such a case, you will want to simulate this "worst case" condition by switching the HRV to its defrost mode. Usually this can be done by adjusting the thermostat setting on the HRV to room temperatures. Prior to adjusting the thermostat on a HRV, record the setting, so it can be reset properly after the test.

After operating the two-way fan systems, read the pressure on the manometer and record the results on the Report Form. Leave these systems operating if the effect is to further depressurize the house. Otherwise, turn the two-way fan systems off.

4. Exhaust fans: Turn on all the exhaust fans in the house (except fans in combustion venting systems, such as "draft inducers"). All the exhaust fans should be operating at their highest speed, and at the same time.

   To make sure that the fans are blowing as much as possible, remove lint from clothes dryer lint screens prior to operation and remove the grease filter from the kitchen range hood fan if the filter is plugged or dirty. To operate a whole house vacuum, insert the vacuum hose in the wall socket. If bathroom fans have timer switches, use tape to ensure that the fans remain on for the period of the test. Recirculating fans that do not exhaust air from the dwelling, do not need to be operated. If there is any doubt as to whether the fan is an exhaust fan or a recirculating fan, leave the fan operating.

   Read the manometer and record the pressure on the Report Form. Leave all exhaust fans operating.

Wood Fire Simulation

If the house has a fireplace, now is the time to use your propane stove. If the house has two fireplaces, begin with the fireplace which appears to be used most frequently, and then repeat this section of the test for the second fireplace.

5. Before operating the propane stove, open the chimney damper, and open any combustion air supply to the fireplace.

6. Also, temporarily open a nearby door or window to the outdoors. Opening a door or window is necessary in some houses to get the fireplace operating properly while all exhaust devices are in operation.

7. Light the propane stove/wood fire simulator and adjust it to its highest rate of burn.

8. Use the smoke pencil to check around the fireplace opening for spillage of hot gases. If significant spillage is occurring at this time, it can't be because of house depressurization, because you still have a door or window open to outdoors. Consequently, there must be something wrong with the fireplace, such as a poorly designed chimney, or a blocked or broken chimney. Wind downdrafts may also be a problem. Such problems are rare, but if they occur, then record what has occurred on the Report Form, shut off the stove, close up the fireplace and skip to the next section of the test.

   If no major spillage is apparent at this time, then continue with the fireplace test.

9. Close the door or window that you previously opened to the outdoors. Use the smoke pencil to check once again for spillage around the fireplace opening. Record the quantities of spillage, if any, on the Report Form (e.g. none, slight, major). If spillage is slight or non-existent, continue with the test. If major spillage is occurs, this means that the fireplace is not functioning as an exhaust vent, and will not be contributing to house depressurization. Shut off the stove, close up the fireplace and proceed to step 13. (Chimney spillage from a hot fireplace is common if the fans depressurize the house more than 5 Pascals.)

   If no major spillage is apparent, continue with the fireplace test as outlined below.

   With the fireplace operating, read the manometer and record the pressure on the Report Form.

10. If the house has more than one fireplace, repeat the wood fire simulation in the second fireplace, leaving the first fireplace in operation.

The steps in the Venting System Test described thus far are summarized in Figure 2.1.

VENTING SYSTEM TEST

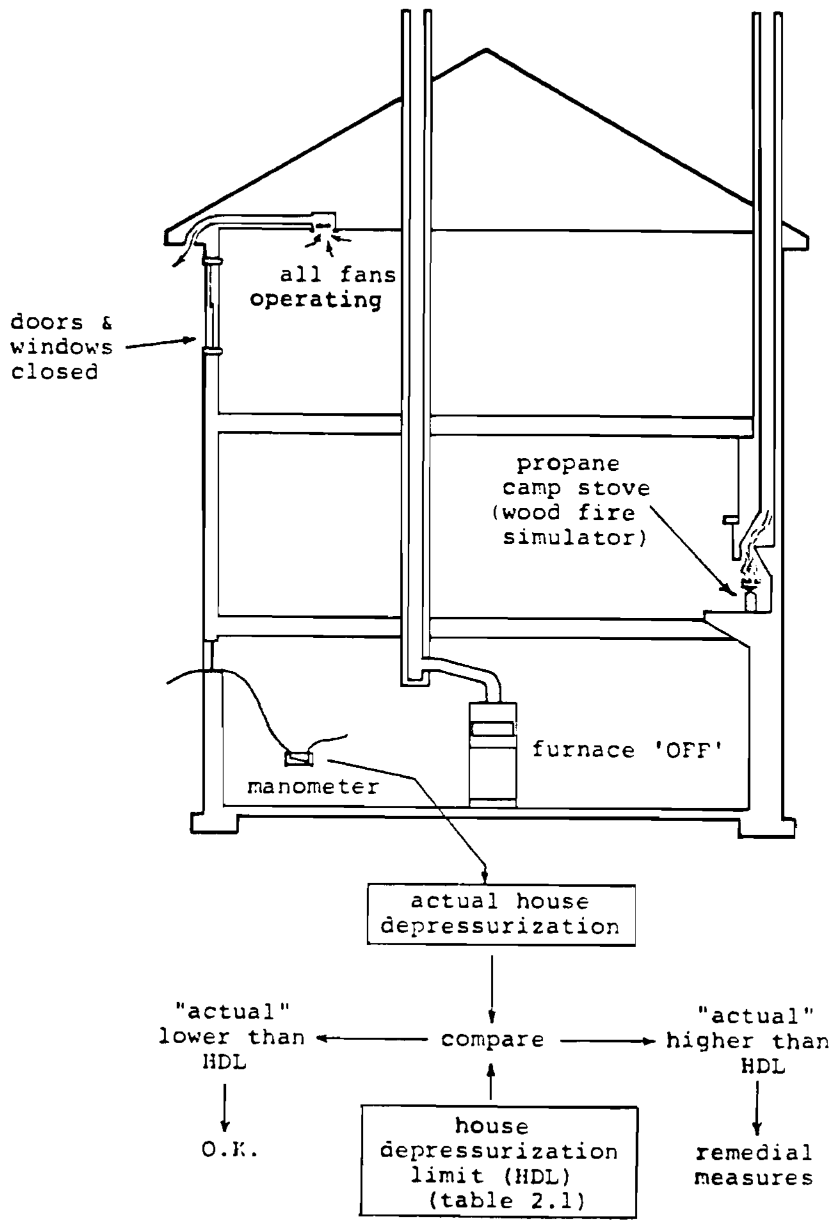


Figure 2.1

Furnace Spillage Check

All the exhaust fans and fireplaces in the house should now be operating at maximum, unless one or more fireplaces had to be shut off and closed up due to excess spillage. The next step is to start up the furnace and check for spillage through the dilution air inlet of the furnace.

11. If a window was open close it.

12. The furnace is started by adjusting the household thermostat to a high temperature. But first make sure that your smoke pencil is ready, and that you have a watch or time piece for recording the number of seconds of spillage. The best procedure is to have the householder or somebody else turn the thermostat up, so you can be standing next to the furnace. However, a few seconds delay in getting from the house thermostat to the furnace will not be a problem.

13. Once the furnace is started, squirt smoke all around the dilution air inlet, and especially along the upper edge. If hot gases are spilling out of the dilution air inlet, and into the house, record the duration of the spillage. Some start-up spillage is a normal event. However, if the duration of spillage exceeds 30 seconds, there is likely a problem with the venting systems. If the spillage duration exceeds 3 minutes, you can stop recording, since this is sufficient evidence of a serious spillage problem.

14. If no spillage is occurring at the dilution air inlet, use the smoke pencil to test for spillage along the flue pipe and at the junction between the furnace flue, the water heater flue and the chimney.

15. If spillage has occurred for longer than 3 minutes, you need to determine if this spillage is affected by the house depressurization, or is a result of some other problem such as weak chimney draft. This is an easy matter, since by opening a window or door to the outside you can eliminate the house depressurization, and then see whether or not the spillage continues. Leave the furnace operating and open a nearby door or window to the outside. Checking again with the smoke pencil will show you whether the spillage is still occurring, despite the absence of house depressurization. If it is still occurring, house depressurization is unlikely to be the cause of the observed spillage.

16. If the spillage you have observed exceeded 30 seconds, but eventually disappeared when proper chimney draft was established, you will have to repeat the furnace test with a door or window open to the outdoors. Shut off the furnace with the house thermostat, open the door or window to the outdoors, prepare your smoke pencil and watch, and then turn the furnace on and time spillage once again. If spillage still occurs, house depressurization is not the cause.

17. Record the results of your furnace spillage check on the Report Form. Ensure the door or window you opened to check the cause of spillage is closed again.

Water Heater Spillage Check

18. If the hot water heater is non-electric, you will need to do a water heater spillage check. With the furnace operating, and fireplaces and exhaust fans still operating as they were for the Furnace Spillage Check, operate the water heater and check for spillage in a way similar to that used for the furnace. To operate the hot water heater, run hot water from a tap in a nearby sink for several minutes.

19. Once the water heater begins to operate, check for spillage with the smoke pencil at the dilution air inlet of the water heater. If spillage is occurring for longer than 30 seconds, open a nearby window or door and check for spillage again. If spillage still occurs, house depressurization is not the cause.

20. Check for spillage along the flue pipe.

21. Record the duration and severity of any spillage from the water heater on the Report Form, and note the effect of opening an outside door or window.

Fireplace Depressurization Level

22. Fans and Furnace Exhaust Only: If the house has fireplaces with propane stoves still operating, shut off the stoves and close up the fireplaces (damper, combustion air doors).

23. With the exhaust fans still operating, turn on the furnace and water heater, read the manometer and record

the pressure on the Report Form. This pressure is the worst house depressurization that can be experienced by the fireplaces.

STAGE 3 - CLEAN-UP:

Return the house to its normal operating condition.

1. Reset the house thermostat.

2. Turn off the hot water tap.

3. Shut off the furnace blower switch.

4. Shut off all the exhaust fans. Remove the tape on any timer switches, and replace filters so that the fans are left in the same position you found them in Step 11.

5. If there was a heat recovery ventilator in the house, reset its thermostat to the position you recorded.

6. Return all the doors and windows in the house to their original position.

7. Pack up your test apparatus. Roll up the pressure tubing, pack up the manometer.

8. Pick up the propane stoves (wood fire simulators), and pack up the smoke pencils.

STAGE 4 - REPORTING:

Record the need for any follow-up action on the Report Form. Let the householder know immediately about any urgent problems.

CHECKING FOR SPILLAGE WITH A SMOKE PENCIL

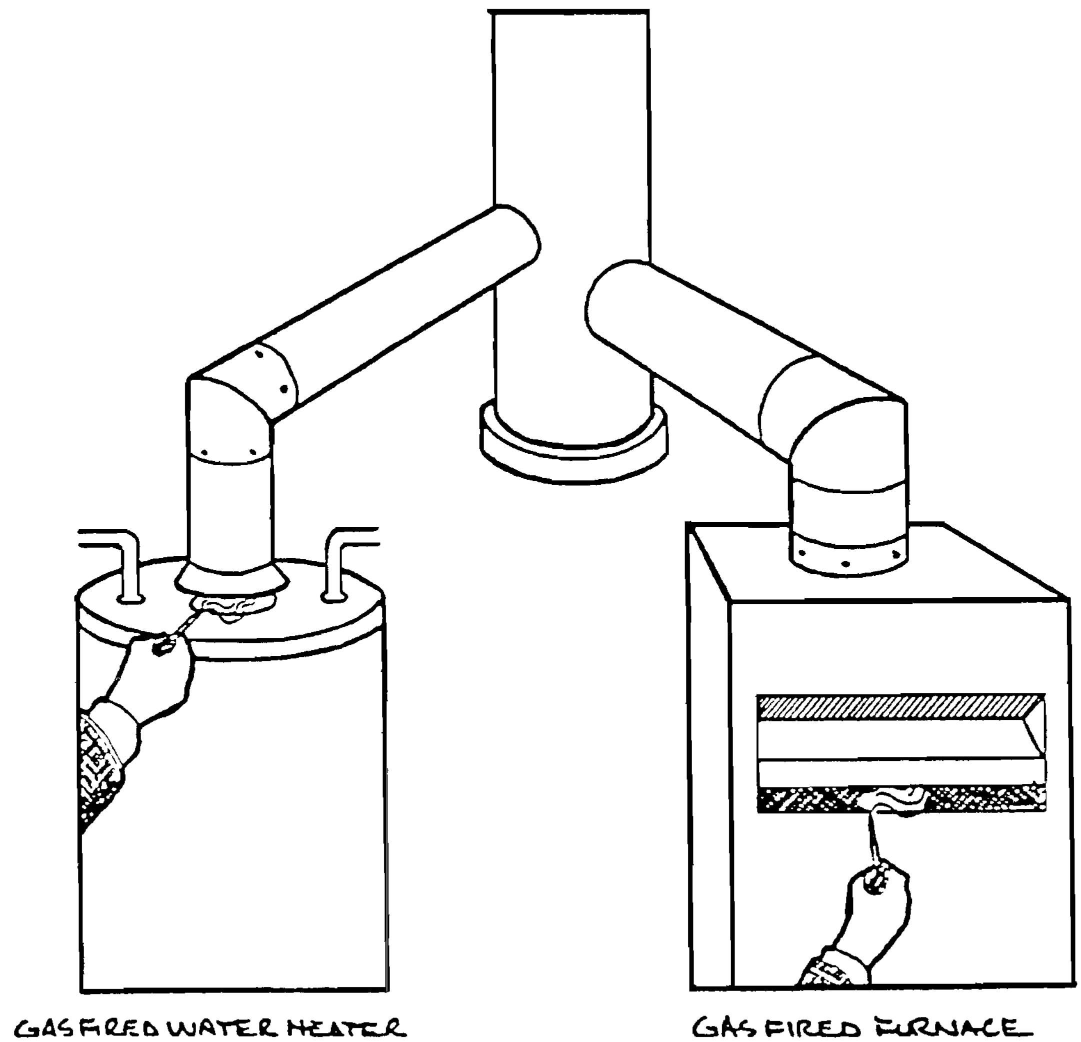


Figure 2.2

Table 2.1

HOUSE DEPRESSURIZATION LIMITS (HDLs)

		H. D. Limit in Pascals	
Appliance	Chimney Height to closest metre	Unlined Chimneys on Exterior Walls	Metal-Lined Insulated or Interior Chimneys
Gas-Fired Furnace, Boiler, or Water Heater	4 or less	5	5
	5, 6	5	6
	7 or more	5	7
Oil-Fired Furnace or Water Heater	4 or less	4	4
	5, 6	4	5
	7 or more	4	6
Fireplace (wood or gas)	N/A	3	4
Airtight Wood-Stove or Fireplace	N/A	10	10
Appliances with Retrofitted Induced Draft Fans	N/A	15	15

CHECKLIST FOR THE VENTING SYSTEM TEST

EQUIPMENT REQUIRED

______ Pressure gauge and tubing
______ Smoke pencil and squeeze bulb
______ Propane stove(s) with propane canister and lighter

1. PREPARATION

______ Complete test identification on Report Form
______ Record outdoor temperature and wind
______ Switch off fans
______ Switch off furnace
______ Switch off water heater (if operating)
______ Close windows and exterior doors and hatches
______ Close interior doorways to passive rooms and basement rooms
______ Install wood fire simulator
______ Close-up fireplace
______ Set-up pressure gauge
______ Extend pressure tap to exterior
______ Zero gauge
______ Record pressure fluctuations
______ Install pressure averaging system, if required

2. TEST

______ Operate blower and record pressure
______ Open basement and furnace room doors
______ Operate two-way fans and record pressure
______ Operate exhaust fans and record pressure

___ dryer	___ bath	___ bath 2
___ bath 3	___ kitchen range	
___ barbecue	___ vacuum	___ other

______ Operate fireplace and record pressure
______ Open fireplace doors, damper and air supply
______ Open window (or door) to outdoors
______ Light wood fire simulator
______ Check for spillage and record
______ Close window (or door) and record pressure

- ______ Repeat for second fireplace
- ______ Check furnace for backdrafting and, if backdraft exists, open a window or door to outside during the first few seconds of furnace operation
- ______ Adjust house thermostat to high and begin timing furnace spillage
- ______ Check spillage along flue pipe
- ______ Record the duration of start-up spillage
- ______ If spillage exceeds 30 seconds, turn down house thermostat,open a window, let furnace cool, and check again
- ______ Run a hot water tap to operate water heater
- ______ Time spillage from water heater
- ______ Check spillage along flue pipe
- ______ Record duration and quantity of spillage (furnace and water heater)
- ______ Turn off fire and close fireplaces
- ______ Record pressure

3. CLEAN-UP

- ______ Reset house thermostat
- ______ Turn off the hot water tap
- ______ Switch off exhaust fans
- ______ Open doors and windows (as found)
- ______ Switch off furnace blower switch
- ______ Reset two-way fan controls (e.g. heat recovery ventilator)
- ______ Pack up gauge and tubing
- ______ Pack up wood fire simulators

VENTING SYSTEM TEST REPORT FORM

Test Date ____________
Report Date ____________

TEST IDENTIFICATION

Company name: ____________
Company address: ____________
Name of tester: ____________
Address of dwelling: ____________
Reason for test: ____________

TEST CONDITIONS

Outdoor temperature: ____________ Wind direction: ____________
Approximate wind speed and variability: ____________
Pressure gauge type - Inclined manometer: ____________ Other: ____________
Pressure averaging system - None: ____________ Other: ____________
Deviations from standard procedure: ____________

HOUSE DEPRESSURIZATION LIMITS (from Table 2.1)

Appliance	H.D. Limit (Pa)
1. Furnace	____________
2. Water heater	____________
3. Wood fireplace	____________
4. Other: ____________	____________
5. Other: ____________	____________

PRESSURE READINGS

Systems Operating	House Depressurization	Exceeds H.D. Limit for Appliance No. 1	2	3	4	5
Blower	____________					
Two-way fans	____________					
Exhaust fans	____________					
Fireplace ____	____________					
Fireplace ____	____________					
Furnace and water heaters (fireplaces off)	____________					

VENTING SYSTEM TEST REPORT FORM (Continued)

SPILLAGE OBSERVATIONS

		Quantity			Duration		
		None	Slight	Major	Less than 30 sec.	More than 30 sec.	More than 3 min.
Fireplace:	Tight house	____	____	____	____	____	____
	Open house	____	____	____	____	____	____
Furnace:	Tight house	____	____	____	____	____	____
	Open house	____	____	____	____	____	____
Water	Tight house	____	____	____	____	____	____
Heater:	Open house	____	____	____	____	____	____
Other:	Tight house	____	____	____	____	____	____
	Open house	____	____	____	____	____	____

FOLLOW-UP ACTION TAKEN:

Discussion with occupants: ____

____

Notification of authority: ____

____

Remedial measures: ____

____

Urgency of remedial measures:

None Urgent Today Routine Optional

Details: ____

____

____

____

____

____

SECTION 3

HEAT EXCHANGER LEAKAGE TEST

1. INTRODUCTION

General

The Heat Exchanger Leakage Test is a simple, fast and accurate way to detect major leaks in heat exchangers in oil- or gas-fired forced air furnaces. Major leaks are those which are capable of permitting excessive combustion gas spillage from the combustion chamber into the living area.

Alternative Ways to Detect Heat Exchanger Leaks

A variety of techniques have been used to identify leaky heat exchangers. Some examples are smoke bombs, the use of strong smelling oils, visual inspections with flashlights, sticking a match into the heat exchanger and watching for flame movement, and spraying a salt solution into the flame and testing for the salt vapours in the circulating household air. All these techniques are messy and less effective than the test described here.

However, this Heat Exchanger Leakage Test is not always the best procedure. A more sophisticated procedure is sometimes desirable, especially if it is necessary to know precisely where the leak is located, the quantity of leakage, or if appliance repair is under consideration. In these situations, the best alternative is usually to use an electronic combustion gas analyzer, and search for leakage directly by disconnecting the circulating blower and then cutting a hole in the warm air plenum. Such detailed techniques are not discussed in this manual.

Heat exchanger leaks in forced air furnaces can cause combustion gas spillage in two ways. First, before the furnace blower starts to operate, combustion gases may leak from the combustion chamber into the forced air plenum since some portions of the chamber will be pressurized with respect to the plenum. When the blower fan turns on, the leaked gases are blown throughout the houses. Occupants may notice this leakage as a sudden blast of smelly or dirty air when the blower operates.

The second form of heat exchanger leakage occurs after the blower fan starts to operate. If leaks are present in the heat exchanger, the fan will force circulating air through the leaks into the combustion chamber at high pressures of between 50-75 Pascals. This pressurized stream of incoming air can cause the combustion flame to be distorted and cooled, leading to sooting and carbon monoxide production.

If the leak is very large, larger amounts of air can enter the combustion chamber which pressurizes the chamber. This can lead to further problems such as rumbling and back-puffing in an oil furnace or continuous spillage through the dilution air inlet of a gas furnace.

The Heat Exchanger Leakage Test can detect furnaces which may be experiencing these kinds of problems. Furthermore, since spillage caused by the heat exchanger is very similar to spillage caused by house depressurization, poor draft or a flue blockage, the test is a useful diagnostic method for pinpointing whether or not the heat exchanger is at fault in a house in which spillage events have been reported.

The Heat Exchanger Leakage Test can be completed in about 15 minutes. An air current tester, such as smoke pencil, is required.

Intended Users and Necessary Qualifications

The test is intended for use by heating tradesmen. However, no provincial licenses or certification are currently required to conduct a Heat Exchanger Leakage Test.

The test procedure is particularly straightforward for oil furnaces. Virtually anyone should be able to identify major leaks in an oil furnace heat exchanger after becoming familiar with the test procedure.

However, the test procedure for gas furnaces is more complicated. To do the test, the pilot light must be extinguished and later re-lit. It is also necessary to temporarily tape off the upper portions of the combustion chamber. For these reasons, the test should only be performed on gas furnaces by individuals who are licensed for working on heating and ventilating equipment. Alternatively, a contractor or tradesman who is not licenced for work on gas-fired appliances may ask the appropriate provincial labour regulatory office for special permission to conduct this test, and particularly for permission to shut off and re-light the pilot light on gas furnaces.

Uses of the Test

After a bit of practice, users will find that the Heat Exchanger Leakage Test is a quick and easy way to obtain important information about how the furnace is operating. There are a number of situations in which the test could be useful:

(a) as a standard part of servicing or repairing a furnace

(b) when householders complain about odors, noises or other symptoms of combustion gas spillage

(c) when combustion gas spillage has been detected but the cause has not been pinpointed

(d) in combination with the Venting System Test (described in Section 2 of this manual) in order to provide a comprehensive check of venting safety. (However, because the test requires a cool furnace, it should always be done PRIOR to the Venting System Test.)

2. GENERAL PRINCIPLES AND PROCEDURES

The Heat Exchanger Leakage Test is based on the fact that the circulating blower of the furnace forces air over the heat exchanger at relatively high pressures. If there is a leak in the heat exchanger some of the circulating air will likely be forced through the leak into the combustion chamber. The test procedure provides a method of detecting the entry of the circulating air into the combustion chamber and hence to detect the presence of any leaks.

Even if there are no leaks in the heat exchanger, there is normally considerable air movement into the combustion chamber when the furnace is operating due to the chimney draft. To eliminate this convective air movement, the heat exchanger is tested cool with the exit port or flue collar sealed. The circulating blower is then manually operated. A smoke pencil is used to visually identify any major air movement out of the combustion chamber through the primary air intake of a gas furnace or through the inspection port of an oil furnace. Under the test conditions, if air currents are detected emerging from the combustion chamber, it can only be as a result of the circulating fan forcing air into the combustion chamber through a leak in the heat exchanger.

Major leaks are normally easy to identify in this way. Small leaks are sometimes difficult to identify but identification of small leaks is not the objective of this test since they are unlikely to produce significant combustion gas spillage.

There are a couple of problems with this test procedure which are worth remembering. The greatest problem is that the heat exchanger is tested cold. Some leaks only exist when the heat exchanger is hot, and the metal has expanded. Nobody knows whether this type of leak is a common occurrence or not. If the cold test does not show any leakage, but you are still suspicious, you can always repeat the test with a hot heat exchanger. This won't change the simplicity of the test for oil furnaces. For gas furnaces however, it is a little more difficult to seal the ports and identify air movements when a heat exchanger is hot.

One other small complication is the possibility of encountering poor gaskets around the heat exchanger of a gas furnace. A leaky gasket may permit air to leak out of the plenum or around the front of the combustion chamber, giving the appearance of a leaky heat exchanger. This type of leak is still worth locating and correcting, although it is less of a problem than a cracked heat exchanger.

3. TOOLS AND TIME REQUIREMENTS

The Heat Exchanger Leakage Test requires the following tools and materials:

- Smoke pencils.

- A flue sealing material. A variety of materials can be used to seal off the exit ports of the combustion chamber. On a gas furnace, a simple procedure is to use a strip of packing tape placed across the combustion ports. The wider the tape, the quicker the job. You may want to purchase a roll of clear, 100 mm packing tape for this purpose. Alternatively, the ports can be plugged with pieces of foam rubber, or rags, which are often more effective when testing a hot heat exchanger.

  The exit port of an oil furnace can be plugged with a piece of tin foil across the flue collar (after disconnecting the flue pipe). Another technique sometimes used for this purpose is to use a balloon attached to a plastic tubing, sucking the tubing and inserting the balloon through the barometric damper and down towards the furnace. The balloon can then be inflated to completely fill the flue pipe, and the plastic tubing temporarily crimped. The advantage to using the balloon is that it is a very quick and safe procedure.

- A flashlight to improve visibility.

- Matches for re-lighting pilot lights on gas furnaces.

Total time required for conducting a Heat Exchanger Leakage Test will be about five minutes, including all the set-up and clean-up time. If the heat exchanger requires time to cool, this will extend the test period.

4. THE HEAT EXCHANGER LEAKAGE TEST, STEP-BY-STEP

To conduct a Heat Exchanger Leakage Test, follow the following steps using the report form provided. Check off each of the steps on the checklist provided on the report form. Also use the report form to record all your results, observations and recommendations.

1. Initial Preparations

Check for a blower switch, and make sure you have the tools and equipment you need.

Blower switches are often located at the side of the furnace, or behind the front cover of a gas furnace on a hand-sized box with a white push button. Oil furnace blower switches are sometimes located inside or just above the blower compartment.

If the furnace does not have a manual switch (summer switch) for operating the circulating blower, it will have to be tested hot, which is possible but is beyond the scope of this manual.

2. Thermostats

The leakage test requires a cool furnace. In order to given the furnace time to cool and to be sure it doesn't operate during the test, turn down the house thermostat. Lock the household thermostat in its position by using a piece of tape across the thermostat. This tape will prevent operation of the thermostat by the householder during the test. It will also ensure that the householder does not use the thermostat in the event that you fail to reset and unseal the furnace.

3. Pilot Light

Blow out the pilot light if testing a gas furnace. The reason for blowing out the pilot, rather than just turning off the valve, is to ensure that safety controls on the furnace are operating properly. After blowing out the pilot light, the thermocouple next to the pilot will cool and eventually shut off the gas valve. This process can take up to three minutes. It is usually possible to hear when the valve is turned off because the gas hissing will stop and a click will occur in the main gas valve. Be sure not to light a flame near the furnace during this period. If a thermocouple fails to shut off the gas valve after three minutes of waiting, then it is a deficient part and has to be replaced. The main gas valve can be manually shut off under such circumstances, and then you can proceed with the test.

4. Exit Ports of the Combustion Chamber

On a gas furnace, use one or more pieces of tape to seal the exit ports of the combustion chamber. Pieces of foam rubber can also do the job.

On an oil furnace, disconnect the flue pipe and tape a piece of foil across the flue collar of the furnace. Alternatively, use a balloon inflated in the flue pipe below the barometric damper.

5. Precheck for Air Movement

Gently squeeze smoke into and around the remaining opening into the combustion chamber.

On a gas furnace, squeeze smoke into each of the combustion chambers and all around the burner jets and observe the air movements that are occurring.

On an oil furnace, squeeze smoke around and into the inspection port. Observe the air movements that are occurring.

6. Circulating Blower

After switching on the circulating blower, squeeze smoke into and around the combustion chamber. If a steady movement of smoke out of the combustion chamber is now occurring that was not occurring during Step Five, there is definitely a leak in the heat exchanger.

Detecting leaks this way with an oil furnace is easy, since the inspection port is a small opening that creates a high velocity air stream.

On a gas furnace, the open area is still quite large, and the velocity of air movement will be slower for similar sized leaks. If it is hard to be sure whether air movement is occurring, then the leak is not worth worrying about.

Note your observations on the Report Form.

7. Clean-up

Shut off the blower, and unseal the combustion chamber. IT IS VERY IMPORTANT TO REMEMBER TO UNSEAL THE COMBUSTION CHAMBER.

Relight the pilot light (gas furnaces only).

Untape the house thermostat and use it to turn on the furnace.

Observe the furnace operation, and make sure no spillage is occurring. If there is spillage evident, you will have to inform the householder, and you may want to investigate other causes using other tests in this manual.

Reset the house thermostat to its original position.

Clean-up any tools and materials.

The Heat Exchanger Leakage Test is summarized in Figure 3.1.

HEAT EXCHANGER LEAKAGE TEST

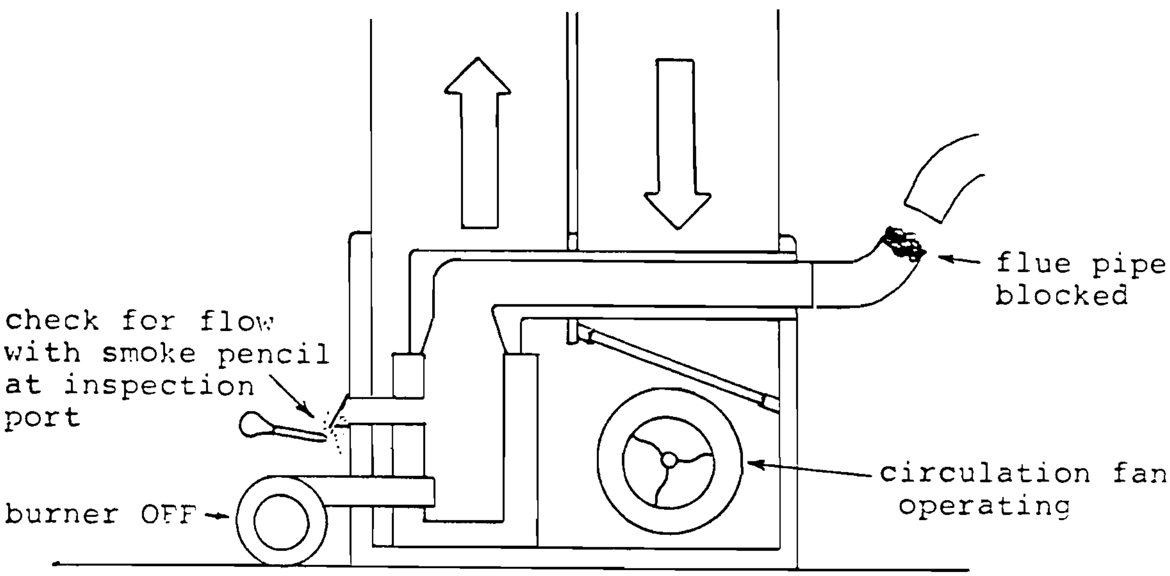


Figure 3.1

HEAT EXCHANGER LEAKAGE TEST

CHECKLIST AND REPORT FORM

______ Check for blower switch on furnace
______ Check tools: smoke pencil, tape, flashlight, etc.
______ Turn off and tape household thermostat
______ Blow out pilot light (gas furnace only) and check to see valve shuts off
______ Seal exit port(s) of combustion chamber
______ Pre-check for air movement using smoke pencil and flashlight
______ Switch on blower and check again
______ Shut off blower
______ Unseal the combustion chamber
______ Light pilot (gas furnace only)
______ Untape and turn-up thermostat to high
______ Check for proper operation (no spillage)
______ Re-set house thermostat
______ Clean-up tools and materials

ADDRESS: ______________________________
DATE: ______________________________
COMPANY: ______________________________
TESTER: ______________________________
FURNACE TYPE: ______________________________

DEVIATIONS FROM STANDARD PROCEDURES (if any): ______________________________

RESULTS: ______________________________ No leakage detectable; or:

AMOUNT OF LEAKAGE	LOCATION	COMMENTS
______________	______________	______________
______________	______________	______________

RECOMMENDED FOLLOW-UP ACTION: ______________ None; or: ______________
____

SECTION 4

SAFETY INSPECTION

1. INTRODUCTION

The Safety Inspection is a visual check for problems with the chimneys, the heating appliances, and the furnace room in a house. A thorough inspection of these items is worthwhile because it is often the quickest way to identify chimney problems - or the potential for chimney problems. By following the inspection procedures outlined in this manual, you can be sure to use your time efficiently without forgetting or ignoring problem areas. Even experienced heating contractors will benefit.

This manual includes a Safety Inspection Checklist, which you will use as a guide to conducting a thorough Safety Inspection. The Safety Inspection Checklist (or SIC) includes recommendations for repairing the chimney system, or for taking other actions which might improve performance and safety of the chimney.

The manual also provides a brief explanation for each item listed on the SIC. The explanations will give you a clear idea of what is meant by a particular recommendation, and why it is worth considering. The explanation will also help you learn how to use reference tables (or code books) to recognize unsafe situations. Once you are familiar with the explanations in this manual, the SIC and the reference tables are all you will require to conduct a Safety Inspection.

Intended Users and Applications

No special certificates or licenses are required to conduct a Safety Inspection of a residential combustion venting system. However, the Safety Inspection assumes a working knowledge of heating systems in houses, and an awareness of the applicable codes and regulations. Consequently, the Safety Inspection is most appropriate for persons who work regularly in the heating and ventilating trades. In fact, the greater your experience and knowledge in the area of chimneys and venting systems, the better will be your Safety Inspections.

The Safety Inspection is especially useful as a problem-solving tool in houses where there is a history of venting problems. The Safety Inspection is a good "first step" in your investigation. There is no point in carrying out more complicated and time-consuming procedures, such as the Venting System Test, if a simple visual inspection can identify the nature of the problem. In other cases, a Safety Inspection might point to the need for further tests. For example, if you see evidence of chimney backdrafting, you can recommend that a Venting System Test be carried out. Or if you see evidence of blockages and leaks in the chimney, you could recommend a Chimney Performance Test. (The Venting System Test and Chimney Performance Test are described in other parts of this Manual.)

If you work for a heating contractor, it is a good idea to carry out Safety Inspections as part of annual furnace servicing. All too often, the appliance servicing is completed without an overall inspection of the chimney and furnace room. The result can be problems for the occupants, and for you, when chimneys malfunction despite your recent service call. Since the Safety Inspection doesn't consider issues like energy efficiency, flame characteristics, safety limit controls and so on, you will have to consider how best to combine such service with the Safety Inspection. As a general rule, the Safety Inspection is conducted before any service work.

2. GENERAL PRINCIPLES AND PROCEDURES

The Safety Inspection begins with an inspection of the chimney from outside the house, and ends with an inspection of the chimney, ash clean-out, flue connector, appliances, and furnace room from inside the house. During this process, the safety inspector reviews each of the recommendations in the SIC. The SIC includes most of the maintenance and repair problems that can be identified during a Safety Inspection. By considering whether particular recommendations apply to the house under inspection, you will be forced to closely examine and evaluate each component of the system.

In some cases, the Safety Inspection recommendations refer to code specifications for chimney design. If you are not already familiar with the code specifications, you will want to refer to the appropriate code book. These code books should always be carried with you when you are conducting a Safety Inspection.

The SIC is divided into eight parts (A, B, C, D, E, F, G and H). These parts are organized in the way in which most Safety Inspections are carried out (beginning outside the house, and then moving inside). Each recommendation has been given a number (1, 2, 3, etc.). By referring to the part of the SIC, and to the number of the recommendation (example A5 or C4), you can make rapid notes on any recommendation. The flip side of the SIC is a convenient location to record notes, and elaborate on the recommendations.

3. TOOL AND TIME REQUIREMENTS

A flashlight and a serviceman's mirror are the only tools needed during a Safety Inspection.

The time required for a thorough chimney investigation is about ten minutes. Less time is needed by someone who knows reference tables and codes by heart. More time is needed for chimneys with problems.

Other tools are sometimes useful, depending on the situation. For example, a ladder or rope is an advantage if you ever plan to conduct roof-top inspections of chimneys. (Roof-top inspections are rarely worth the trouble, and should be considered a special measure for houses with chimney blockage or broken linings.)

4. THE SAFETY INSPECTION CHECKLIST OF RECOMMENDATIONS

A. MASONRY CHIMNEYS (Inspect from outdoors and via ash clean-out)

_______ 1. Cap is recommended to keep out moisture
_______ 2. Cap needs repair
_______ 3. Cap with greater free area is recommended
_______ 4. Cap or extension is required to avoid down winds
_______ 5. Extension is required to avoid drawing fireplace smoke
_______ 6. Flashing needs repair
_______ 7. Brickwork needs repair
_______ 8. Flue appears leaky and should be tightened
_______ 9. Tile lining needs repair or replacement
_______ 10. Steel lining is required
_______ 11. Obstacles in flue must be removed
_______ 12. Supports are required to straighten or strengthen chimney
_______ 13. Chimney cleaning is required to remove excess soot or creosote
_______ 14. Clean-out door needs repair or tightening
_______ 15. Old thimbles should be replaced with a sleeve

B. B-VENT

_______ 1. Cap needs replacement
_______ 2. Cap needs cleaning
_______ 3. Extension is required to avoid down winds
_______ 4. Flashing needs repair
_______ 5. Diameter of vent is undersized
_______ 6. Vent appears leaky and should be tightened
_______ 7. Supports are required to straighten or strengthen chimney

C. METAL LINING IN MASONRY

_______ 1. Joins require tightening or sealing
_______ 2. Lining requires replacement due to corrosion
_______ 3. Lining is incomplete or broken and must be replaced
_______ 4. Diameter of lining is too small
_______ 5. Insulation is recommended between liner and masonry

THE SAFETY INSPECTION CHECKLIST OF RECOMMENDATIONS (Continued)

D. FURNACE FLUE PIPE OR VENT CONNECTOR

______ 1. Diameter is too small
______ 2. Diameter is too large
______ 3. Joins are too loose
______ 4. Pipe is too leaky and should be tightened
______ 5. Pipe is corroded and needs repair or replacement
______ 6. Pipe should be replaced with a new, double-walled pipe
______ 7. Barometric damper needs balancing
______ 8. Barometric damper needs lubrication
______ 9. Vent needs straightening
______ 10. Vent slope needs to be increased
______ 11. Vent needs more supports
______ 12. Clearance to combustible needs to be increased
______ 13. Pipe needs soot removed

E. WATER HEATER FLUE PIPE CONNECTOR

______ 1. Diameter is too small
______ 2. Diameter is too large
______ 3. Joins are too loose
______ 4. Pipe is too leaky and should be tightened
______ 5. Pipe is corroded and needs repair or replacement
______ 6. Pipe should be replaced with a new, double-walled pipe
______ 7. Damper needs balancing
______ 8. Damper needs lubrication
______ 9. Pipe needs straightening
______ 10. Pipe slope needs to be increased
______ 11. Pipe needs more supports
______ 12. Clearance to combustible needs to be increased
______ 13. Pipe needs soot removed

F. FURNACE AND FURNACE ROOM

______ 1. Odours, particles or staining suggest need for a Venting Systems Test
______ 2. Blower compartment door needs tightening
______ 3. Filter is plugged and needs replacement
______ 4. Burner jets need cleaning
______ 5. Burner fan needs cleaning
______ 6. Make-up air supply needs repair, cleaning or opening
______ 7. Make-up air supply needs relocating
______ 8. Warm air register required in furnace room
______ 9. Return air ducting needs tightening

THE SAFETY INSPECTION CHECKLIST OF RECOMMENDATIONS (Continued)

G. WATER HEATER

______ 1. Stained hood or burnt grommets suggest need for a Venting Systems Test
______ 2. Burner jets need cleaning
______ 3. Burner air supply needs cleaning

H. FIREPLACE

______ 1. Stained mantle suggests need for a Venting Systems Test
______ 2. Chimney top damper is recommended
______ 3. Masonry needs repair
______ 4. Clearance to combustible should be increased
______ 5. Chimney needs cleaning
______ 6. Combustion air supply is required
______ 7. Combustion air supply needs repair or relocation

SECTION 5

CHIMNEY PERFORMANCE TEST

1. INTRODUCTION

General

The Chimney Performance Test is designed to determine whether a chimney might be performing especially poorly. Some chimneys suffer from poor draft problems and spillage because of major design flaws (e.g. too many restrictions), blockage, cracks and large leakage areas. It is not always possible to recognize these types of problems just by looking at a chimney. In cases where a chimney is suspected of poor performance, the best approach is to test the chimney and ensure that it performs at least as well as other chimneys of similar design.

Overview of the Procedure

The Chimney Performance Test is a very simple procedure. It consists of two measurements:

- chimney gas temperature
- chimney static pressure

The gas temperature is measured after the system has warmed up (that is, under steady-state conditions). The temperature must be high enough to avoid problems from condensation and poor draft, but not so high as to be a potential fire hazard, or to damage chimney materials.

The static pressure is also measured after the system has warmed up. The house is opened-up, so that house depressurization can not interfere with chimney performance. Although static pressure is not a measurement of the total chimney draft, it does provide a rough indication of the total chimney draft. Total draft includes the velocity pressure as well.

If the static pressure is very low, it is probable that total draft is also low, and that something is wrong with the chimney itself. Both excess restrictions and excess leakage in the chimney will have the effect of lowering the chimney draft, and increasing potential for spillage. When chimney draft is low, because of restrictions or leakage, the chimney is more easily influenced by wind pressures and house pressures.

Intended Users and Applications

The Chimney Performance Test is simple enough to be included with most other tests in this manual and could be considered an important part of every chimney evaluation or inspection. The test can be performed by anyone with the essential tools and trainig. No special licenses or approvals are required.

The Chimney Performance Test is especially useful in helping to diagnose spillage problems identified during the Venting System Test. For example, if a chimney is found to spill when the house is depressurized to a level below the House Depressurization Limit for its chimney type, the problem may be an exceptionally weak chimney. House Depressurization Limits (HDL's) are for chimneys in relatively good condition.

A Safety Inspection (see Section 4) may reveal unusual constrictions or leakage and thus indicate a need for testing chimney performance.

2. GENERAL PRINCIPLES AND PROCEDURES

Because chimney draft is developed by high temperatures, the first step in evaluating chimney performance is to measure chimney temperatures at the breech (furnace outlet). Excessively low chimney temperatures will, of course, develop inadequate chimney draft. Also, if temperatures are too low at the chimney bottom, the possibility exists that condensation problems will occur at the chimney top.

Exterior chimneys require higher breech temperatures than interior chimneys because of the extra heat losses through the chimney sides. An exterior chimney is a chimney with one or more sides exposed to outdoor temperatures, from top to bottom.

Higher chimney gas temperatures are certain to improve the draft and reduce the amount of condensation. However, if temperatures are too high, the temperature of nearby combustibles may exceed fire safety limits. Also, temperatures above about 370°C can damage a venting system by destroying the galvanized surfaces of steel vent connectors.

Although chimney temperatures tend to get warmer and warmer the longer an appliance operates, temperatures will start to level off after 3 to 4 minutes of operation. Most thermometers require a minute or so to reach these high temperatures. Consequently, the measurements of chimney temperature (and draft) are taken after at least 5 minutes of appliance operation.

The static pressure measurement is simply a measurement of the pressure difference across the metal wall of the vent connector. To complete this measurement, a metal probe is inserted through an appropriately sized hole in the vent connector and attached with tubing to a pressure gauge. Pressure inside the vent will be lower than the house. As gases move up the chimney, part of the pressure difference - or draft - is converted into energy of motion (velocity pressure). Consequently, the static pressure is only a partial measurement of chimney draft.

3. TOOLS AND TIME REQUIREMENTS

Thermometer

The scale of the thermometer must cover a temperature range of 100°C to 350°C. The thermometer should have a probe 75 mm to 150 mm in length, suitable for inserting through a 5 mm hole. Dial type thermometers are convenient to insert and leave in place, and are easy to read.

Pressure Gauge

An inclined manometer if needed with a scale in 1 Pascal divisions, and a range from 0 to 50 Pascals. (Most of the small, hand-held, mechanical gauges are not sufficiently accurate for Chimney Performance Testing.) Refer to the Venting System Test (Section 2) for more details on how to operate a manometer.

Pressure Tubing

A short piece of flexible tubing is required to connect the pressure gauge to the vent connector. To avoid melting plastic or rubber tubing, use a short metal tube for inserting into the vent. Suppliers of pressure gauges will also supply specially designed probes for measuring static pressure, which may include a heat resistant rubber gasket, and a clip for holding the probe in place.

Time Requirements

Measurement of chimney temperature and draft requires between 5 and 10 minutes. The pressure gauge and tubing can be set-up while the chimney is warming up.

4. THE CHIMNEY PERFORMANCE TEST, STEP-BY STEP

1. Partially open a nearby door or window to the outside.

2. Begin operation of the appliance. If the appliance is a furnace (or boiler), turn up the house thermostat. If it is a hot water heater, turn on a hot water tap.

3. Once the appliance begins to operate, begin timing.

4. Look for a 5 mm diameter hole in the vent connector close to the appliance, preferably 300 mm from the outlet, and on a straight section of pipe. If no hole exists, make a hole with a drill bit, or a punch and hammer.

5. Insert a thermometer in the 5 mm hole.

6. Set up the manometer on a level surface, close to the 5 mm hole. Open the pressure ports, connect the tubing, and zero the gauge.

7. After 5 minutes of appliance operation, record the temperature of the chimney gases, and remove the thermometer.

8. Insert the static pressure probe in the 5 mm hole. (The probe should not penetrate into the pipe more than 2 or 3 mm.)

9. Record the static pressure, and remove the pressure probe.

10. Shut off the appliance by resetting the house thermostat (or turning off the hot water tap).

11. Close the door or window to the outside.

12. Pack-up the test equipment.

13. Evaluate the adequacy of chimney gas temperatures using Table 5.1.

14. Evaluate the adequacy of static pressure by comparing the static pressure with the House Depressurization Limit (HDL) for the system being tested. Static pressure should be at least 1 Pascal above the HDL. Refer to Table 5.2 for HDL's.

The Chimney Performance Test is Summarized in Figures 5.1 and 5.2.

Table 5.1

Temperature Limits for Flue Gases

Chimney Type	Chimney Height* (to nearest metre)	Minimum Temperature** (°C) Gas	Oil	Maximum Temperature (°C) Gas	Oil
Uninsulated	4 or less	210	230	300	430
Exterior	5, 6	230	250	300	430
Masonry	7 or more	270	290	300	430
Other Types	6 or less	210	225	300	430
	7 or more	230	250	300	430

* Vertical distance from chimney cap to breech

** Values are approximated, and are intended to avoid condensation occurrence at chimney top after 5 minutes of appliance operation, with an outdoor temperature of -10°C and a dew point of 58°C.

Table 5.2

HOUSE DEPRESSURIZATION LIMITS (HDLs)

Appliance	Chimney Height to closest metre	H. D. Limit in Pascals: Unlined Chimneys on Exterior Walls	H. D. Limit in Pascals: Metal-Lined Insulated or Interior Chimneys
Gas-Fired Furnace, Boiler, or Water Heater	4 or less	5	5
	5, 6	5	6
	7 or more	5	7
Oil-Fired Furnace or Water Heater	4 or less	4	4
	5, 6	4	5
	7 or more	4	6
Fireplace (wood or gas)	N/A	3	4
Airtight Wood-Stove or Fireplace	N/A	10	10
Appliances with Retrofitted Induced Draft Fans	N/A	15	15

CHIMNEY PERFORMANCE TEST - TEMPERATURE

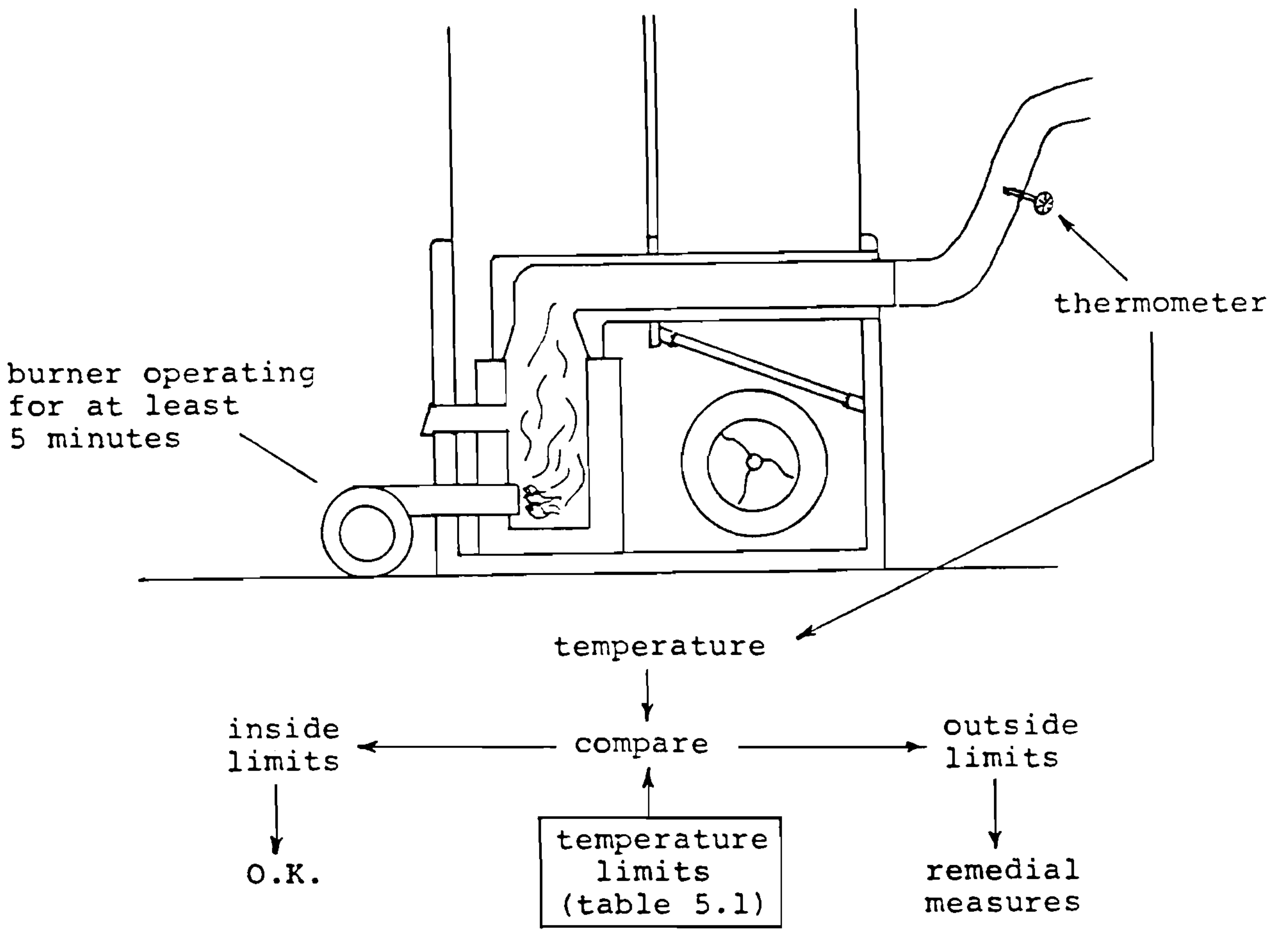
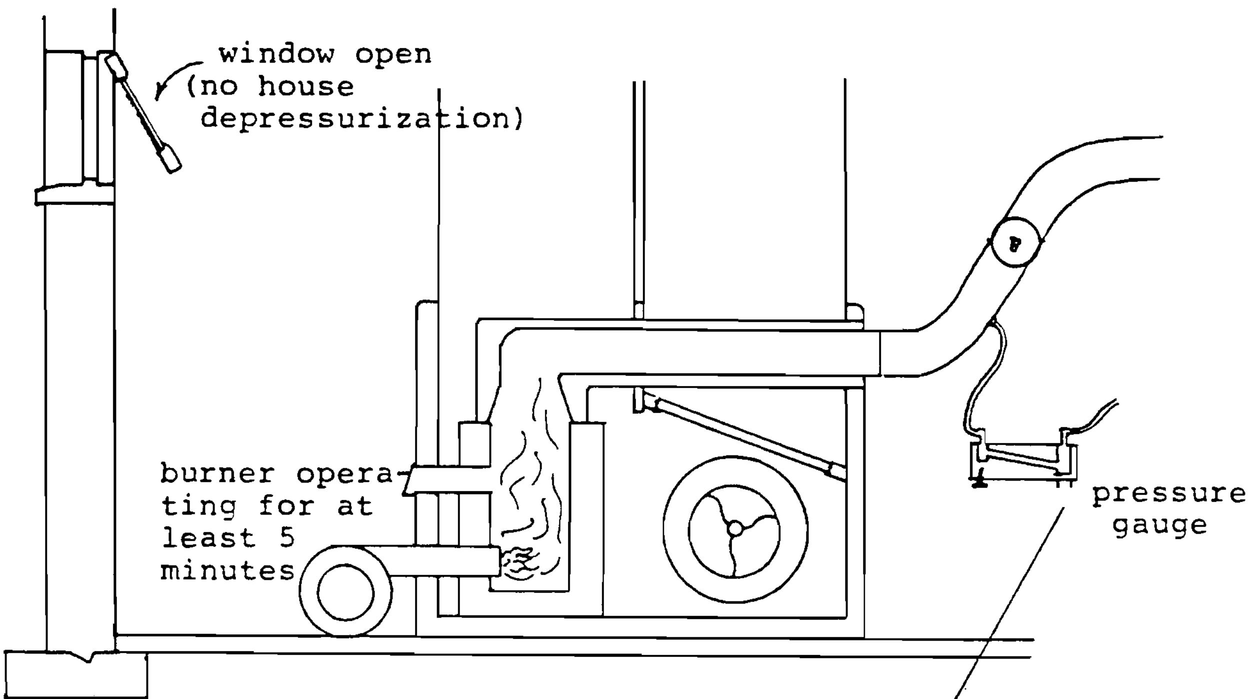


Figure 5.1

CHIMNEY PERFORMANCE TEST - PRESSURE



flue static pressure

↓

"static" more than 1 Pa higher than HDL ← compare → "static" less than 1 Pa higher than HDL

↑

house depressurization limit (HDL) (table 5.2)

"static" more than 1 Pa higher than HDL → O.K.

"static" less than 1 Pa higher than HDL → remedial measures

Figure 5.2