From:	Sarah Drummond
To:	Nancy Bonner
Subject:	FW: Proposed Canterbury Air Plan
Date:	Monday, 27 July 2015 11:04:15 a.m.
Attachments:	Environment Canterbury Submission.pdf ATT00001.htm

From: Dave & Jenny Pullen [mailto:european@xtra.co.nz]
Sent: Monday, 27 July 2015 10:45 a.m.
To: Sarah Drummond
Subject: Re: Proposed Canterbury Air Plan

Hi Sarah

We agree with all the previous submissions that the NZHHA have put forward and would like to have the following attachment put forward as a Service Submission in support of the previous submissions put in by the New Zealand Home Heating assn Inc.

Kind regards

Dave Pullen
Field Officer
New Zealand Home Heating Assn Inc.
Ph: 03 319 8642

On 27/07/2015, at 10:12 AM, Sarah Drummond <sarah.drummond@ecan.govt.nz> wrote:

Hi Dave

As per our call today are you please able to send me a submission that indicates you wish to make a further submissions support all of the original submission points of the Home Heating Association, summarised in the Summary of Decisions Requested

Regards
Sarah

Sarah Drummond
Planning Officer Hearings
Environment Canterbury

PO Box 345, Christchurch 8140
Customer Services: 0800 324 636
Pollution Hotline: 0800 76 55 88

027 549 7663
sarah.drummond@ecan.govt.nz

From:	Accounts, New Zealand Home Heating Assn Inc.
To:	Mailroom Mailbox
Cc:	Nadeine Dommisse
Subject:	Further Submission pn Proposed Canterbury Air Regional Plan
Date:	Monday, 6 July 2015 1:20:10 p.m.
Attachments:	ATT00001.htm ATT00002.htm Environment Canterbury Submission.pdf ATT00003.htm

As attached.

Dave Pullen
New Zealand Home Heating Assn Inc.
P O Box 6042
Awapuni
Palmerston North 4445
Ph: 03 319 8642

FOR OFFICE USE ONLY

Submitter ID:

File No:

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Further Submission on Proposed Canterbury Air Regional Plan

Form 6: Further Submissions in support of, or in opposition to, submission on a Publicly Notified Proposed Policy Statement or Regional Plan under Clause 8 of Schedule 1 of the Resource Management Act 1991

Return your signed further submission by 5.00pm Friday 10 July 2015 to:

Freepost 1201 Proposed Canterbury Air Regional Plan
Environment Canterbury
P O Box 345
Christchurch 8140

Full Name: GAVIN EDWARDS NEW ZEALAND HOME HEATING ASSN

Phone (Hm):

Organisation*: " " " "

Phone (Wk): 06 354 1696

* the organisation that this further submission is made on behalf of

Postal Address: P O BOX 6042 ANAPUNI PALMERSTON NORTH.

Phone (Cell):

Postcode: 4445

Email: info@homeheat.co.nz

Fax:

Contact name and postal address for service of person making further submission (if different from above):
NZHHA. SECRETARY AS ABOVE

Only certain people can make further submissions. Please tick the option that applies to you:

- [x] I am a person representing a relevant aspect of the public interest; or
- [ ] I am a person who has an interest in the proposal that is greater than the interest the general public has (for example, I am affected by the content of a submission); or
- [ ] I am the local authority for the relevant area.

- [ ] I do not wish to be heard in support of my further submission; or
- [x] I do wish to be heard in support of my further submission; and if so,
- [x] I would be prepared to consider presenting your further submission in a joint case with others making a similar submission at any hearing

Service of your further submission:
Please note: any person making a further submission must **serve a copy of that submission on the original submitter no later than five working days after the submission has been provided to Environment Canterbury.** If you have made a further submission on a number of original submissions, then copies of your further submission will need to be served with each original submitter.

Signature: [signature] pp G. EDWARDS **Date:** 6/7/15

(Signature of person making submission or person authorised to sign on behalf of person making the submission)

Please note:
(1) all information contained in a submission under the Resource Management Act 1991, including names and addresses for service, becomes public information.

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

FOR OFFICE USE ONLY

Submitter ID:

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Postal Address: P O BOX 6042 AWAPUNI PALMERSTON NORTH.

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Signature: [signature] pp G. EDWARDS **Date:** 6/7/15

(Signature of person making submission or person authorised to sign on behalf of person making the submission)

Please note:
(1) all information contained in a submission under the Resource Management Act 1991, including names and addresses for service, becomes public information.

NZHHA
New Zealand Home Heating Association Inc
P O Box 6042, Awapuni, Palmerston North 4445

Submission to Environment Canterbury of the New Zealand Home Heating Assn Inc. Training Programmes

* Process of Training Programmes supplied on flow chart headed Training Requirements.

* Description of Training Programmes:

1) Introductory Course is for everyone in the industry including building inspectors. It is a 71 page document covering the following:-

   Section 1: Environmental and health impacts of solid fuel burning for home heating.

   Section 2: Selecting the appliance

   Section 3: Installation

   Section 4: Operation of solid fuel burning appliance

   Section 5: Maintenance

   This course covers one day with multiple choice questions throughout the day. There is a condensed version taking 4 hours for building inspectors

2) Solid Fuel Appliance Installation Technician (SFAIT). The Training Manual for installers (231 pages) covers the subjects, as per attached list Pages 1 to 4.
   90% of Sections 2 and 3 were written and supplied by the Ministry for the Environment.
   This is a one day course for installers only with written questions provided before the start of the course. The installer is then audited (copy of audit sheet attached) before obtaining his/her certificate.

Builders do not cover solid fuel appliance installations in their training and plumbers cover it in two pages, only in the correspondence section of their training.

NZHHA Registered Installers are kept up to date with changes in the industry or building codes by emailed newsletters, which are sent out as required. Also, all registered installers have to re-sit the SFAIT course every two years and it is at this course where many discussions take place on changes in the industry or building codes.

In both programmes, there is a great emphasis put on the correct construction of a flue system, so that the solid fuel appliance will run with a clean hot fire. It is because of this, that Section 4.9.1 was added to AS/NZS 2918:2001 and also added to our own training manuals.

In the SFAIT Training Manual there is a whole section that covers flue systems from Page 122 to Page 133, along with Troubleshooting questions and solutions on Pages 209 to 211. These sections are included with this submission.

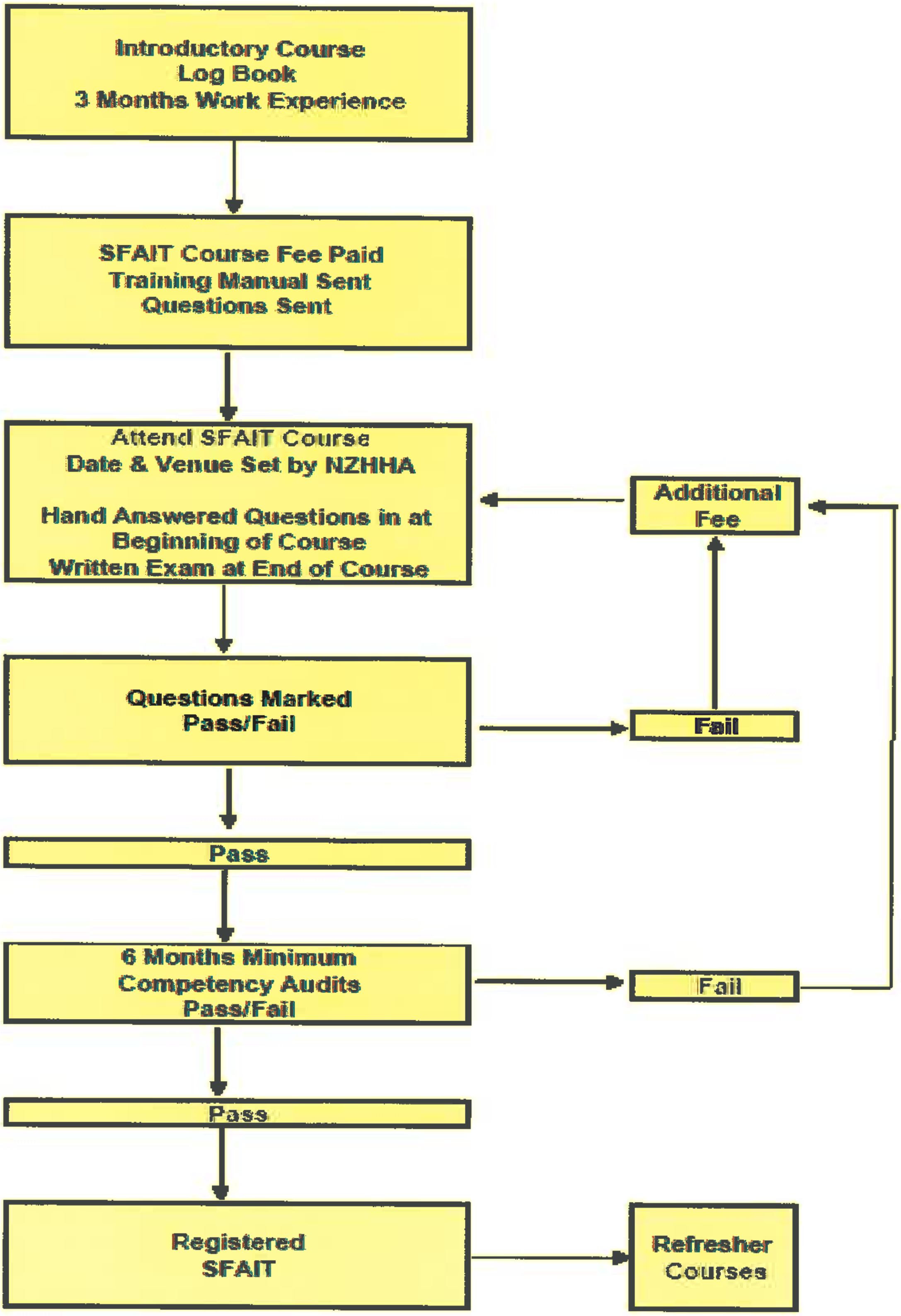
NZHHA installers understand these sections so that a solid fuel appliance will burn clean and hot and so that the most potential out of the woodfire and wood fuel is obtained.

NZHHA's first obligation to the public is that its installers will install the solid fuel appliance so that it is a safe appliance for the home and will not cause any unfriendly fires. The Association's second obligation is to ensure that the fire will produce clean, hot heat to keep the home warm and dry and the environment clean.

Regards

Gavin Edwards
President of NZHHA

Training Requirements



NZHHA
New Zealand Home Heating Association Inc
www.nzhha.co.nz

2011

AUDIT OF SOLID FUEL HEATING APPLIANCE

Make & Model of Product: ______________________________
Name and address of client: ______________________________
____

Contact details: ______________________________

Table A: Compliance Failure	Risk	Points
1. Unsafe – not installed to manufacturer's instructions	High (safety-relevant)	100
2. Other safety-relevant compliance failure. e.g. Flue system incorrect.	High (safety-relevant)	100
3. Failed on up to 10% of Checklist	High (safety-relevant)	80
4. Shielding not used when required on internal flue system or walls.	High (safety-relevant)	80
5. Floor protector incorrect including seismic restraint	High (safety-relevant)	80
6. Work carried out without required Building Consent	High	80
7. The overall quality of an installation is so poor that it undermines the purpose, performance or durability of the installation, although safe to use.	High	80
8. No initial assessment carried out prior to installation	Medium	40
9. Post-installation check does not meet the requirements set out in manufacturer's manual.	Medium	40
10. Notified compliance failure (other than a high-risk compliance failure) not remedied within 20 working days	Medium	40
11. Heater not sized correctly for primary living area	Medium	40
12. Product not covered under agreement between service provider and Council	Medium	20
13. Debris not removed	Low	5

A service provider's risk status is determined by the service provider's average audit score. *Table B: Average audit score and risk status* below sets out how a service provider's average audit score translates into the service provider's risk status.

Installer Name: ______________________ NZHHA Registration No. ________

Does Registration number comply with NZHHA records **Yes/No**

Table B: Average audit score and risk status

	Risk status
76-100+	High
40-75	Medium
0-39	Low

Auditor: ______________________ **Signed:** ______________________ **Date:** ______

TABLE OF CONTENTS

14. FLUE SYSTEMS

14.1 Function of a Flue System

A flue system has two important functions

(a) To provide a *safe* means for the combustion products to exit the building
(b) To provide '*draft*' so air is drawn into the fire box

Manufacturers of woodburners either provide a flue system (flue kit) to be installed with their appliance or specify the design of the flue system required for installation. If a flue system or specific design is not provided AS/NZS 2918:2001 provides the means for determining the requirements for the correct and safe installation of wood burners.

Flue systems are divided into 3 types

(a) Freestanding
(b) Chimney, insert or masonry liner
(c) Built-in or zero clearance

Freestanding Flue systems may be either tested or untested.

(i) Untested flue systems must conform to the material, air ventilation and clearance requirements of AS/NZS 2918:2001

(ii) Tested flue systems have been tested to and passed the requirements of AS/NZS 2918:2001, Appendix F. For a Tested Flue system to be installed in accordance with AS/NZS 2918:2001 the flue system must also be tested with the model of woodburner it is being installed on and passed the requirements of AS/NZS 2918:2001, Appendix B

A flue system is comprised of a number of components including flue pipes, casings, spacers, ceiling plate, casing cover and cowl. Tested flue systems are usually supplied as a packaged unit, a flue kit. The flue kit shall contain a set of installation instructions. For the installation to meet the requirements of AS/NZS 2918:2001 the installation instructions supplied by the manufacturer must be strictly adhered to. Additional componentry may be required for complex installations or to meet flue height and external requirements.

Bends offsets and extensions to the length of a flue system are allowed. However a tested flue system altered in any way from, or not installed according to the manufacturer's specifications, is considered to be an untested flue system.

14.2 Flue System Assembly

Both single and double casing flue systems require spacers to be fitted between the casings to ensure that an equal spacing is provided between the flue pipe and casing. It is important that any spacers do not restrict air-flow within the casings. Allowance shall be made for expansion of stainless steel flue. Flue systems are designed to be assembled so that the smaller, tapered or crimped swaged end of the flue pipe faces down towards the woodburner. This is essential to ensure that any creosote or condensation does not leak from the flue pipe joints.

All flue pipe sections must be secured with a minimum of 3 fixings equally spaced, using stainless steel or monel rivets or screws. A minimum of 3 screws or rivets must be used as 2 fixings can result in a hinge effect. Flue pipe joints should be sealed with fire cement to prevent loss of draught in the flue system.

Vitreous enamelled flue pipes must only be used where they are visible and can be inspected for damage or deterioration. Vitreous enamelled flue pipe must not be used for insert or built-in woodburners.

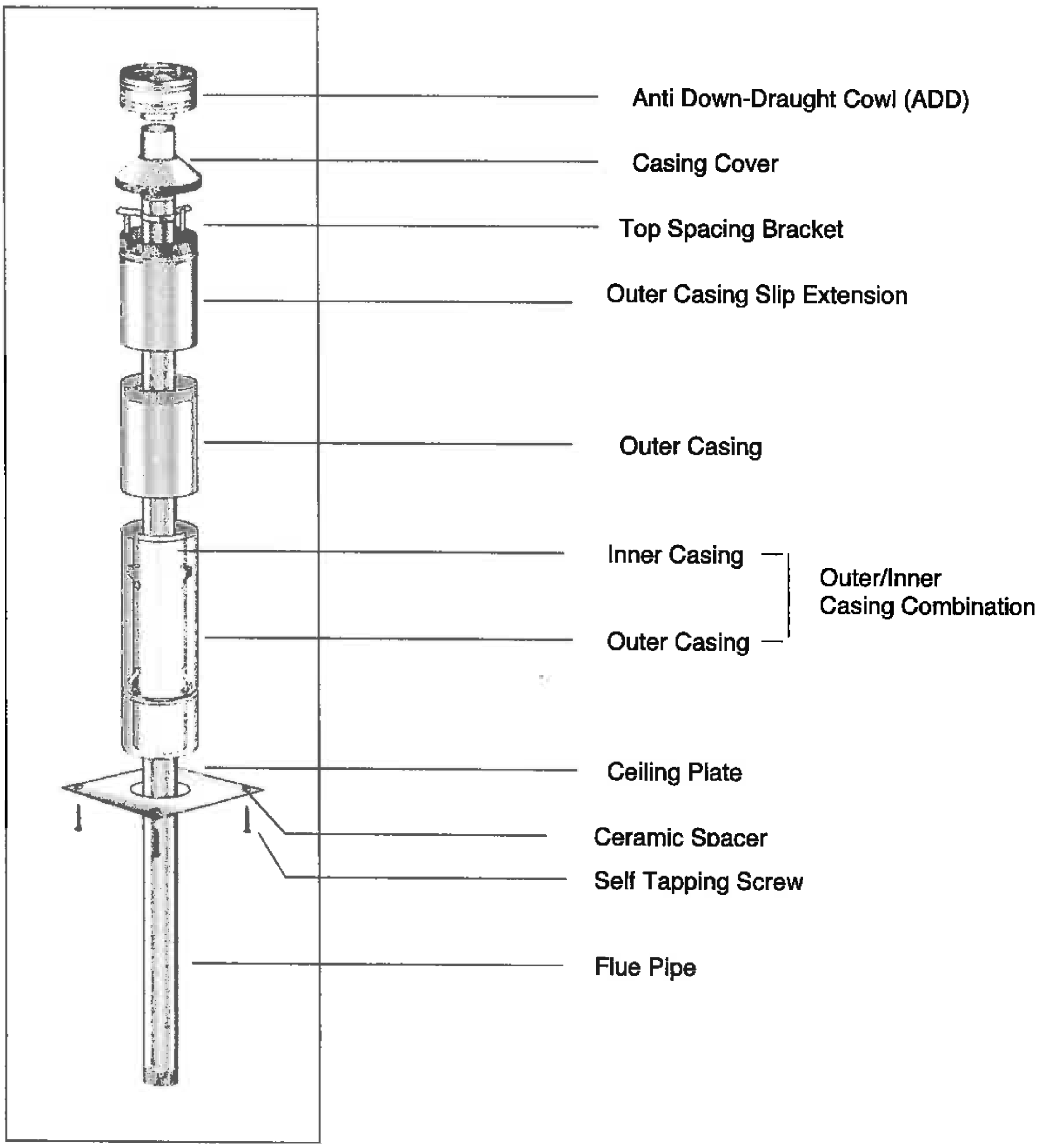
14.3 Flue System Diameter and Height

Flue System Diameter

Reducing or enlarging the flue pipe size from that of the woodburners flue collar opening may cause operating problems. Reducing the flue pipe size can reduce draught and affect combustion or cause down-drafting and smoke spillage when the woodburners door is opened. Increasing flue pipe diameter will tend to slow down the exhaust gas flow, reduce flue temperature and increase creosote formation. Cross-sectional area of flue systems is specified in AS/NZS 2918:2001 Section 4.2.

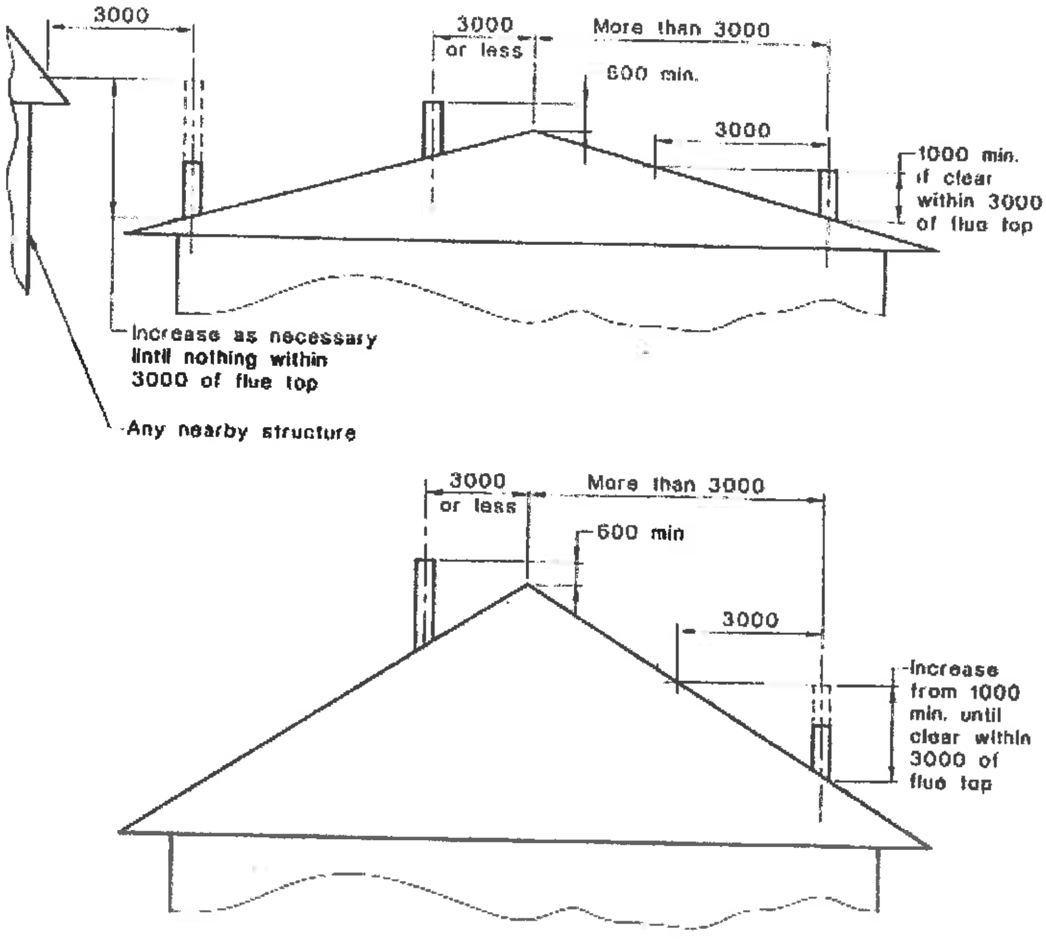
Flue System Height

Flue System height is critical to the performance of the woodburner. If a flue system is installed according to AS/NZS 2918:2001 down-draft and smoke spillage problems due to lack of draft or windy conditions are reduced. Minimum flue system height and roof penetration requirements are specified in AS/NZS 2918:2001 Section 4.9.


Anti Down-Draught Cowl (ADD)
Casing Cover
Top Spacing Bracket
Outer Casing Slip Extension
Outer Casing
Inner Casing
Outer Casing
Outer/Inner Casing Combination
Ceiling Plate
Ceramic Spacer
Self Tapping Screw
Flue Pipe

AS/NZS2918:2001 specifies the following requirements:-

- Flue system exiting roof within 3m of ridgeline – not less than 0.6m above ridgeline.
- Flue system existing roof more than 3m from ridgeline – not less than 1m above roof penetration.



DIMENSIONS IN MILLIMETRES

FIGURE 4.9 MINIMUM HEIGHT OF FLUE SYSTEM EXIT

Additional information on flue systems is given in the following extract from AS/NZS2918:2001:-

14.4 External Requirements

The products of combustion shall discharge not less than 12mm and not more than one flue pipe diameter beyond the end of the flue-pipe casing. The flue exit and the end of the flue-pipe casing shall both be fitted with the means to prevent significant ingress of water and debris, and such means shall be constructed and fitted so as not to significantly obstruct the flue discharge and convection ventilation of the flue-pipe casing, where required.

The flue exit shall be located outside the building (see Figure 4.9) in which the appliance is installed so that –

(a) the flue pipe shall extend not less than 4.6m above the top of the floor protector;
(b) the minimum height of the flue system within 3m distance from the highest point of the roof shall be 600mm above that point;
(c) the minimum height of a flue system further than 3m from the highest point of the roof shall be 1000mm above roof penetration;
(d) no part of any building lies in or above a circular area described by a horizontal radius of 3m about the flue system exit;
(e) termination of the flue system does not constitute a risk of fire to heat-sensitive materials; and
(f) there is no foreseen risk of penetration of the flue gases through nearby windows or other openings, fresh air inlets, mechanical ventilation inlets or exhausts, or the like.

Note – Where a flue pipe terminates in a region of high pressure relative to the combustion air inlet of the appliance, products of combustion may enter the building instead of being exhausted outside. This is known as a down-draught. The products of combustion may contain carbon monoxide, carbon dioxide, unburnt hydrocarbons and water vapour. A down-draught condition must always be corrected as these products of combustion may otherwise build up to concentrations which may be hazardous to health.

Common causes of down-draught are:-

(a) Termination of the flue in a high pressure zone such as on the downstream side of a nearby obstruction to airflow (e.g. trees, hills, adjacent buildings or part of the building where the appliance is installed).
(b) Generation of negative pressures within the building caused by air exhaust systems, air conditioning systems and window openings on the side of the building away from the wind direction.
(c) Overcooling of the flue system caused for example by the exposure of the fire system to cold outside air or use of too large a flue system.

Down-draughts commonly become apparent in low fire conditions and are often affected by the wind direction at the time. Spillage into the building may also occur for other reasons (e.g. use of too small a flue system or lack of a sufficient combustion air supply to the appliance due to the air tightness of the building). Momentary puffs of spillage may also occur during reloading an appliance or when fuel loading doors are opened too rapidly, however this is not normally of concern.

Typical methods for correcting down-draught conditions include:-

(i) Ensuring that the flue system is sized correctly for the appliance.

(ii) Extending the flue into a region of undisturbed airflow. This is the most important and successful corrective measure.

(iii) Providing an outside source of combustion air to the appliance.

(iv) Ensuring the flue is not being overcooled.

(v) Removing any causes of negative pressure within the building.

(vi) Fitting a suitable cowling.

Where a flue system is extended high above the roof line, it is important to ensure that the flue pipe is adequately cased to the top to prevent over cooling of the flue pipe that may cause condensation, creosote build-up and a poor draught. Care must also be taken so as not to obstruct or restrict cooling air from reaching the casings below roof level.

Flue Sealants

Manufacturers may require the sealing of all flue pipe joints including the joint between the flue pipe and the stub on the top or rear of the appliance. Poor appliance performance can result when the flue pipe is not airtight.

Refer AS/NZS2918:2001 - Section 4 Flue System Installation – Pages 23-37

14.5 Draft Fundamentals

Flue systems are just as important as appliances for successful heating with solid fuels. If an appliance lets smoke into the room, an inadequate flue system is the most likely reason. If an appliance is not producing enough heat, the problem could be inadequate draft from the flue system. Creosote problems are not exclusively related to flue design but can be lessened by a well designed flue system. Heating efficiency is affected by flue location and type.

A flue pipe carries the undesirable combustion products (smoke and so on) out of the house and supplies the draft necessary to feed air to the fire. The force necessary for both functions comes from the tendency of hot air to rise, an effect called ***buoyancy.*** The air flow up a flue is restrained by resistance from flue walls, bends, dampers and the appliance itself. It is the balancing of buoyancy and flow resistance that determines the smoke velocity in a flue pipe.

Because of the buoyancy effect of the hot gases, air pressure outside the appliance is greater than air pressure inside the appliance. If the air inlets of an appliance are open, or if there are any cracks or holes in the appliances, air will be pushed (or drawn) in. The term used to describe and quantify this effect is ***draft.***
Draft is a measure of the force making gases flow. At a place where the draft is high, air will be drawn hard into any opening but if the opening is small, not much air will get in. Thus, draft and actual air or flue-gas are not the same.

14.5.1 Measuring Draft

A common device used to measure draft is a transparent U-shaped tube partly filled with water. One end is left open and "senses" the pressure of the atmosphere outside the flue or appliance. The other end is connected to a metal tube that is inserted into the flue or appliance perpendicular to the flow; it senses the pressure inside the flue. If there is some draft, the pressures are unequal, as indicated by a difference of level of water on the 2 sides of the U-tube. In America, the common unit used to measure draft is "inches of water", referring directly to this height difference. Drafts in residential flues are usually between .01 and .15 inches. Because this difference in water level is too small to be seen easily in a U-tube, many draft gauges use different geometries to amplify the visual effect or use different principles entirely.

The draft is zero at the top of the flue; the pressure of flue gases as they emerge essentially equals that of the surrounding air. The draft is usually highest at the bottom of the flue or in the stove pipe connector. If there is some draft (suction) everywhere in the system, no smoke can leak into the house even if there are cracks; air will be pulled into the cracks rather than smoke pushed out. This is usually the case in solid fuel appliance systems.

14.5.2 Flue Height

To estimate drafts and capacities of venting systems, flue heights are measured from the flue collar on the appliance to the flue top. Vertical sections of the appliance pipe connector contain buoyant gases just as does a flue so they also contribute to flue capacity.

Increasing flue height improves flow capacity but not in direct proportion to the change in height. If all other things remained unchanged, a doubling of flue height would result in a 41% increase in capacity; a 10% height increase would improve performance by 5% (flue flow is proportional to the square root of its height, other things being equal).

Other variables do change with height alterations. The higher the flue, the more the flue gases cool before emerging from the top which has a negative effect on flue capacity. There is always an improvement in flue capacity with increased height but the amount of improvement is diminished if heat is conducted out through the flue walls. Insulated flues benefit the most from height increases.

In practice, height is determined by the need to end the flue above wind pressure influences and by architectural considerations. In mobile homes and other flat roofed, single story structures, flue heights are often only 3 metres (measured from the fluepipe collar to the flue top) and they usually work well. For such short flues, adding a metre to the height can make a noticeable improvement. But for more typical installations, where the venting system height is 8-10 metres, adding another metre or so is not likely to solve calm weather draft problems.

14.5.3 Flue Diameter

Flue diameter affects the flow capacity more than flue height. Assuming the whole venting system (flue and flue connector) is of the same diameter, the capacity of the system is approximately proportional to its cross sectional area (the proportionality is not exact since heat loss through flue walls and the resistance to flow also are affected by flue diameter).

In practice, it is usually safe to take the recommendations made by the appliance manufacturer concerning minimum flue diameter. Lacking explicit instructions, a flue of the same size as the flue collar on the appliance is usually adequate. Substantially larger flues are ***not*** desirable.

14.5.4 Flow Resistance

Do the number of elbows and the length of flue pipe affect flue performance? Yes.
Building codes usually require appliances to be located close to their flues. Some codes specify no more than two 90° elbows in the connector. Some metal appliance manufacturers specify no more than four 30° elbows. But, in practice, many appliances have been used successfully with very long flue pipe connectors and more than two 90° elbows.

Such long and complex additions to normal venting systems are not recommended but they will work if the original system has sufficient excess capacity. This is usually the case with closed appliances such as stoves, furnaces and boilers; it is usually ***not*** the case with open appliances such as fireplaces and fireplace appliances. The air inlet on closed burners offers so much more resistance to flow than does any other part of the system that a few more flue pipe lengths or elbows are just not very important to the performance of the whole system. On the other hand, in open appliances, most of the resistance to flow is due to the venting system itself – since the appliance is open, it offers little flow resistance. In this case, extra elbows, extra lengths of horizontal flue pipe or, in some cases, even a flue cap can be disastrous – smoke will spill out of the appliance into the house because it does not all get out through the flue pipe and flue.

Long lengths of flue pipe inside a building increase the heating efficiency of the system but on balance, they are not recommended. Although flue pipe is not inherently unsafe, the sloppy way in which it is often installed and maintained results in a serious hazard. In addition, such installations usually result in very high rates of creosote accumulation.

14.5.5 Excess Capacity

Too large a flue results in excess capacity, which means less draft and more creosote. The larger the flue, the more flue surface area there is through which the flue gases will lose heat, and the slower the flue gases will rise, allowing more time for heat to be lost. Cooler temperatures mean less draft and more creosote accumulation.

Excess capacity occurs most often when a large appliance flue is used for an insert or a wood burner. If the flue runs up the outside of the house, the cooling of the smoke is even greater. In extreme cases, cold outdoor air can descend down the flue from the top at the same time smoke is rising. To avoid the problems of excess capacity, do not use a flue with a cross-sectional area greater than twice the area of the flue collar on the appliance.

14.5.6 House Flue Interactions

Many draft and smoking problems are not due to inadequate flues. Tight houses can restrict the air supply to the appliance, other appliances can depressurise the house, and the "stack effect" of the house itself can compete with the draft of the flue.

What happens if a house is ***too*** air tight? The effects depend on the type of appliance. For a closed appliance, such as a wood burner, furnace or boiler, the consequences may be annoying but are rarely dangerous. When less air enters a wood burner, the fire is less intense and so the heat output is less. But smoke may spill out of an open appliance such as a fireplace or wood burner. A minimum flow of air, about 250mm per second averaged over the opening, is needed to keep the smoke eddies inside the combustion chamber.

All houses have some air leakage both into and out of the structure, even with all doors and windows closed. Much of this occurs around doors and windows. A certain amount of this ***air exchange*** or infiltration plus "exfiltration" is necessary to keep the humidity from getting too high. Typical air exchange rates are from ½ to 2 air changes per hour, although in extremely tight houses, the rate can be as low as ¼ air change per hour.

In homes with typical natural air leakage, only open appliances are likely to run short of air. Typically, ***closed*** appliances need roughly 10% of the air that is naturally entering and leaving the house anyway; but ***fireplaces*** may need more air than the house can provide.

This air shortage is most likely to occur in electrically heated houses, energy conservative houses, mobile homes and earth sheltered (partly underground) houses. Opening a window, decreasing the area of the fireplace opening and ducting outdoor air to the fireplace may make it possible to use open appliances in houses that are too tight. In very tight houses, or even in closed rooms, even closed appliances may perform better with outside air.

Another reason for poor draft can be the slight depressurization of a house caused by other appliances. Kitchen and bathroom exhaust fans are common culprits. Perhaps more important in practice are other vented fuel burning appliances such as central heaters and other solid fuel appliances. For instance, in many houses with more than one fireplace, only one can be used at a time. Even then, air is pulled down the unused flue, bringing with it creosote odors and sometimes even smoke from the other fireplace flue. A strong draft in one large flue literally sucks on the house, making it harder for any other flue to operate properly. The suction can be enough to pull outdoor air down any unused (cool) flue to cause smoke to spill into the house from operating open appliances, to result in sluggish operation of closed appliances and to cause poor combustion and fume spillage in gas burning and oil burning equipment. The only practical solution is to supply outdoor air to one or more of the larger appliances.

Sometimes the house itself acts somewhat like a flue. On a cold day, the warm air inside the house is relatively buoyant. The warm air pushes out any available cracks in the upper portions of the building and cold outdoor air is sucked in through openings in the lower portions of the building. In very tall buildings, the resulting wind coming into open street level doors can be very fierce unless special countermeasures are taken.

But the more important effect on flue performance is the slight changes in house pressure caused by this buoyant house air. If the house has more cracks in its upper portions than near ground level, warm air can get out more easily than cold air can get in and the result is a slight depressurization of the whole house. Lower pressures inside the house mean less tendency for air and smoke to go up the flue. In essence the house itself is acting like a competitive flue. In fact, building engineers call this pressure effect in buildings the ***stack effect.*** In a two story or three story house, the effect can be as large as 1 inch of water.

At the opposite extreme is a house that is predominantly leaky in its lower portions as would be the case with a ground level door open. Since cold air can then move in more easily than the warm air can get out, pressure at the bottom of the house tends to equalize with the outdoor pressure at ground level. This pressurisation encourages the flow of smoke up the flue.

When the stack effect of the building is working against the flue's own draft, not only is the flue's draft generally decreased but the flow in the flue can even reverse! This is most likely with an exterior flue starting on the ground floor of a multistory house. Exterior flues run cooler so the smoke is less buoyant. A multistory house has a stronger stack effect. If the average temperature of the smoke in the flue is less than the average temperature of the air in the house, the flow is likely to reverse. Cold air descends down the flue, feeds the fire and all the smoke comes into the house through the air inlet of the appliance.

Since a contributing cause of flow reversal is cool smoke in the flue, flues with high heat loss contribute to the problem as does operating the appliance at a low firing rate (often done overnight with wood burners). Also colder outdoor temperatures make reversal more likely.

Correcting reverse flow in a flue can be difficult. The first thing to do ***any*** time smoke is spilling into the house from a wood burning appliance is to open a door or window on the ground floor and on the upwind side of the house if it is windy and ***close*** all other openings. This maximizes the pressure in the house which may by itself, correct the situation. If a window fan is available, use it to force outside air into the room; close all other windows and all doors, both exterior and interior. The resulting pressurization of the room will almost certainly correct the flue's reverse flow. Directing a strong portable fan at the air inlet or into the open combustion chamber is ***not likely*** to help and can cause sparks to be blown into the room. In flues with easily accessible cleanout doors or unused breachings, it sometimes helps to insert some newspaper inside the flue and light it; the additional warmth increases the buoyance enough to get the flue operating properly.

Interior flue systems are rarely susceptible to flow reversal because their warmer environment keeps the smoke at least as warm as the house air temperature.
You can test a flue for its flow-reversing tendency before actually using it. On a very cold calm day when the flue has not been in use for a day or two, susceptible flues are likely to have cold outdoor air descending and entering the house. If the air flow is not obvious by its force, temperature or its flue odour, you can use cigarette or incense smoke or tissue paper, or tinsel to see which way the air is moving. Flues that run backwards when cold are called ***non-self-starting.*** The non-self-starting problem itself is traditionally solved by lighting newspaper stuck up into the flue.

Non-self-starting is only an annoyance. But flow reversal is dangerous because it can lead to asphyxiation. It is best not to use such flues, especially for airtight wood burners and inserts. If such flues are used, smoke detectors in the house are essential.

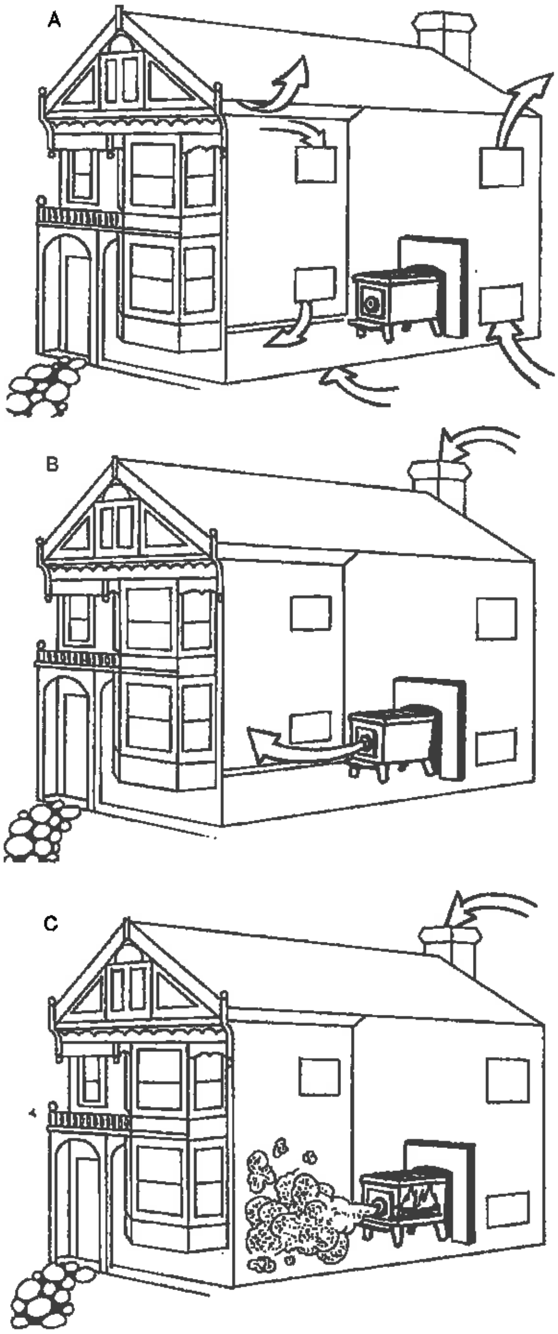


Figure 6-5. Exterior chimneys in multistory houses often have poor draft. A: The normal air flow into and out of a house on a calm winter day. The air tends to be drawn into the house on the ground floor. B: As a result, many exterior chimneys are non-self-starting; air flows down the chimney when it is cold. C: Even when the chimney is in use, smoke can become sufficiently cool that flow reversal occurs.

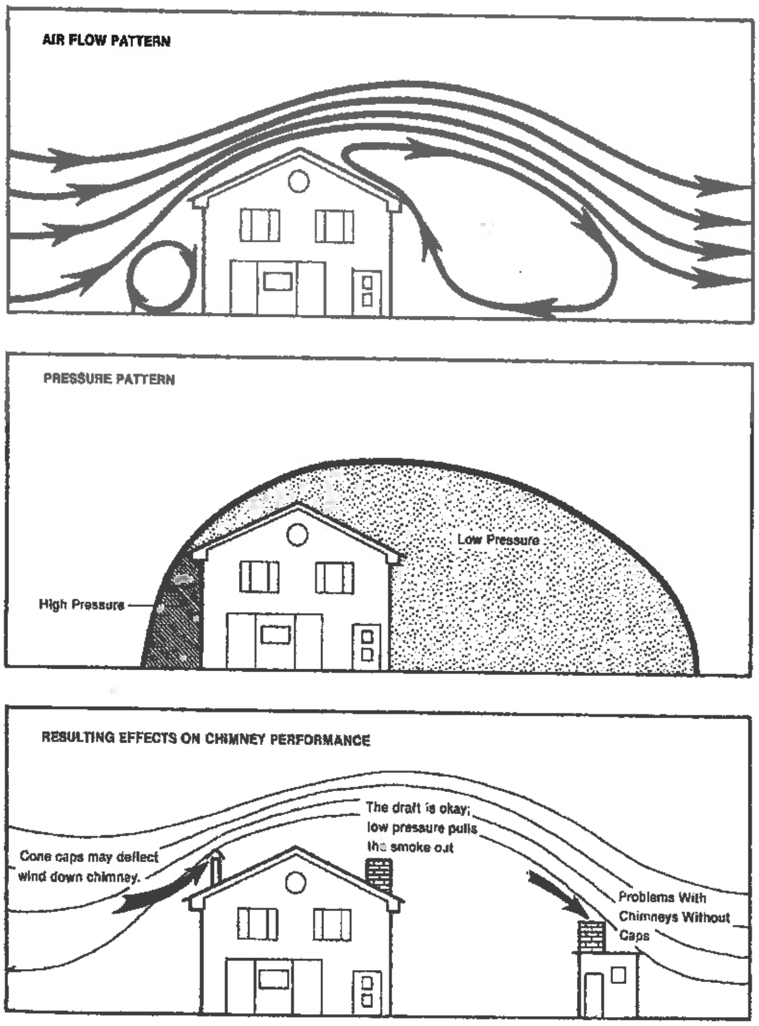


Figure 6-6. Typical wind effects around a building. Similar patterns are caused by trees and hills.

14.5.7 Weather and Altitude

Windy weather can affect flue performance adversely by reducing or even reversing the flue gas – making the fireplace or wood burner smoke. Properly locating the flue top relative to the roof can alleviate some of the problem and flue caps can be very effective.

There are three kinds of wind effects. If the wind direction is into an opening through which smoke is trying to come out, the smoke flow is impeded. For example, a low, open (uncapped) flue at certain locations downwind of a building may not perform well if the wind blows too hard. This first effect is caused by what is called the "velocity pressure" of the wind.

There are two ways to alleviate this problem. If the flue extends high enough, the wind generally will blow across it, not into it. This is one reason why it is usually recommended that the flue top be 600mm higher than any portion of the roof within 3 metres of it and 1 metre higher than the roof area through which it penetrates. The other reason is to prevent hot flue gases or sparks from igniting the roof.

Installing a flue cap is the other way to alleviate this wind back-pressure effect. Wind caps make the calm weather smoke discharge multi-directional. Then, with wind blowing from any direction, some smoke can still always get out on the other side. A flat plate is a common and simple wind cap for masonry flues. Many kinds of metal caps are used especially on metal flues. Flue caps that rotate or have moving parts are sometimes unsatisfactory for use with wood fire – creosote deposits can foul up the caps to the point where they become stuck.

A second wind effect always helps flue performance. Air exerts what is called ***static pressure*** which, in still air, is the same as atmospheric pressure. But in moving air, the static pressure is less. In principle, a barometer in moving air would read a lower pressure than in nearby still air. Thus, if a flue top is in a region of strong winds, the general (static) pressure level all around it is reduced. This effectively applies suction on the gases in the flue and so it draws better – the wind aspirates smoke from the flue. The stronger the wind, the larger is the effect. This effect is in addition to the velocity pressure effect previously discussed.

A third effect, related to the viscosity of the air and its turbulent motion, is the creation of a large low pressure eddy region on the downward side of a house (and a much smaller high pressure region on the upwind side). A flue terminating in this low pressure region performs better since the low air pressure tends to suck the smoke out.

When all the effects are combined and if the flue has a good cap, winds usually do not cause serious problems. For wind velocities up to the flue-gas velocity, there is very little effect. For wind speeds 1-3 times the flue-gas velocity, there is a slight reduction in flue flow. At wind speeds greater than about 3 times the flue-gas velocity, flue performance is better than in still air.

With an effective flue cap, wind speeds between roughly 8 km and 32 km per hour may cause a slight decrease in flue capacity. Slower winds will have little effect and faster winds will often improve performance. Gusty winds can cause slight smoke spillage into a house with any kind of flue and cap but less with taller flues. Wind can change the pressure inside a house which then affects flue performance. If the house has some open windows or doors on the side facing into the wind, the house pressure increases, which helps the flue; openings on the downwind side decrease the pressure inside the house, hurting flue performance. A temporary solution to a badly smoking appliance or fireplace on a windy day is to open a downstairs window or two on the upwind side of the house.

Outdoor temperature can affect flue performance because the draft depends on the difference between the flue-gas temperature and outdoor temperature. The colder the weather, the better the draft in interior flues. As the temperature drops, from 10°C to -20°C, flue capacity can double. Exterior flues also perform better in cold weather if their insulating value is high enough and if the flue-gas temperature and flow rate is high enough to prevent excessive cooling of the smoke.

Barometric pressure also has a small effect on flue capacity. When the pressure is high, the combustion air and the flue gases are a little more dense, so more smoke can get through the flue. An increase in pressure of 1 inch of mercury increases flue capacity by about 4%. Typical variations in barometric pressure span no more than 2 inches of mercury, which causes an 8% change in flue capacity.

It is unlikely that humidity in the air has an effect on appliance performance. Even when the relative humidity is 100%, water vapor can never constitute more than 1.5% of air by weight, so changes in humidity can affect the composition of air by only this small amount. The maximum effect of humidity on the oxygen content, density, thermal conductivity and specific heat in air, is less than 1.5% which is negligible.

None of these weather effects is very big by itself, but they frequently act together. When barometric pressure is high in the winter, the weather is often cold and calm; when the pressure drops, the weather is often windy and not as cold. Adding all the effects together suggests that weather can affect flue capacity by as much as 20%, the higher capacity often coinciding with high barometric pressure, making it easier to have hotter fires.

Weather effects will be most noticeable in systems that are marginal to begin with. In many cases, there is enough excess flue capacity that these weather effects will never be noticed.

Altitude also affects flue performance. The thinner air at high altitudes decreases flue capacity, the same as low barometric pressure. For every 330 metres of elevation above sea level, flue capacity is decreased by about 4% relative to the same flue at sea level. At 1,650 metres, a flue would have to be designed with 20% extra capacity compared to a flue at sea level serving the same appliance. At 3,300 metres, the effect is bout 40%-50%.

Although elevation effect is much larger than the barometric pressure effect, it is usually of little practical consequence for solid fuel appliances because flues usually have generous excess capacity. Also, the thinner air at high altitudes can mean less oxygen gets to the fire; if the fire is not as intense, the flue need not have as much capacity.

14.6 Safety Fundamentals

Flues are frequently implicated in wood-heating-related house fires, but exact causes are often difficult to determine. Certainly, improper installation and, in particular, inadequate clearance between a flue and combustible parts of houses are common causes. In dry climates, sparks coming out of flue tops can start fires. Some flues are unsafe due to improper construction or manufacture. Flues must be able to safely endure flue fires – the burning of accumulated creosote deposits inside the flue.

Regardless of the quality of the flue, flue fires are always potentially dangerous. Flues must have convenient access for inspection and cleaning of creosote. Flue pipe has very little insulation value. As a result, the exterior can get very hot, which is why most building codes require 450mm of clearance to combustible materials, an inconveniently large clearance for a flue. Also, the flue gases can get quite cool, resulting in decreased draft and the possibility of very rapid creosote accumulation. Flue pipe is relatively flimsy. Such thin gauge ordinary steel can rust out in a matter of months, particularly when used outdoors.

There are two basic traditional types of potentially safe flues for solid fuel burning appliances: prefabricated (also called factory built) metal flues and masonry flues. The phase "potentially safe" is used because flue safety also depends on proper construction and installation, proper maintenance and non-abusive use of the flue.

1.I can't get a good fire going – what am I doing wrong?

Diagnostic Questions	**Possible Causes of Condition**	**Solutions**
Is the damper open? ***WS***: Are the air controls open?	No draft No combustion air	Open damper ***WS***: Open air controls
Is there enough paper/starter?	Insufficient heat to ignite kindling	Use more paper/starter
Is there enough kindling? Is the kindling dry?	Insufficient heat to ignite fuel	Use more dry kindling
Is there enough or too much wood? Is it too large? Is it dry enough?	Insufficient heat to establish draft. Insufficient air passage. Insufficient surface area. Ignition temperature high due to moisture.	Use small split wood that is well seasoned (split, covered on top at least 6 months, preferably a year).
Are there adequate air spaces between fuel pieces?	Insufficient combustion air and exposed surface area.	Arrange kindling and wood for air movement.
Is the chimney pre-warmed?	Exposed cold chimney downdrafting	Use lighted rolled newspaper at throat or flue opening to start upward movement
Is there smoke in the house?	Damper closed. Obstruction in chimney. Downdraft from chimney temperature or from negative house pressure.	Check damper; have chimney checked if it worked previously; pre-warm chimney, shut off exhaust devices, open window slightly. Perform Simplified House Pressure Test.
Does the kindling, wood not ignite?	Condition, amount, arrangement of kindling and fuel.	Use more, drier, well-spaced kindling and fuel.
Does the kindling ignite but the fuel doesn't?	Amount of kindling. Condition of fuel.	Use more kindling; use smaller dry wood.
Does the fuel ignite but not burn well?	Condition of fuel Draft problem	Use well-seasoned wood and sufficient amount; turn exhaust fans off; open window slightly. Perform Simplified House Pressure Test.

2. I smell smoke in the house during operation – What's causing that?

Diagnostic Questions	Possible Causes	Solutions
Do fires start and burn well?	**No:** Damper not fully open. Chimney obstruction Not enough kindling and/or fuel to establish draft. Inadequate combustion air ***WS:*** Air controls open **Yes:** ***FP***: Fire too close to front. Competition with exhaust devices.	**No:** Open damper; check and clean chimney if needed; use adequate kindling and fuel; open air controls on glass doors or open window, check for need for balanced air make-up. ***WS***: open air controls. **Yes:** ***FP***: Build fire further back. Do not use exhaust fans during start-up and/or check for need for balanced air make-up system.

3. I smell smoke in the house after we've had a fire. What is the cause/what can we do?

Diagnostic Questions	Possible Causes	Solutions
Is the damper closed?	**No:** Downdraft or negative pressure. **Yes:** Negative pressure from exhaust fans and/or house stack effect.	**No:** Close damper at end of burn. **Yes:** ***FP***: Check for need for glass doors. Check for need for balanced air make-up system or raising chimney.
Is the chimney clean?	**No:** Creosote odour. **Yes:** ***FP***: Damper closed too early.	**No:** Close damper at end of burn. **Yes:** ***FP***: Wait until fire completely out before closing damper.

4. I don't get enough/any heat from the fireplace/woodstove. What can I do about it?

Diagnostic Questions	Possible Causes	Solutions
How much wood is used for fire?	Insufficient fuel.	Make larger fires.
How well seasoned is the wood?	Condition of fuel.	Burn seasoned wood: covered on top, split and stacked for 9 months to 2 years.
Do you have a blower (where possible)?	**Yes:** Turning blower on too early or setting too high, cooling firebox. **No:** Need for all heat boosts possible.	**Yes:** Wait until fire established and leave on lower speed. **No:** Add blower if available.
How much heat output do you expect?	Unrealistic expectations.	Explanation of decorative nature of fireplace; suggestion of approved fireplace insert.
WS: How are air controls and dampers set?	***WS***: Operational problems.	***WS***: Follow manufacturer's instructions. Use thermometer for damper and air control operation.
WS: What is the condition of the catalytic combustor?	***WS***: Combustor clogged, damaged or inoperative.	***WS***: Check condition of combustor: clean if possible; replace if necessary.

5. The Fireplace/Woodstove burns the wood too fast. What can I do?

Diagnostic Questions	Possible Causes	Solutions
FP: Do you have glass doors?	***FP***: Need to slow air intake.	***FP***: Add glass doors; use air controls on glass doors.
What is the condition of wood?	Extremely dry wood.	Mix in les seasoned wood after fire established.
WS: What are damper and air control settings?	Operational problems.	Follow manufacturer's instructions; use thermometer for damper and air control operation.