CFM

CFM SPECIALTY HOME PRODUCTS

a division of CFM Corporation

HOME

Depressurization and Windloading

We recommend that our products be installed and serviced by professionals who are certified in the U.S. by NFI (National Fireplace Institute) or in Canada by WETT (Wood Energy Technical Training).

INTRODUCTION:
Occasionally, users of fireplaces and stoves will complain that they are not achieving a good draw from their pre-engineered fireplace or wood stove. This is usually due to cold air or smoke that is filtering into the living quarters of the home. This can be very frustrating for the homeowner, builder, architect, dealer and the manufacturer since the exact same model may be working extremely well in homes located perhaps next door or down the street.

Wood and gas burning products built by CFM Specialty Home Products are thoroughly tested in our laboratory with some of the most advanced technology equipment available in order to ensure that the product will work with satisfaction for many years. Furthermore, all models tested and listed by nationally recognized agencies such as Underwriters Laboratories (UL) or Warnock Hersey for wood burning products. Gas products are also thoroughly tested with Canadian Standard Association (CSA) . Theses testing agencies require that we meet or exceed the standards of other national codes before they can be commercially marketed. Even with these precautionary measures, issues concerning improper drafting and smoking can occur.

When cold air or smoking becomes an issue, the natural tendencies of the homeowner are to blame the fireplace or stove design or question the installation; nonetheless, the most probable cause is home depressurization.

Since this issue from time to time confronts fireplace and stove professionals, it is important that this phenomenon be addressed so that we can become a valuable resource in order to offer solutions to architects, builders and the end users.

As professionals, we need to be able to identify potential problems before they happen (proactive) and to help those who may be currently experiencing depressurization (reactive). Proactive solutions are always the ideal and we can accomplish this goal if we are able to educate people to recognize any potential architectural factor that may create depressurization.

THE PROBLEM:
Depessurization (negative pressure) is caused by the interaction of air, where small differences in air pressure between indoors and outdoors (pressure differentials) amounting to no more than .0001 atmosphere creates a "stack effect" which is the tendency for air, is to rise whenever it is warmer than the surrounding atmosphere.

The stack effect is the working principle of all chimney systems…. heated flue gasses rise up the chimney or vent into the atmosphere pulling cooler air behind it to fill the void. Therefore, when the air is warmer indoors than outdoors, air tends to flow through the lower part of the structure and out through the upper part. Air turnover is accomplished by infiltration through various openings and in heater and furnace flue pipes. If a person would measure the flow of air inside a typical home, they would be amazed at the amount of movement that occurs even though the condition is not generally noticeable.

Based on the "stack principle", the house itself acts as if it were a short, fat chimney with air moving from the bottom of the structure to the top.

TYPICAL SCENARIO:
Take an example of a typical home with its natural stack effect and add weather proofing which makes a structure even tighter. Next, place vents in the structure for exhaust fans for bathroom and stoves. Add a large attic fan plus flues for venting hot water heater, furnace and fireplace gasses, we now create an opportunity for a great tug-of-war.

During the winter months, the air within the home is generally much warmer and less dense than the outside and, as a result, the cooler outside air seek ways to work into the structure. The easiest link to the interior of the home is generally through chimney flues and other openings connected directly to the inside.

A typical comment comes from the person who states, "I don't seem to get a good draft and when I open my damper, cold air rushes in." In this case you are immediately tipped off to the probable cause of the problem – depressurization. The flue system is simply a conduit through which incoming air is drawn into the home to equalize the pressure.

Depressurization is a contributing factor to back drafting 75% of the time and is the sole cause of back drafting 40% of the time. The greater the exhaust capacity and the tighter the building envelope, the more a house will depressurize.

The combination of forces of exhausting air from the house can be so strong that it is possible for hot flue gasses from the fire in the fireplace or stove to be overpowered resulting in a down draft during or the fire cycle. The competing factors are the exhaust devices located throughout the home which work in concert with the natural draw of the house causing a depressurized environment pulling at the bottom of the chimney, thereby reducing the net chimney draft.

Air is pulled down the chimney where it provides make-up air (replacement air). The cool back drafting air coming down the chimney will not allow all of the hot combustion gasses to rise up the chimney; therefore, chimney drafting is curtailed resulting in the escape of gasses and smoke into the living area.

It doesn't take a lot of activity to create a depressurization effect. For example, a typical gas furnace requires 1,450 cubic feet of air per hour for proper combustion air, another 4,000 cubic feet of air per hour to maintain a draft. All this air has to come from somewhere.

A surprising amount of outdoor air manages to leak into the house by infiltration but the point is infiltrating air can not be depended upon as a reliable source of combustion air. Add to this factor a fireplace or stove that needs combustion air to operate in a properly insulated, airtight home and you quickly realize how a problem can occur.

AIR MOVEMENT:

In most houses, outdoor air replaces the volume of indoor air every 1 or 2 hours. After the energy crisis, people became more concerned with tightening the home with insulation, caulking and weather stripping. As a result, the infiltration rate was reduced by 10% – 30%. Because of better construction techniques combined with a gas furnace that requires outside venting in conjunction with other home exhaust system and the natural draw of the house, the fireplace or stove flue can be made virtually inoperable because of the onrush of incoming air required to fill the void.

Again, when you open the damper on a fireplace or stove and experience a rush of cold air washing over you blowing into the house it is a result of making up for the air requirements inside the house. Some people complain that this rush of air is so intense that it occasionally blow ashes into the room. The point that needs to be clearly communicated is that the fireplace or stove isn't doing anything unusual, air is being drawn into the home because the home is using the air somewhere.

OTHER FACTORS:

So far we have discussed depressurization (negative pressure) being caused by the stack effect of the house, mechanical exhaust systems and high volume users such as a gas fired furnace. Next, we will cover how wind can cause a problem. Figures 1 through 4 show various situations.

Dynamic wind loading is the influence of wind on the internal air pressure of a building. If a window or door is open on the side of a structure other than the windward side, air will be drawn out of the structure and negative indoor pressure will result. Make up air will enter the house via the path of least resistance with the result being chimney smoking and back puffing.

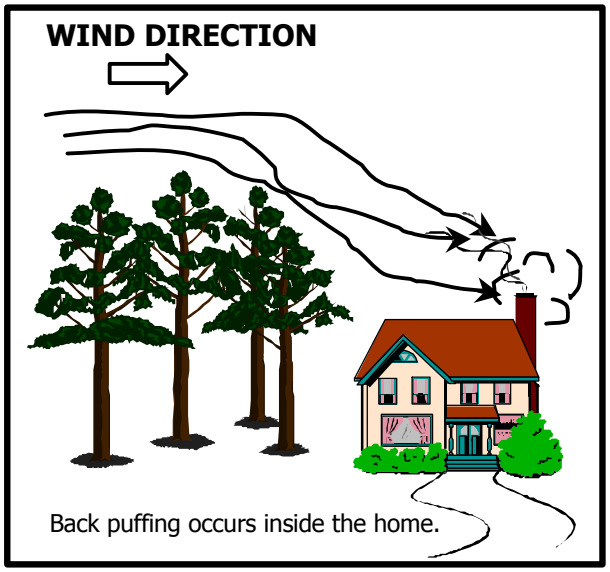

Fig. 1 Wind Induced Downdraft from nearby tall trees.

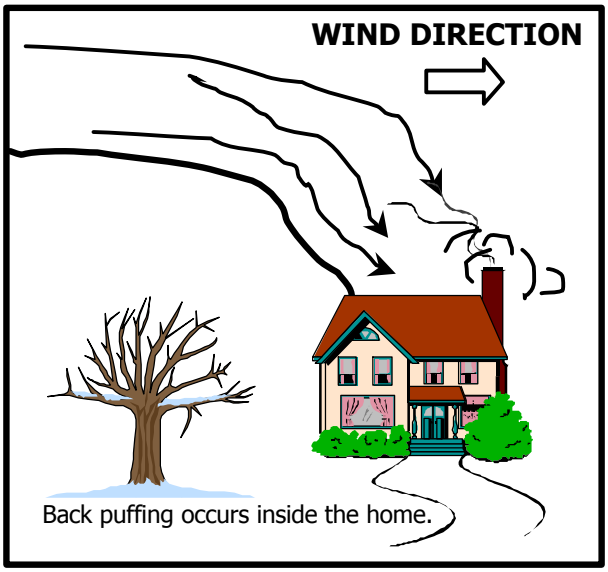

Fig. 2. Wind Induced Downdraft from nearby hills.

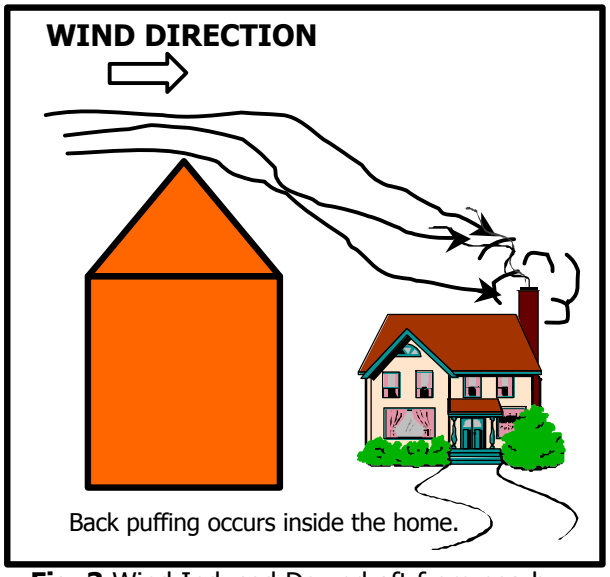

Fig. 3 Wind Induced Downdraft from nearby tall buildings.

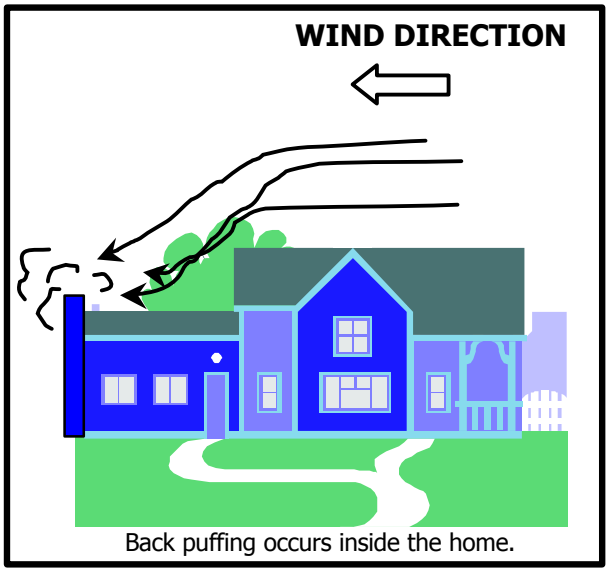

Fig. 4. Wind Induced Downdraft from two-story to one-story house.

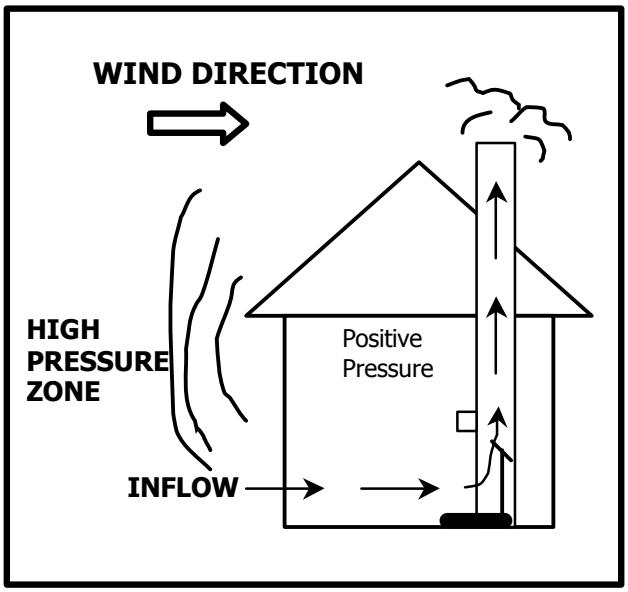

Fig. 5 WIND LOADING. Dominant opening on windward wall tends to increase draft.

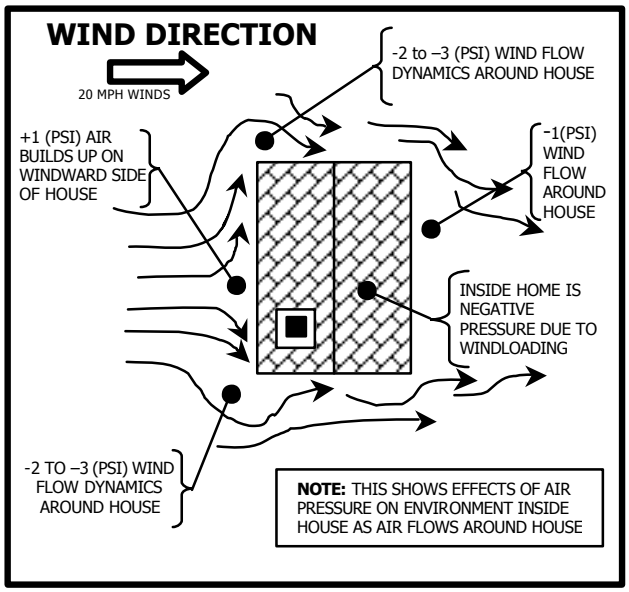

Fig. 6 WIND LOADING inside the house as air flow around the structure.

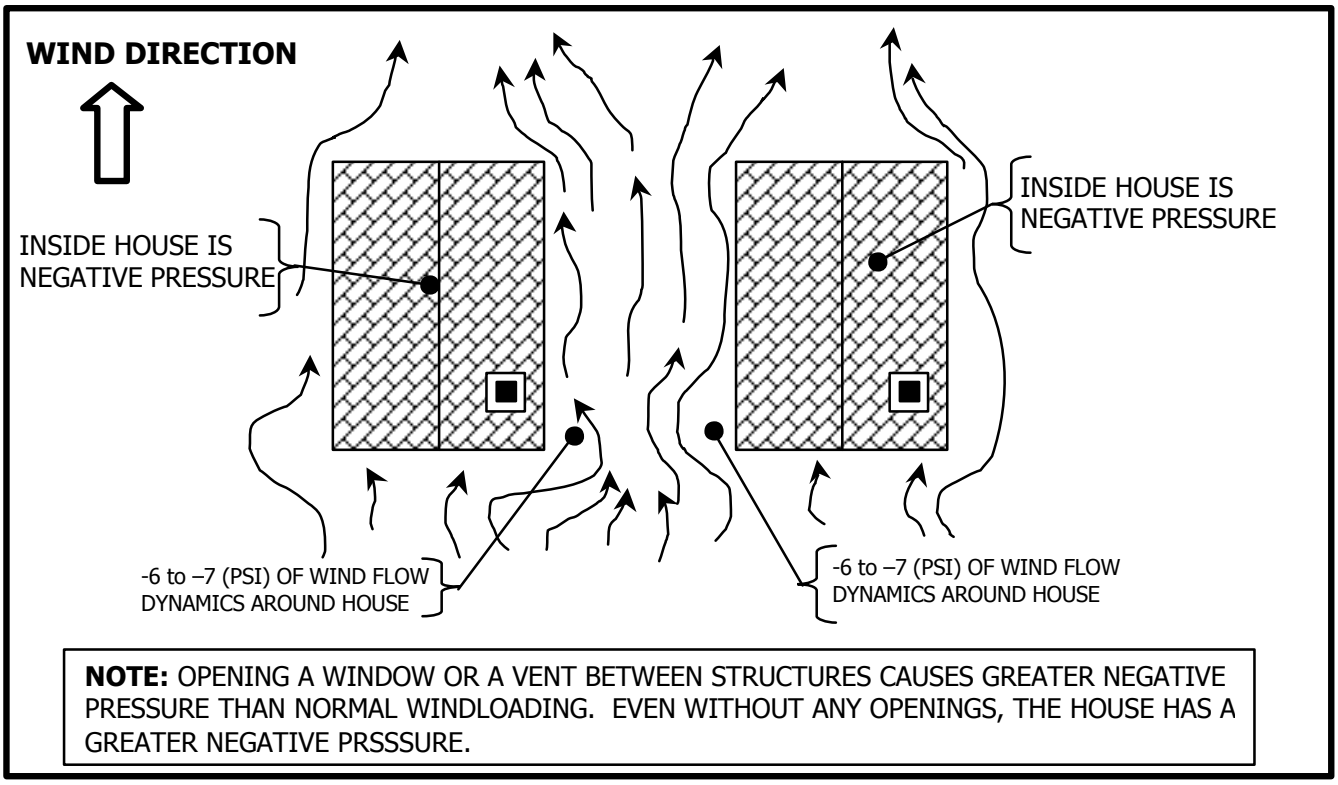

Fig. 7 WIND LOADING. The velocity increases as wind is funneled between two houses.

Cracking open a window on the windward side of the home with all other areas closed can easily solve wind loading. Keep in mind, this may not be an immediate reaction, it could take up to 5-10 minutes

to reverse the flow of smoke. If reverse flow does not take place be sure to take note of the wind direction and be sure to open the window on the windward side. (See figures 5-7)

Windloading is one reason why sometimes when a window is opened to relieve pressure, nothing happens to improve the performance of the fireplace or stove.

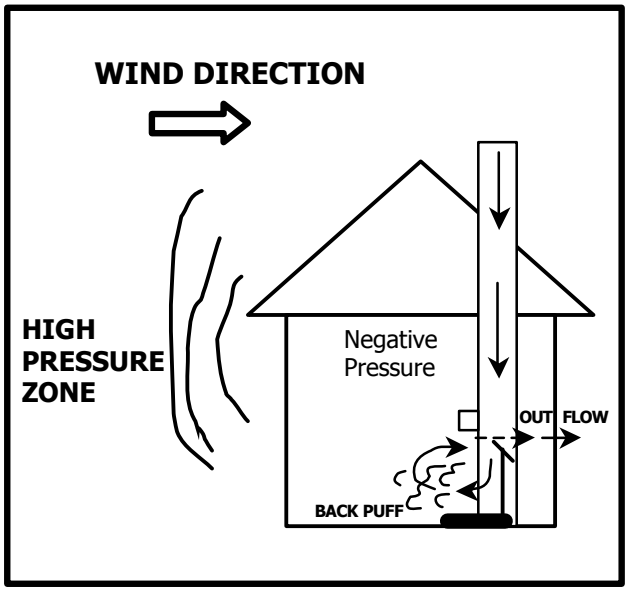

Fig. 8 WIND LOADING. Dominant opening on leeward wall tends to reduce draft.

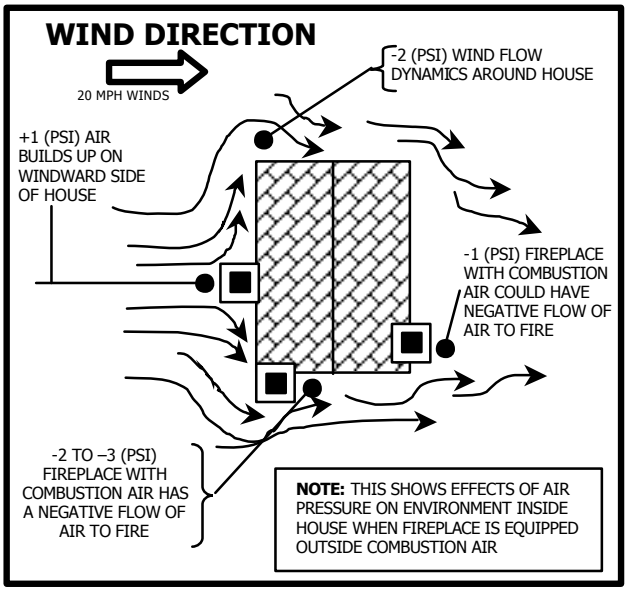

Fig. 9 WIND LOADING inside the house when fireplace is equipped with combustion air.

COMBUSTION AIR LOSS:

If we take the case of a fireplace installed with outside combustion air and the homeowner complains of smoking and or air rushing down the open flue damper, we would naturally assume the combustion air is not working properly. This assumption is correct but not for the reasons that may seem obvious.

Looking at the drawings of wind dynamics, one needs to determine if the fireplace is located on the side of the house where wind is inducing a negative pressure on the structure. If it is, air may be sucked out of the fireplace through the outside air kit thereby creating problems. (See figure 9)

ATTIC BYPASS:

Another factor to consider is a wind related problem called "Attic Bypass." In this case, warm air from the house leaks into the attic and the loss becomes so strong, under certain conditions, that it overwhelms the natural draft of a fireplace or stove flue.

A major culprit of heat loss is the attic fan louver cover that is not sealed during the cold winter months. Heat losses from attic fans cause the homeowner a tremendous loss of heat and energy efficiency.

Bathroom vent ducts which terminates in the attic and not on the roof can create depressurization problems. These ducts allow large quantities of air to flow through them even when not in operation.

With all of these factors influencing the air inside the home, it is not surprising to find that even after air is allowed to enter the house that it takes time to equalize the pressure. With all this air being pulled into the home as a result of depressurization, we begin to understand why cold air penetrates the structure through a fireplace. To help eliminate part of this problem, the chase enclosure requires insulation and sealing to curtail airflow.

CEILING/MULTISTORY HOMES:
Cathedral ceilings or the open multistory home can create conditions that result in a weak draft in a fireplace or stove. (See figures 10 & 11) If the ceiling level exceeds the flue termination level (the top of the house envelope extends past the chimney termination), you will experience a weak draw, if any at all. This is overcome by raising the flue termination until it exceeds the ceiling levels highest point or is extended above the peak of the roof. However, this issue is best dealt with at the design stage by trying to relocate the fireplace so that the chimney is located as close to the peak as possible. While it may be desirable from a design perspective to locate the fireplace at the lowest part of the eaves, it may cause chronic draft issues and hearth odors if installed there.

When dealing with fireplaces and stoves installed into multistory apartments or condominiums, it is important to note the fact that the most modern units are built with a master vacuum fan installed in a central location that is designed to create negative pressure in bathroom throughout the complex. The vacuum pump is in constant operation pulling at least 150 to well over 200 cubic feet of air per minute out of each bathroom. This air movement, while usually unnoticed by occupants, can greatly affect a fireplace or stove performance.

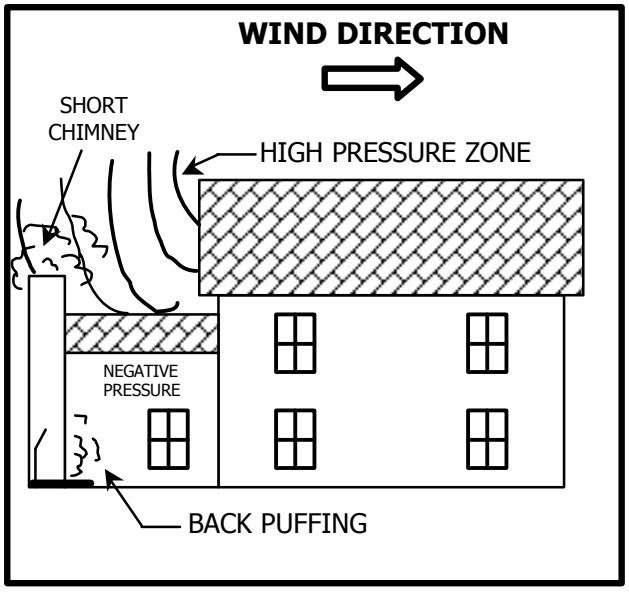

Fig. 10 WIND LOADING. One-story additions on a multistory houses.

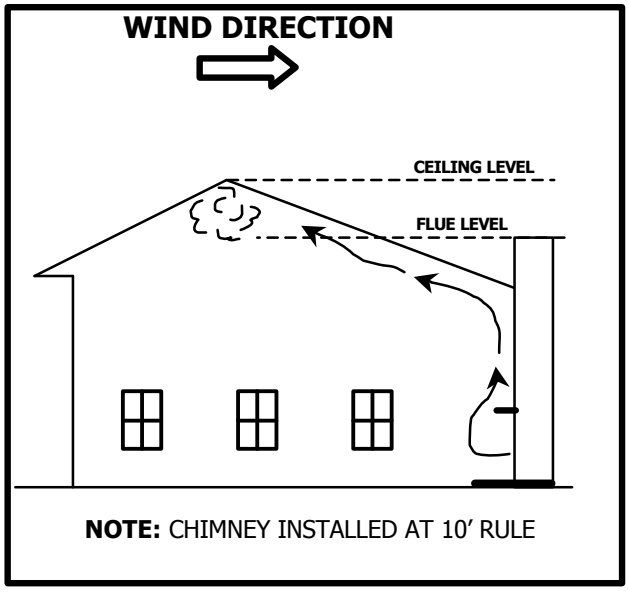

Fig. 11 WIND LOADING. The highest point of a cathedral ceiling can overpower the fireplace's natural draw.

SUMMARY:
Throughout this technical bulletin we have attempted to point out some of the major causes of user complaints relative to depressurization concerns. Again, all CFM Specialty Home Products models have been thoroughly tested to ensure that they work properly under the most demanding conditions. Nonetheless, there are always exceptions to the rule, particularly when depressurization conditions are present.

By understanding some of the contributing factors of depressurization, we hope that you will be better prepared to take proactive steps to help eliminate conditions that may create these troublesome problems through some of our educational programs for builders, architects, distributors and dealers. And, when the condition exists with a homeowner, you can become the expert by providing possible solutions.

APPENDIX

Now that you know some of the causes of cold air and smoking problems by understanding the strong influences of depressurization, the following suggestions are presented in order to help you solve some of the issues related to this phenomenon and other factors.

COLD AIR PROBLEMS:

Two conditions necessary to notice cold air problems.

1. An opening must exist to the outside.
2. Outside air must be cooler than the inside air.

Some common issues that cause cold air issues are:

1. Open or damaged dampers.
2. Lack of seal of insulation between fireplace and the wall.
3. Defective gaskets on stove doors.
4. Propagation of cold air via exposed pipe.
5. Exterior of a fireplace exposed to improperly insulated chase; one result is that warm room air may circulate through the upper grill, cool within the fireplace and be expelled as cool draft through the lower grill.

Possible fixes for cold air issues:

1. Close and/or fix a damaged damper.
2. Close and/or fix a damaged outside air kit.
3. Check and replace gasket on outside air kit.
4. Check and replace gaskets on stove doors and/or griddle.
5. Check all seals and insulation around a chase installation.
6. Check for seals around fireplace.
7. Check for any cracks in masonry and repair where necessary.

SMOKING PROBLEMS:

Three conditions are generally responsible for smoking issues:

1. A blockage in the flue system.
2. Inadequate air flow.
3. Improper operation.

Smoke may enter the room from basically three places – gaps in the seals around the fireplace, heating grills/louvers or around the lintel.

The most common issue, in addition to negative air problems as previously discussed, is a blocked chimney. This may be caused by a crushed termination, ice saturation, bird's nest, collapsed flue, creosote or a closed or damaged damper.
Other causes of smoking are incorrect use of the fireplace or stove, improper installation, and at times, weather conditions. Also see through fireplaces with the openings in different pressure zones (such as cathedral on one side and eight foot floor to ceiling on the other) may spill out one side of the unit.