The Healthy Hearth Summary

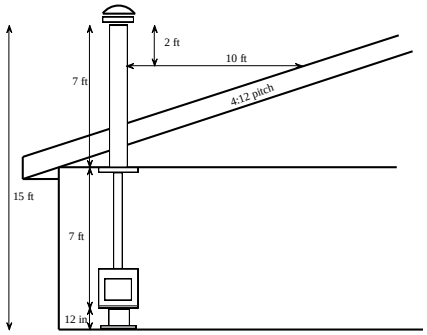
Design and Diagnose with Confidence

System Effectiveness is in Your Hands

All wood stoves and fireplaces and their chimneys must be safety tested so that installation instructions are reliable. Wood stoves must be emissions certified so they burn efficiently. While important, these certifications do not guarantee that a system will function well. Good system design ensures effective and reliable performance and no smoke spillage. That part of the installation is up to the hearth specialist. Providing good system design is something a trained dealer can do and no mass merchandiser can. This paper summarizes how to design hearth systems so they function well in modern houses.

The Chimney is the Engine That Drives the Wood Burning System

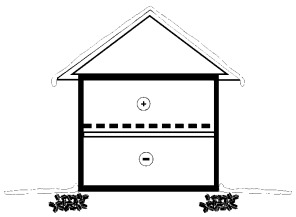
1. When air is heated it expands, making it buoyant compared to surrounding cooler air.
2. Warm air or hot exhaust rising in the chimney creates a pressure difference called draft, which pulls combustion air to the fire and sends the exhaust up and outside the house.
3. The chimney is the engine that drives the wood heating system. Good wood stove or fireplace performance depends on a good chimney.
4. A good chimney has a durable shell and an insulated liner that can withstand high temperatures.
5. The greater the temperature difference, the higher the draft.
6. Draft is a very weak pressure. Good chimney draft is about 1/4000 of atmospheric pressure. That means draft can be affected by other outdoor conditions, such as wind.
7. Taller chimneys produce stronger draft. For example, at a given temperature difference, the draft in a 25 foot tall system is 60% higher than in a 15 foot chimney. Minimum chimney height is 15 feet from the appliance base.



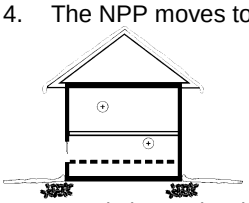
8. Installation codes say the chimney must project at least 3 feet out of the roof and be 2 feet taller than any obstacle or roofline within 10 horizontal feet.
9. Note that an old summer cottage or an installation in a porch could have a system height at the minimum allowable. Short systems like this produce low draft.

Why Chimneys Should be Installed Inside and Through the Highest Warm Space

1. In winter the warm air in a house is more buoyant than the cold air outside, so it rises, just like in a hot air balloon.
2. This tendency for warm air to rise creates a slight pressure difference in the house compared to outside. The pressure low in the house is slightly negative and the pressure high in the house is slightly positive compared to atmospheric pressure outside.



3. Between the slight high pressure zone high in the house and the slight low pressure zone low in the house is an area at the same pressure as atmospheric pressure outside. This is called the neutral pressure plane or NPP (dashed line).
4. The NPP moves toward the biggest leaks.

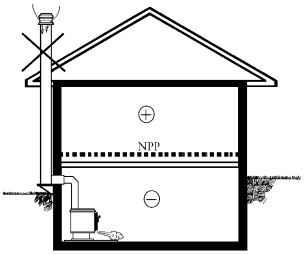


An open window or door low in the house moves the NPP down. This is why opening a window low in the house can correct a backdraft.

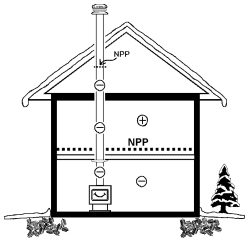
An open window high in the house raises the NPP and increases the negative pressure low in the house.

5. Air flows IN through leaks that are low in the house, below the NPP. That is why basement rooms are often drafty. Air flows OUT through leaks high in the house. That is why second floor bedrooms are rarely drafty.

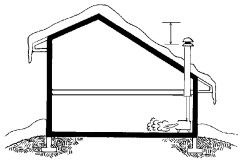
6. With no fire burning to heat it up, the air in a chimney that runs up the outside of a building can cool almost to outdoor temperature so that it produces no standby draft. The slight negative pressure low in the house can cause an outside chimney to backdraft, spilling cold air and odors into the house.



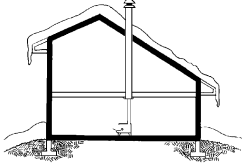
7. A chimney installed up through the warm house always produces some standby draft. This is because the top of the chimney is a very big leak so the chimney has its own NPP and it is very high.



8. A chimney should also penetrate the highest part of the heated space so that it can compete with stack effect.



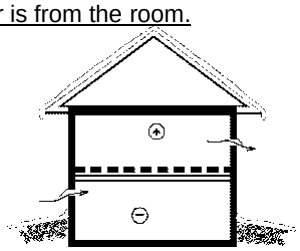
A chimney installed low on a cathedral ceiling can cold backdraft when no fire burns.



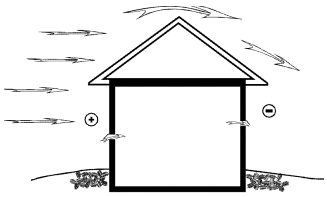
A chimney that penetrates the roof near its highest point will usually produce standby draft.

Combustion Air Supply: Passive Holes Are Not Effective or Reliable

1. A wood stove or fireplace needs a source of combustion air that is freely available at neutral pressure. In the past it was thought that air supplied from outdoors, either through a duct or from a passive hole, was the only reliable source. Research has shown that this is not true. <u>The best place to take combustion air is from the room.</u>
2. <u>Air flows to zones of lower pressure.</u> Air will flow into the house through a hole below the NPP. Air will flow out through a passive air supply above the NPP.



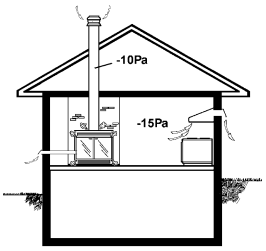
3. A passive supply of combustion air would have to be a very large hole to supply enough combustion air.
4. Wind causes a positive pressure zone on the windward side of a house, and a negative pressure zone on the downwind side. Therefore, passive combustion air supplies are not a consistent or predictable source of air.



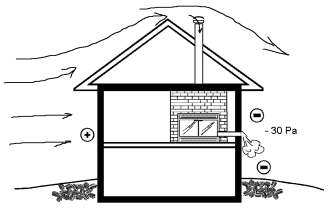
5. Building codes still require outdoor combustion air supplies for all fireplaces and for stoves installed in mobile homes. Theses air supplies must be installed, but do not expect them to reliably provide combustion air or provide protection against house depressurization.

Ducted Air Supplies Do Not Offer Protection and Can be Dangerous

1. Directly ducted air supplies were thought to isolate the appliance and chimney from house depressurization caused by large exhausts like kitchen range hoods. Research has shown this not to be true. There are three reasons ducted air supplies are not ideal: a) they do not isolate the appliance, b) wind effects can cause reversal, and c) very cold combustion air.
2. Wood stoves and fireplaces are never truly airtight. <u>Air always flows to zones of lower pressure.</u> If the house is depressurized more than the chimney is producing in draft, smoke will spill into the room through any small leaks.



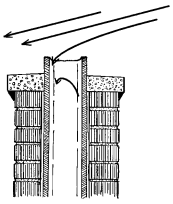
3. Air taken from the room has already been heated, so it doesn't chill the fire when it enters the firebox.
4. If the weatherhood of the outdoor air supply is on the downwind side of the house on a windy day, the negative pressure there can overcome chimney draft and cause hot exhaust to flow backwards through the duct. This hot exhaust could cause a house fire.



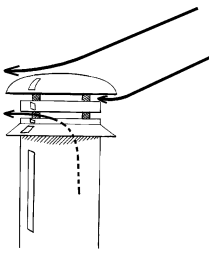
5. Combustion air should be taken from the room in which the hearth is installed. The building envelope tends to damp out the pressure fluctuations caused by wind so it is a calmer, more reliable place to take combustion air.
6. The alternative to supplying combustion air from outdoors is to provide warning of smoke spillage. That is why <u>a carbon monoxide detector is required in the hearth room</u>.

Other Wind Related Problems to Look Out For

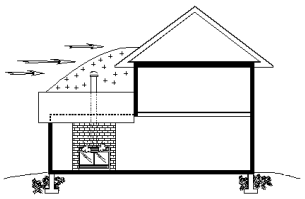
1. <u>Chimneys without caps are vulnerable to wind effects.</u> In the past, masonry chimneys rarely had rain caps, which is one reason why they did not perform as well as modern chimneys.



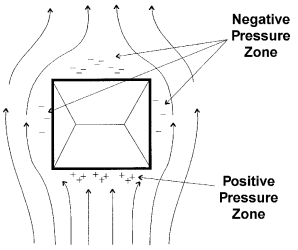
2. The cover over the top of a chimney is usually called a rain cap, but it could also be called a wind cap because it has a big effect on how vulnerable the chimney is to adverse winds.
3. A good cap for a metal chimney has a top cover and a band around the space between the opening and the cover. This design can convert wind pressure from an adverse direction into a driving pressure that pulls exhaust up and out of the chimney.



4. The top of the chimney illustrated at right can be in a high pressure zone due to wind pressure, which can force exhaust gases back down. This hearth also suffers from a chimney that does not penetrate the highest part of the building envelope.



5. Wind blowing around a house is more likely to depressurize than to pressurize it. This is because wind tends to produce negative pressure on three sides and positive pressure on just one. When diagnosing a wind related failure, look at the house, not just the chimney.



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For more details on these issues see **www.woodheat.org**