

House as a System Gets Serious

— David Hill, Eneready Products

With the flurry of energy retro-fit programs hitting the market, this article is particularly timely. It underscores our concerns regarding the serious consequences that can result from not using knowledgeable and trained heating contractors to install upgraded ventilation and heating equipment in draft-proofed homes.

"House as a system" is more than a catch phrase. Read on . . . —Ed.

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To be successful in the residential HVAC market today, a heating contractor not only needs to know how to properly install and service equipment, but also how that equipment affects and is affected by the home he installs it in. All houses today must be considered as systems. Contractors need to look at dwelling units in this new way if they wish to maintain customer satisfaction and avoid liability for combustion pollutants entering the home.

Draft-Proofing

In the quest for improved winter thermal comfort and fuel efficiency, up-to-date builders incorporate good draft-proofing. This includes using gasketed electrical boxes and sealing around wiring and plumbing penetrations. Upgraded draft-proofing serves other functions as well.

In multifamily complexes especially, it not only improves each unit's fire and smoke protection from neighbouring units, but it can also be a major improvement to suite liveability as it decreases noise—from the street and from neighbours. Also in urban areas, exterior wall plate sealing will eliminate black, perimeter, carpet ghosting. In farming areas, draft-proofing the attic floor will stop flies from entering the house via plumbing stacks.

However, now that we routinely build draft-proofed homes we must consider a serious safety issue. That problem is the installation of naturally aspirated, fuel fired, vented appliances (NAFFVA) in combination with large kitchen exhaust fans (especially of the downdraft variety)—a common situation in today's residential market. The following analogy may help explain why this can lead to safety concerns regarding combustion pollutants being dispersed in the home.

Your Built-to-Code Home

The average house could be compared to a 100,000 gallon, steel storage tank shot full of various sized holes in the walls and lid.

Let's say you bought this 37' wide by 16' high tank to convert into your retirement home just hours before the welder was due to start filling the holes. Instead, you convinced him to install a floor across the whole tank eight feet above the concrete floor on which the tank rests. Since you're an HVAC contractor, you used all those convenient holes when you installed a kitchen exhaust fan, 2 bathroom fans, a clothes dryer, a fireplace, a hot water heater and a forced-air furnace. What you created was the aerodynamic equivalent of a new, 2000 square foot, built-to-code home.

Now let's look at how your tank house and exhaust fans may affect the safe operation of those combustion appliances you installed. The three, real-world biggies to look out for are as follows:

- 1) Big kitchen exhaust fans, especially downdraft type
- 2) Cold, exterior wall chimneys
- 3) Leaky return air duct systems

Big Exhaust Fans

It is commonly, yet incorrectly, believed that you have anywhere from 15 minutes to one hour after starting an exhaust fan before your tank will be affected. In other words, before your tank begins to be depressurized and starts sucking air in through any hole it can. In reality, even before the smallest fan has reached full rpm, your tank will feel outside air passively pressing inward. It will reach final depressurization in 2 to 10 seconds. It is primarily the size of your tank that determines the time to reach full depressurization.

The amount of depressurization your tank will experience depends, on the other hand, on the installed cfm capacity of the exhaust fan and the combined area of the bullet holes in your tank. In the average tank where a gravity dependent chimney is present, there is generally enough leakage area (all holes combined) that only a large exhaust fan can threaten the draw of the chimney. How large is large? If the exhaust fan exceeds 1/2 an air change per hour it can cause problems. Downdraft exhaust fans are of particular concern because to exhaust down they must overcome the gravity of rising moisture- and grease-laden air from cooking. Therefore they require much higher cfm ratings than range hood exhaust fans to do the same job.

Without a chimney (a non-NAFFVA home), depressurization is rarely a concern. In many cases, it is even an asset as it helps keep the structure dried out. In NAFFVA homes however, there is a safe depressurization limit. If exceeded, combustion products can be drawn back into the home instead of being exhausted up the chimney. This safe limit for your tank is normally determined by its weakest—lowest and coldest—chimney.

Cold Chimneys

A chimney is really just another hole that we call a chimney. This chimney hole will penetrate either the lid or wall of the tank. When penetrating the lid it is called a warm chimney since the majority of chimney walls are surrounded by warm, interior air. When penetrating the wall, it is called a cold chimney since the chimney is outside the tank surrounded by cold, outdoor air. Both chimneys function identically until winter comes and you turn on the heat.

As the outside temperature falls, indoor air becomes warmer and therefore lighter than outdoor air. It will begin to draft upward through the hole in the lid. The strength of this draft or stack-action increases as the temperature difference increases. Any hole penetrating the wall at low- or mid-height location will become a make-up air source to replace the air being expelled in this manner through high-level wall or lid holes.

Unfortunately, this means that the safe start-up and draft performance

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of a cold chimney is determined more by the placement of the majority of other holes in your tank than by any other factor. If the majority of other penetrations are low-wall, safety is increased as the chance of back-drafting is reduced. If the majority of other penetrations are high-wall or lid penetrations, safety is decreased. So you can see that the use of exhaust fans combined with cold chimneys only make what is inherently unsafe even worse.

Moreover, this B-vented back-draft problem will occur without the use of any exhaust fans at all. Most tanks have many high-wall and especially lid holes which will successfully challenge the updraft capability of all holes except those which penetrate the lid only. Simply, this upper structure air loss makes draft performance of the low-wall penetrating chimney to questionable to count on for safe exhaust of combustion products—a very common problem with basement wood and gas fireplaces connected to masonry A or B vent chimneys.

Return Air Duct Leakage

The moment you decide to install a forced air heating system into your 2-level tank the risk of drafting problems increases. We have in the past assumed incorrectly, that the furnace will deliver as much air to any level through its supply air ducts as it draws from that level through its return air ducts. This is only true if the entire duct system is properly sized and properly sealed. Sealing R/A systems is often difficult when joist space and stud cavities form part of the system.

Because of the relatively large fan capacity of a forced-air furnace, even a small mismatch between delivered and returned air volumes to and from any level will cause one level to become pressurized and one level to become depressurized. These mechanically induced pressures can easily dwarf building stack-action. They can almost as easily challenge the gravity forces of a fully pre-warmed, lid penetrating chimney.

Conclusions

No longer can we sell, install and service NAFFVA products in isolation. We must adopt the "house as a system" mentality, foresee these problems, and respond to them. Keep these four points in mind.

- 1) It is unlikely that we can ever fully protect against the negative pressures induced by customer-selected, large, kitchen exhaust appliances except by using absolutely sealed, direct-vent appliances.
- 2) We will always be vulnerable to start-up and tail-out spillage problems if we connect our appliances to cold chimneys.
- 3) We will likely never be able to protect ourselves against these same problems when furnace duct systems are undersized and poorly sealed/installed. (What HVAC's Quality First training is all about.)
- 4) When other subcontractors cause safety problems by installing air handling equipment after our work is complete, we must have the conviction to demand the home be returned to a safe condition.

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