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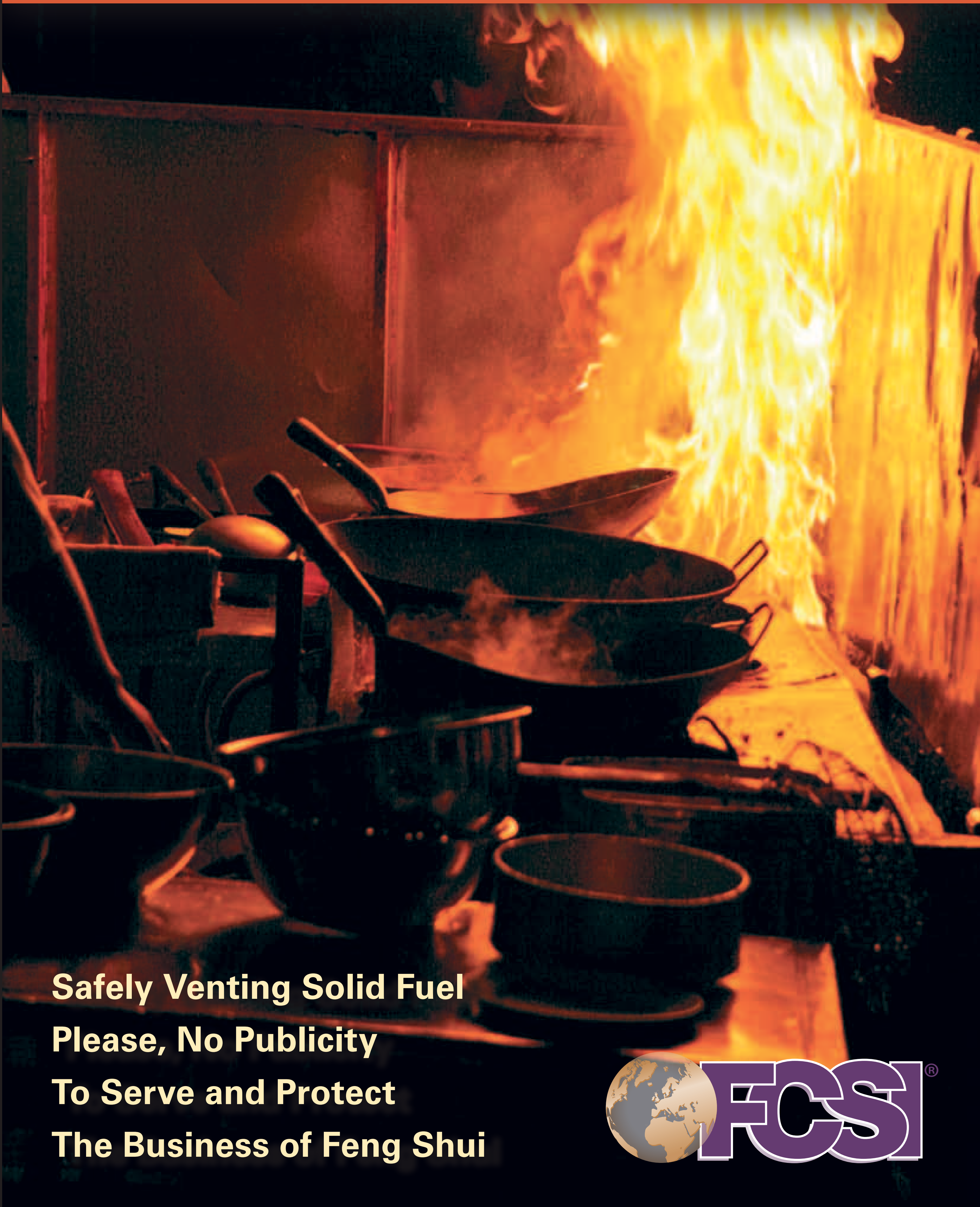

Safely Venting Solid Fuel

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Best Practices for Safely Venting Solid Fuel

By Merrill Bevan

Kitchen fires are true life safety threats which all foodservice professionals must guard against. Best practices are the best defense.

One of the major life safety issues facing foodservice operators and consultants today is the proper ventilation of solid fuel equipment. In North America there is strong regulation and enforcement, as NFPA 96 and the IMC (International Mechanical Code) set out clear guidelines which are supported by local fire and building inspectors. In many developing markets, however, there is a lack of oversight. And there are other markets that feature some regulation, but often lack enforcement mechanisms. This inconsistent approach creates confusion in the marketplace and ultimately results in solid fuel equipment that is installed with under-specified, inadequate ventilation—which puts lives at risk. The good news is that solid fuel equipment can be vented safely, but it takes knowledge, proper design and installation, and dedicated maintenance.

The goal of this article is to discuss the best practices for solid fuel ventilation. We will first examine why solid fuel ventilation must be handled carefully. We will then review time-tested, field-proven solutions. This will provide us with enough background to address many common mistakes, dissect why they are so often made, and suggest common sense approaches to avoid them. Finally, we will tackle the efficacy of "Silver Bullet" solutions. Do they stand the test of science? And, perhaps more importantly, do they stand up to the realities of installation and maintenance?

With a clear void in accountability, how does a consultant meaningfully impress upon the owners, as well as on other stakeholders, the importance of safe solid fuel ventilation? The answer is through education.

Fuel For The Fire – What gets past the filters adds up quickly, as seen with this creosote buildup in a solid fuel duct.

Best Practice: Vent solid fuel separately; clean regularly.

Where there's smoke, there's (the risk of) fire

Burning wood and other solid fuels for heat and cooking is, quite literally, as old as cooking itself. The challenge is that burning solid fuel creates smoke-laden vapors with many byproducts. The focus of our conversation about fire risks will be creosote. Creosote is an oily liquid produced by the distillation of wood tar; in layman's terms, it is a byproduct of burning wood. In the arena of foodservice ventilation, creosote behaves like grease-laden vapors from other cooking equipment but exhibits these key risk increasing characteristics – heavier-than-air, stickiness, flammability – to a greater extent than grease vapors.

What role does creosote play in creating a potential fire hazard? You may be familiar with the concept of the "Fire Triangle": heat, fuel and oxygen. These three legs of the Fire Triangle must be present to start a fire. Conversely, you can prevent a fire by removing one or more of these elements. Oxygen is omnipresent in air – our goal with ventilation is, after all, to move air – so removing oxygen is not a viable solution to fire prevention in ventilation. Sparks from the wood fire are the most common source of the "heat". This deserves its own conversation and we will revisit it later. So now let's talk about the "fuel". If oxygen and heat are present, all that is missing is something for the fire to run on: its presence will complete the Fire Triangle. In foodservice ventilation, this is where grease-laden vapors and creosote enter the picture; they are literally fuel for the fire.

The conventional approach to limiting the risk posed by creosote and grease is to try removing them completely from the system. But anyone familiar with ventilation knows that traditional filtration systems can remove only a portion of the grease and creosote. The dirty little secret about ventilation is that it is not what you capture, but what you don't capture. According to many ventilation experts, the best systems available today are only effective at capturing 50% of the grease from the exhaust stream. With solid fuel equipment filters would clog in a matter of hours. Even a theoretical system that captured 99% of all creosote and grease would not be worry-free. That 1% might seem like an insignificant amount, but add that up over weeks and months of operation with no duct cleaning and a fire is inevitable. Since oxygen is always present you end up relying on spark abatement alone. Yet, if that spark

abatement system fails for any reason our Fire Triangle is suddenly completed.

Best practices – use fire-rated grease duct and keep it separate

What are the best practices for solid fuel ventilation? With experience in more than 75 countries around the world, from Europe to Asia, Africa to Latin America, we feel the most comprehensive and the safest standards are the North American-influenced NFPA 96 and IMC. Although these detailed standards should be read carefully, we will provide a brief synopsis to put their approach in a broader context.

To appreciate NFPA 96 and the IMC standards, we must understand that they approach solid fuel venting – and all venting for grease equipment – from the worst case scenario perspective. Even with the strict preventions they prescribe, there is an assumption that, through human error and/or mechanical failure, there will be a fire eventually. Therefore, the system must withstand, contain, and suppress a fire. Think of this as akin to requiring seismic testing. Will an earthquake hit during the life of a building? That's an unknown; but the smart move is to make sure the building can withstand a shake.

All ventilation for solid fuel must first meet the standards of a grease duct or what is sometimes referred to as a "Type 1" system. This means the duct itself must be constructed of: Carbon steel at least No. 16 MSG, 1.37mm (0.054 in) in thickness OR Stainless Steel at least No. 18MSG,1.09mm (0.043 in.) in thickness. All joints and seams must have a continuous, liquid-tight external weld, including the duct connection to the hood. Butt-welded connections are not acceptable. There are also listed grease duct systems available that utilize alternate design and connection means. In North America these systems have been tested and listed by a nationally recognized test lab (NRTL) to the UL 1978 standard. These ducts, to be Type 1 systems, will then require fire suppression.

What happens outside the duct is also important. Maintaining proper clearances to combustible construction is critical for grease duct installations. A clearance of 18 inches (460mm) to combustible construction is required for non-insulated, field-fabricated grease duct. Listed manufactured ducts will typically allow for tighter clearances, as most are of a double-wall design that incorporates a layer of insulation. Consult NFPA 96 and/or the IMC for more information regarding clearances on field-fabricated ducts. For manufactured duct, also refer to the manufacturer's specifications.

Solid fuel ventilation must go above and beyond standard grease duct ventilation requirements in several ways, the most important being that it must be a separate duct system entirely. NFPA 96 (Chapter 14.3.3 of edition 2011) states this explicitly: "Exhaust systems serving solid fuel cooking equipment…shall be separate from all other exhaust systems". See the complete Chapter 14 for additional recommendations.

Common mistakes

While the preceding review of NFPA 96 gives you some of the best practices we strongly recommend you read those standards in depth. For a simple overview, what may be more instructive is to discuss the most common mistakes operators make regarding solid fuel ventilation.

The dirty little secret about ventilation is that it is not what you capture, but what you don't capture.

Decoding the Codes

NFPA 96

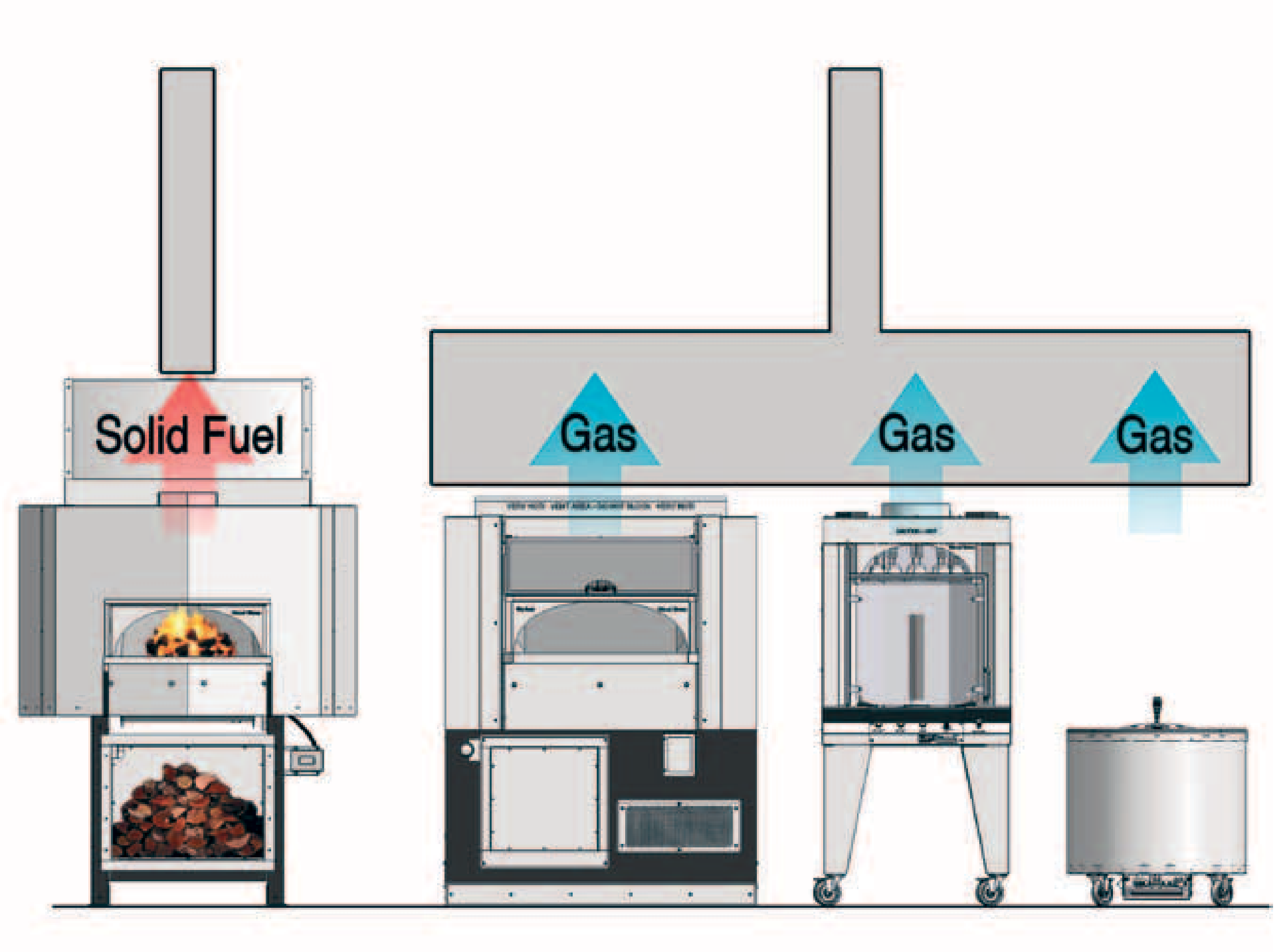
The National Fire Protection Association's Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations (96 refers to the standard number, not the year!). The 2011 code can be purchased at www.nfpa.org.

IMC

The International Mechanical Code. Available for purchase from the International Code Council at www.iccsafe.org

UL 1978

Underwriters Laboratories. UL standard on Grease ducts for restaurant cooking appliances. www.ul.com



Best Practice: All-welded grease duct, separated from other cooking equipment ventilation, allows regular cleaning of the system and can keep a fire from spreading.

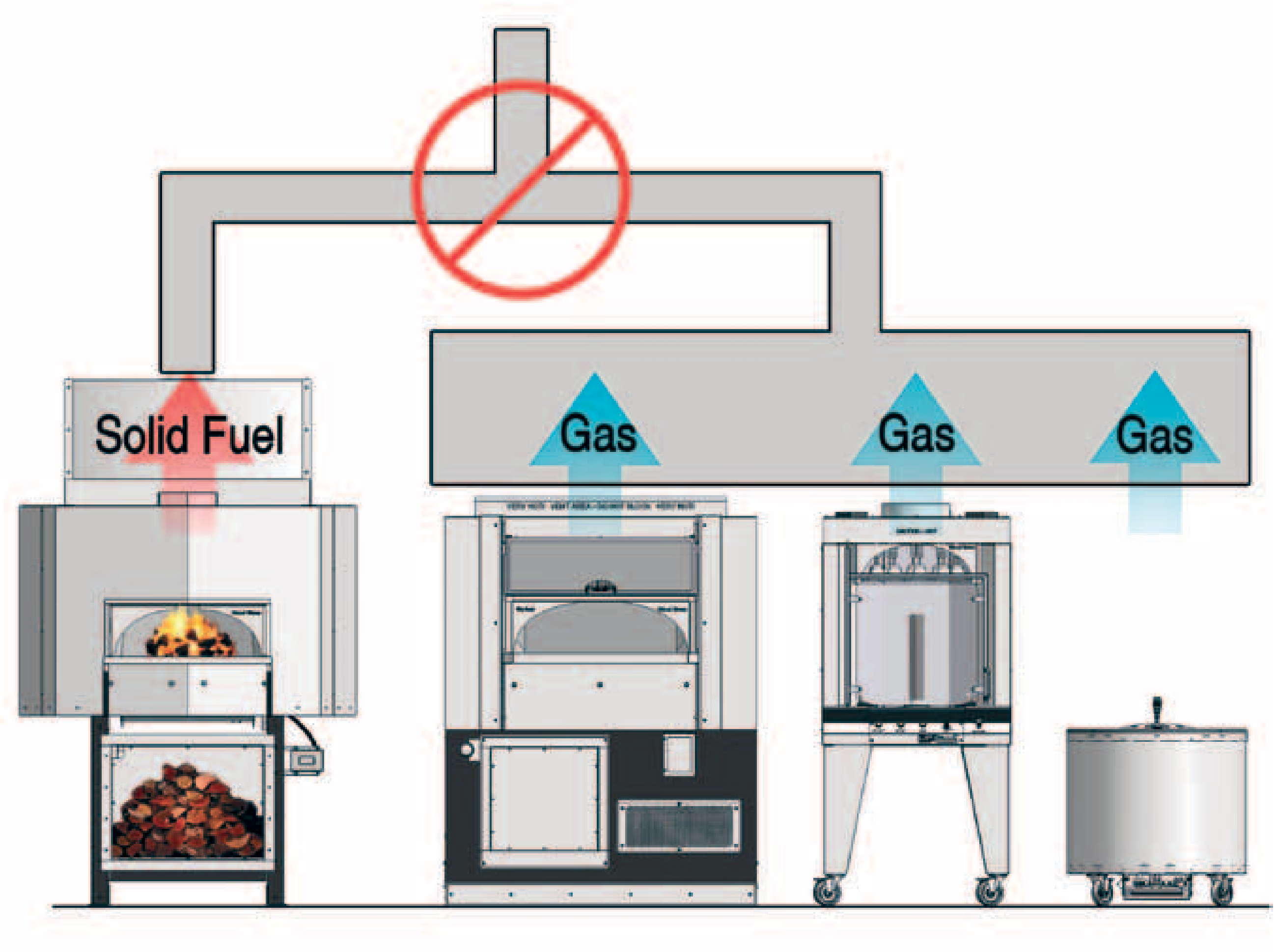
A. Perhaps the most universal mistake is when owners try to incorporate solid fuel equipment into the same ventilation system that serves gas or electric equipment. Many owners look at the cost of a separate duct system and feel that they can save capital costs by eliminating the separate duct for the solid fuel equipment. But as the guidelines describe, there must be separate ventilation. Faced with an increased potential investment in ventilation, operators often ask why they must spend this extra money.

There are several reasons why separate ventilation is necessary. One is to prevent sparks from solid fuel equipment entering duct systems serving other non-solid fuel equipment. Another reason is that there will be less build-up of grease in the entire duct system when it is separated; in other words, there is no cumulative effect from the two systems dumping into one. Third, separate ducts are much easier to clean and maintain. And finally, in the event of a fire, the risk of fire spreading through the duct to other cooking equipment is lessened.

B. Another common mistake is the use of inappropriate duct material. We have discussed the definition of a grease duct. It is critical that the duct be constructed not only so that it is liquid tight (we do not want the creosote and grease – our fuel – to escape out of the ducting), but also so that the material can withstand a fire. A properly constructed, carbon steel (16 GA), all-welded-seams duct will contain a fire and resist melting and/or other damage to the duct.

If a grease duct is replaced by sub-par ducting, for example galvanized “B vent”, such as might be used over a dishwasher or as a common HVAC duct, the probability of significant property damage, and even potentially, the loss of life, goes up dramatically.

Anecdotally, the difference between a fire in a properly built grease duct and one in sub-par ducting is radical.



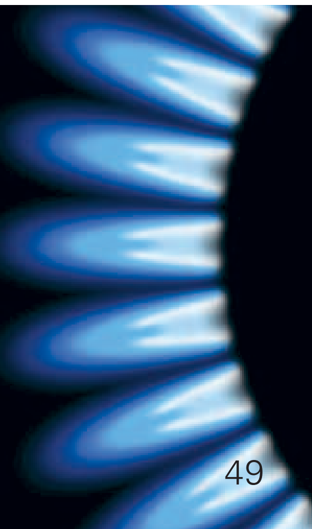
The restaurateur with a properly built duct, who fails to clean it and eventually has a fire, may not even know it occurred. For example, he calls to ask for a free fan motor replacement because it "mysteriously" stopped working. When asked the last time they cleaned the duct, there is a long pause, and we know there was likely a fire and it burned out the fan motor. On the other hand, the owner with the incorrect duct calls to explain their restaurant has burnt down. The difference can be that simple – and that drastic!

C. In-line fans are problematic and should be avoided for solid fuel applications. They provide a potential gathering point for grease and creosote. In a straight vertical duct, superheated air carrying the creosote and grease-laden vapors has far fewer barriers. The heavier-than-air particles are less likely to drop out of the airstream and collect in the duct in a vertical run. An obstacle, such as an in-line fan in the direct airstream, can become a depository for grease and creosote and therefore is a potential ignition point when a spark (heat) enters the system. There is also the challenge that most

Common Mistake: There are no "Silver Bullets." Solid fuel exhaust should not share duct with non-solid fuel equipment.

Have to share ventilation? Use gas

What do you do when separate ventilation is not an option? Choose gas. Many people believe solid fuel equates to a flavor profile and to choose gas is to lose that flavor profile. That is not true in every case. For equipment like a rotisserie or broiler you can make such an argument because you are cooking above the fire, in the smoke zone. But in Stone Hearth Ovens, the great flavor comes from the open flame and baking on the hearth, not from the wood itself. So a gas oven is a very real solution that poses no sacrifice in flavor but opens up many opportunities in application because it is much easier to vent.



in-line fans will not withstand the high temperatures commonly seen in the flue above solid fuel equipment. Temperatures in a duct above a wood-fired oven, for example, can top 500°F (260°C). This leads to the frequent mechanical failure of in-line fans as the bearings and other components cannot handle the high heat. If you absolutely must use an in-line fan, choose a fan listed for grease and solid fuel applications with at least a 450°F temperature rating. Moreover, the fan should be located as far away from the heat source as possible.

Fuel Quality

An often overlooked factor in solid ventilation is fuel quality. With wood, for example, moisture content is critical to use. A 12%–16% moisture content is ideal. Anything above 20% both hinders performance and exponentially increases creosote. The amount of creosote generated from 25% moisture content is much greater than from 20%. Burning wet wood will dampen cooking performance and clog your ducts with excessive creosote. Finding a good supply is as important as finding good equipment.

Lack of properly constructed and accessible duct cleanouts can lead to additional venting challenges. Ideally, a solid fuel ventilation system would have a straight vertical run with no horizontal sections. Horizontal runs create more opportunity for build up (those heavier-than-air particles will drop out of the air during the horizontal run and gravitate to the outside of the bend at any turns, creating more potential ignition points). Sometimes horizontal runs cannot be avoided and, in those cases, it is critical that the duct be provided with approved access panels (cleanouts) to allow for proper inspection and cleaning of the duct system. The duct system and cleanout locations must be designed so that every inch of the duct run is accessible for cleaning and visual inspection. See NFPA 96.

Educating the market

Why are these mistakes so common on international projects? The lack of regulation and enforcement plays a major role. Because there is no oversight, it is easier for these mistakes to go unchecked. Owners worry about costs. The lack of concrete information to counter those concerns, coupled with the real world consequences of cutting corners to save costs allow unsafe choices to be made. In the international arena you can add to the mix a potential disconnect between parties on large scale projects. As a result there is an inherent challenge on many hotel projects. For example, the consultant – who is hired by the property developer/owner – is given the task of specifying everything up to the duct but has no control above the connection. Typically the duct specification is handled by the architect or the Mechanical Engineering firm. The challenge is that with no hard and fast rules, the consultants can only make recommendations. Without regulation and enforcement, those safety recommendations lose out to cost concerns. The owner signing the checks may determine which guidelines, if any, they will follow. But that is a dangerous path.

With a clear void in accountability, how does a consultant meaningfully impress upon the owners, as well as on other stakeholders, the importance of safe solid fuel ventilation? The answer is through education. If we educate the market, they will listen. It is hard to argue with a tight budget, but it is even harder to argue with solid science.

Are there any silver bullet solutions?

Where solid fuel ventilation presents a challenge, it also presents a perceived opportunity. Because of the number of stakeholders in the decision-making process, there is enthusiasm – and pressure – to find a magic solution. This pressure causes the market to produce "silver bullet" quick fixes in order to allow consultants to specify solid fuel equipment and plug it in to a communal duct system (the supposed cost-

cutting panacea). But do these Silver Bullet solutions work? Let's look at one example – the idea of a spray filter as spark abatement.

The theory behind the spray filter is to attack the "heat" component of the Fire Triangle. On paper this is a logical approach. If you could guarantee abatement of all sparks you would, in theory, remove one of the key ingredients to a fire – and remove any chance of fire. The reality, however, is somewhat different than the theory.

The core of the issue in trying to use a filtration system to prepare exhaust to be shared through a communal duct or to a B vent is not a question of would such a system work under the best conditions. It is, instead, a question of: **What happens under the worst conditions?**

As we've discussed, no system captures 100% of all creosote and grease, so there will always be some build-up of grease and creosote in the duct. Thus, if given sufficient time, there will be ample fuel for the Fire Triangle. In fact, we've seen that it is likely that more fuel will build up on the false assumption that the sparks (heat) were eliminated; it can provide a false sense of security. Because these spray filter style solutions are often installed behind a façade or otherwise concealed, there is an "out of sight, out of mind" component to the operator's approach to maintenance. The problems arise when regular, ongoing maintenance fails, or when human error comes into play.

For example, two years after installation, plumbers working on the third floor to repair a leaky faucet, accidently turn off the water supply to the spray filter. Now you have the perfect storm: Plenty of fuel built up from years of relying on spark abatement alone; an unlimited supply of oxygen; and a sudden addition of unabated sparks creating heat. Add to that perfect storm the error of shared solid fuel ventilation into a communal duct of inappropriately constructed B vent – built on a false sense of security that the spark abatement provided will handle the problem – and the results can be devastating.

Designing for the realities of installation and operation

The author, Malcolm Gladwell, in his book, *Outliers: The Story of Success*, has a fascinating chapter on what causes airplane crashes. He shares a very interesting and relevant insight into creating safe systems. He states that, in this modern era of commercial air travel, safety experts and crash investigators have determined it takes not one or two failures to cause a crash, but a total of seven errors, a cascade of mistakes, for catastrophe to strike! This is because all the stakeholders – the manufacturers of the planes, the airline companies, the pilot instructors and the regulators of the industry – have approached the issue of safety in a way that assumes a worst case scenario. They have therefore instituted comprehensive precautions that result in it taking not just one or two failures to cause an accident, but many.

While the realms of airline safety and ventilation for grease-producing solid fuel equipment may seem worlds apart, they are both, at their core, systems. If the overall system design relies on a single safeguard (for example abatement of sparks or a single engine and a parachute) it puts the entire enterprise at risk. There is a lesson if we look at this issue as a challenge of designing safety into a total system. We should intentionally design systems which have multiple layers of safeguards built in.

The goal of this article is to review the best practices for solid fuel ventilation. We feel these best practices, which are represented by NFPA 96 and the IMC, are grounded in the realities of installation, daily operation, and maintenance over time. While they are not the final authority in every country – and we hope that this article generates a much broader conversation about venting in different markets – ultimately, they reflect a design view that factors in a buffer for multiple mistakes and human error.

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