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Grease Duct

Inspecting for Liquid Tight Requires Water Test

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This paper is written with regard to applicable codes and standards, and intended for use and application in the United States of America.

Grease Duct

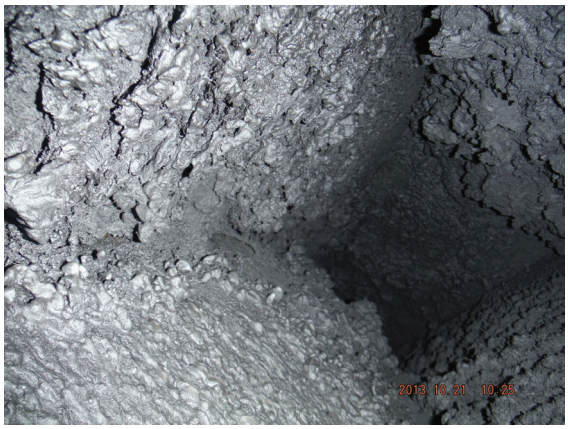
Leak testing is a non-negotiable requirement for Type I grease duct systems installed in commercial kitchens. These tests are meant to ensure the "liquid-tight" integrity of the ducts as required by the International Mechanical Code (IMC) and the National Fire Protection Association (NFPA). However, extensive anecdotal evidence as well as post-fire investigations suggest that commonly administered leak tests (light, smoke or pressure) do not adequately detect leaks.

Growing concern over the effectiveness of these and other procedures has prompted The American National Standards Institute (ANSI) and the International Kitchen Exhaust Cleaners Association (IKECA) to create an ANSI/IKECA Consensus Body Standards Development Committee to develop and improve cleaning, inspection and maintenance standards for commercial kitchens. As recently as January 18, 2018, the ANSI/IKECA Committee issued a statement supporting the exclusive use of water testing to ensure liquid-tight duct.

This paper will discuss the challenges that owners face when it comes to ensuring the integrity of Type I exhaust systems and explain why owners and engineers should embrace the latest ANSI/IKECA recommendations for water testing.

Why Grease Duct Must Be Liquid-Tight

It is a well-known fact that leaks in Type I grease duct, required in applications where the cooking of animal protein produces highly flammable grease and vapors, can cause and exacerbate fires. Basically, the same sticky, greasy residue that collects on the hood above the cooktop also collects on the inside of the duct which is why commercial kitchens are required to routinely clean the entire exhaust system.



Kitchen exhaust duct with years of grease and debris build-up.
Photo courtesy of Derby Pressure Wash, Louisville, KY

At any given time, grease duct may also contain liquified grease which (if the duct system is designed properly) will drain into a trap where it can be accessed and removed. However, improper design, such as insufficient slope, can cause grease to pool inside sections of the duct and/or leak from the duct, creating fire risks as well as property damage and risk of human injury due to slippage. Grease buildup in corners of rectangular duct also create fire risks.

In an article for Engineered Systems magazine, one expert in commercial kitchen ventilation and fire analysis writes:

> "In many routine visits to operating foodservice facilities and fire scenes, the author has seen many leaking grease ducts and access doors, resulting in grease on tops of hoods. . . . on gypsum board ceilings, and permeating lay-in ceiling panels, thus providing flammable fuel for fires."[1]

Grease leaks aren't the only concern. Water can leak from the duct during cleanings. Such cleanings typically involve the spraying of high pressure water (approximately 1000 PSI at 3 GPM) inside the duct. If the duct is not liquid-tight, water will immediately escape through any existing holes, filling light fixtures, soaking ceiling tiles, and causing other types of property damage including the onset of mold.

Duct leaks have also been known to create dangerous "fire balls" when water-based fire suppression systems activate. This can occur when the water-based fire suppression agent contacts the heated hood and duct, causing the water to vaporize and pressurize the duct. Propelled by this pressure, superheated grease vaporizes and expands inside the duct. If leaks exist, this highly flammable vapor will escape through those holes, potentially exploding into fireballs the moment it encounters fresh air and oxygen outside the duct. [2]

For these reasons, all Type I duct and exhaust equipment is subject to the following NFPA and IMC requirements:

- All external joints and seams on the Type I hood must be continuously welded liquid-tight. [IMC 507.5]
- Where pipe or conduit penetrates a duct or hood, the penetration is to be sealed by a liquid-tight, continuous external weld, or by a listed and labeled device designed for such purpose. [NFPA 17, 3-9.1.4]
- All duct joints and seams are to be sealed by a continuous, liquid-tight weld applied to the external surfaces. [IMC 506.5]

Why Leaks Occur and Why Certain Tests Fail to Detect Them

Leaks in field-welded ducts are almost always due to improper installation and/or imperfect welds made at the jobsite. Joints, seams and penetration of grease duct are required to have continuous welds to prevent grease and residue from leaking from the duct interior. But workmanship, jobsite conditions and often unfamiliarity of the codes leave many owners with kitchen exhaust systems that will create problems and expense down the road.

To validate the "liquid-tight" integrity of Type 1 exhaust systems, the IMC's Section 506.3.2 requires that all field-weld duct be leak tested. The IMC prescribes a light test that involves the passage of a minimum 100-watt light bulb through the ductwork to detect leaks, although jurisdictions vary on the test methods they allow.

While most jurisdictions accept one or more of the test methods shown in Table 1, light and smoke tests are by far the most frequently applied. But how effective can a test that is meant to prove liquid tightness be when no actual liquid is used in the test?

Square kitchen exhaust duct that has been screwed together in lieu of welding, opening the door for leaks through seams and screw holes. Photo courtesy of Derby Pressure Wash, Louisville, KY

Table 1

Leak Test Method for Field Welded (Unlisted)*	Test Description
Light Test	A light of no less than 100 watts is passed through the entire duct system, including the hood-to-duct connection. If any light shines through any portion of the ductwork in a darkened room, the hole must be found and welded so that the light is no longer visible.
Smoke Test	After the ductwork has been installed and all sealants have cured for the appropriate amount of time, smoke bombs are lit and placed at the bottom of the duct system. Natural upwards drafts will pull the smoke to the top of the duct system. Once the smoke has reached the top of the duct run, the duct is capped-off and all joints are inspected for smoke leaks.
Air Pressure Test	The ducts must be shown to hold a positive air pressure of 1.0 inch of water column for a minimum of 20 minutes. However, this test is often conducted before access doors are installed – so not many jurisdictions accept it.
Water Test	A high-pressure spin jet is passed through the duct system so that the entire duct interior is exposed to spray water. The duct is then inspected for water anywhere on the exterior. A welder is onsite to repair any leaks as they are discovered, and the duct re-tested until no more leaks are discovered.

Professional exhaust cleaners, who are more than accustomed to discovering leaks as soon as they expose duct to their power washers, tend to agree that these non-liquid leak tests are of little use in detecting leaks. That includes Certified Exhaust Cleaning Specialists (CECS) and Certified Exhaust System Inspectors James M. Roberts and Don Pfleiderer, both of whom are members of the ANSI/IKECA Consensus Body Standards Development Committee. "We find leaks in about 90 percent of ducts we service," said Roberts, owner of Derby Pressure Wash in Louisville, Kentucky and a 40-year veteran of the business.

Pfleiderer's experiences are much the same. The President of Enviromatic Corporation of America, Inc., a more than 40-year-old grease exhaust cleaning and inspection company with outlets located throughout the United States, Pfleiderer says that nearly all the kitchen exhaust systems his company services leak – often badly – despite having passed either smoke or light tests.

Pfleiderer's observations are supported by data that he submitted to the ANSI/IKECA committee in 2017. Over the course of one year, Enviromatic performed water tests on 244 grease duct systems, all of which had previously passed smoke or light tests for leakage. The results were startling: 89.3 percent of the systems failed the pressurized water test. In some cases, the leaks were so bad that some of the duct systems had to be entirely replaced.

In a statement prepared for the ANSI/IKECA Consensus Body Standards Development Committee, Pfleiderer wrote:

> "Our investigations have found that welding slag and/or construction debris and dust would cover up the small holes in the ductwork such that they are not discovered during light or smoke testing. . . . In many cases, the leaks are not found until a later time when grease leaks out of the holes of the grease laden ductwork. . . .
>
> "Unfortunately, many leaks are not found until major damages occur, at which point fire wrap is saturated with grease and/or cleaning wastewater. Additionally, these leaks are often in concealed location such as above ceilings or interstitial spaces. This saturation can limit or even eliminate the fire wrap's fire protection capability and can allow fuel buildup to occur in unprotected areas beyond the fire suppression system."

As Pfleiderer's statements to ANSI/IKECA suggests, a little debris is typically enough to obscure a small gap or hole in the ductwork when only light or smoke is used. Failure to test the entire exhaust system is another cause of undiscovered leaks. This frequently occurs when the test is administered after some of the duct system is concealed and/or not easily accessible.

Finally, sometimes a false pass is not so innocent. Installers have been known to smear flux, silicone and/or epoxy seal over weld joints or place a strip of plain old duct tape over a joint in order to pass a light or smoke test. All of these are quick fixes that will eventually fail.

Unfortunately, there are no safeguards or regulations in place to keep any of this from occurring. And when problems do occur, the inevitable finger pointing ensues.

Grease duct seams inappropriately covered with duct tape (typically used for residential clothes dryer exhaust duct), presumably applied to pass a leak test. Photo courtesy of Derby Pressure Wash, Louisville, KY

Putting the Liquid in "Liquid-Tight" Testing

With so much at stake, what steps can owners, engineers, and inspectors take to ensure safe, liquid-tight kitchen exhaust systems?
In the same Engineered Systems article previously referenced, the author writes:

"Despite the good intentions of fabricators and installers, visits to operating foodservice facilities and fire scenes suggest there are challenges with unlisted, welded-onsite ducts, including:

- Integrity – welds not continuous liquid tight;
- Stability – not holding up to exposure of high temperatures (caused by internal grease fires);
- Poor connections between exhaust ducts and hoods, and also ducts and exhaust fans;
- Insufficient duct clearance to combustible construction or noncompliant duct wrapping;
- Improper penetrations of fire-rate barriers;
- Non-compliance with required slope and drainage means; and
- Lack of required access panels for cleaning"[3]

Four of these challenges can be addressed simply by administering a proper water leak test. Such a test simulates an actual duct washing procedure in which a pressure washer is used to internally spray all welds and duct access doors for the length of the duct. A welder must be present to repair each leak as it is discovered, and then section retested to confirm it is liquid tight before moving on to the next section.

Unlike other test methods, water testing:

- Pinpoints the exact location of leaks, despite any debris, duct tape or sealant that may be covering the hole.
- Ensures that access doors have been properly placed for inspection and cleaning and that they provide liquid tight closure.
- Allows for early discovery of insufficient sloping and drainage of the duct.
- Typically includes documentation and pictures of the system and procedure to verify to the inspector that the test has been done correctly.
- Ensures the problem is discovered during an inspection, not after the kitchen has been approved and is in operation.

The ANSI/IKECA Consensus Body Standards Development Committee is already onboard and released the following statement on January 18, 2018:

Committee: ANSI/ IKECA Consensus Body Standards Development Committee

Topic: Leak Testing of Type I Grease Duct Systems

It is the position of this committee that all Type I grease duct systems be tested to meet the requirements of the International Mechanical Code (IMC), Uniform Mechanical Code (UMC), National Fire Protection Association (NFPA) 96, and ASHRAE Standard 154 to ensure these systems are liquid-tight as required by the codes and standards.

It is further the position of this committee that to ensure the "liquid-tight" requirement is upheld, water-testing as described in ASHRAE 154, 2016 edition section 5.2.1.2 be the method of execution for performing these tests.

While several of the codes and standards do offer alternative testing to the water-test method, it is the experience of this committee that the other methods are less than 100% accurate in the determination of leak locations within the grease duct systems.

Some owners have already standardized on water testing prior to kitchen start-ups. Among them, the well-known restaurant chain, Chipotle.

In an article published in Facilitator magazine, Carolyn Roberts, the Executive Director of Facilities, Construction, Design and Sustainability formerly with Chipotle, describes working with Enviromatic to revamp the chain's protocols related to exhaust systems, including leak testing and cleaning. In the midst of these efforts, Roberts and her team were stunned when Enviromatic discovered over 90 duct leaks in one restaurant undergoing construction. Ironically, the fire inspector was just about to sign a "pass" test right as the Enviromatic crew arrived to administer a water leak test.

Since then, Chipotle has worked hard to implement a protocol for power washing/leak testing in all its locations.

> "After more than eight years, we feel that all our efforts have paid off in spades—not only for Chipotle and our two other concepts—but also for the restaurant industry as a whole. Many municipalities now require water leak testing as their only approved method. Insurance companies offer discounts for premiums by employing this method of cleaning, which quickly pays for many months of regular maintenance." [4]

Many jurisdictions within densely built urban areas, including New York City, Boston and Las Vegas, have also implemented strict requirements for regular cleaning of kitchen exhaust systems. In Boston, a city that has suffered some of the deadliest grease fires, cleaning contractors have 24 hours to report a duct deficiency (e.g. leak) that they discover during a routine cleaning.

These measures underscore the value of pressurized water not just for cleaning but for leak discovery.

Conclusion

Leaking exhaust systems in commercial kitchens are a precursor to a broad set of problems for owners, ranging from varying degrees of property damage to far more devastating consequences that include fire, loss of property, loss of life and all manner of litigation. Traditional methods for leak testing have failed to ensure that ducts meet the liquid tight requirements of the IMC and the NFPA. Water testing, which involves commonly administered power washing procedures, is an owner's best bet for avoiding the many consequences of leaking grease ducts. Such testing not only leads to the discovery and location of the smallest leaks, it alerts owners to other problems like improper drainage and missing or crudely installed access doors. It is also favored by a consensus body of professionals in the kitchen industry. Leak-free, prefab grease duct reduces the probability and consequences of fire and mold.

Owners and engineers would be well-advised to make water testing a non-negotiable requirement for kitchen start-ups.

[1] Horton, Doug. March 2015. "Issues and improvements in commercial kitchen exhaust ducts." Engineered Systems: 42-50.

[2] Horton, Doug. 2015. "Issues and improvements," 44.

[3] Horton, Doug. 2015. "Issues and improvements," 42.

[4] Roberts, Carolyn. Oct/Nov 2014. "Out with the old, in with the new, how Chipotle helped reimagine the exhaust hood cleaning process." Facilitator: 52-53.

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