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*DON'T MISS*

# MITIGATING RISKS OF COMMERCIAL KITCHEN FIRES

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Commercial kitchens are located in increasingly diverse types of buildings. In addition to restaurants, commercial kitchens are found in hotels, retail complexes, schools, universities, airports, office buildings, residential buildings, convention centers, hospitals, factories, elder care facilities and nursing homes, and in catering, cooked food packaging, military feeding and correctional facilities.

With more commercial kitchens, there are more fires. What's surprising is that some fires in commercial kitchens are not being reliably detected and extinguished by conventional fire suppression systems in exhaust hoods, causing damage to buildings, business interruptions, lost revenues, lawsuits and injuries.

Some of the increase in commercial kitchen fires is related to the increasing use of solid-fuel cooking. When moisture is present when wood is burned, incomplete combustion produces highly combustible creosote deposits in hoods and ducts, which adds to the usual fire risk of grease and complicates fire detection and suppression.

Creosote has relatively low flashpoint and auto-ignition temperatures, and many creosote fires start initially in exhaust ducts, above conventional fire suppression system detectors, from sparks, embers and high temperatures. Alternatively, they start in hoods and move into ducts faster than they can be detected by conventional suppression systems.

## Selected case studies

The headquarters of a famous comedy club, theater and performance school experienced a three-alarm fire that ignited in a restaurant's natural gas cooking line in the multi-story complex of buildings. Quoting the fire department spokesman, "the blaze made it past a fire suppression system and spread through vents to the roof."[1] The conventional fire suppression system actuated, but the fire was already burning in the exhaust duct and spread to two floors of offices and the roof structure. Estimated damage and lost business was US$9 million.

A privately owned restaurant recently experienced its third significant fire from a wood-burning combination charbroiler and rotisserie. Significantly, the 11,000-square-foot (1,022-square-meter) restaurant is located on the ground floor of a city-block sized, multi-story condominium building. After the latest fire, the restaurant space was offered for lease, and condominium sales lagged.

In another restaurant, on the ground floor of a three-story building, fire ignited in a pizza and baking oven fueled with both natural gas and wood. According to the fire report,[2] "The heat became so intense, that it burned the buildup of creosote off the inner wall of the oven." The fire was not detected by the conventional fire suppression system and it did not discharge.

An analytical report describes 13 typical commercial kitchen fires, and close reading reveals that in five of these fires, suppression systems did not operate properly.[3]

## Fire suppression issues and solutions

- **Conventional systems.** There are several manufacturers of conventional commercial kitchen fire systems. These systems are sometimes unreliable in extinguishing some cooking fires, especially with solid fuel cooking, for several reasons.

- **Detection.** Conventional systems typically detect fires with fusible links, which is a century-old technology. Detection requires time for the solder holding the brass links together to fuse (melt) when temperature is above set point such as 360 degree Fahrenheit (182 degrees Celsius). Even if the links separate, there are numerous mechanical actions that must occur to actuate typical conventional systems, and even if the system is actuated, a fixed amount of liquid suppressant is dispersed for only about one minute.

- **Fire speed.** Another detection and suppression issue is the speed with which cooking fires can travel. As a minimum, fires travel at the speed of exhaust airflow. With an example duct length of 15 feet (4.6 meters) and exhaust speed of 1,500 feet per minute (457 meters per minute), it takes less than one second for fire to travel the length of the duct.

- **Fuel shut-offs.** Unlike the ability of conventional fire suppression systems to automatically shut off natural gas and electricity to appliances, there is no means of automatically turning off burning solid fuel.

- **Reliability analysis of conventional systems.** There are about 30 sequential actions and component functions necessary for setup, detection, actuation and suppression with typical conventional systems. Many of these actions and components are "go" or "no go," with resultant system failure if only one action or component fails. Examples include grease-encrusted fusible links and fouled detection cables.

- **Spark arresters.** Though "spark arrestor filters" are available, there are no known standards or listing tests for application of these products to hoods over solid fuel cooking.

## Fire suppression system improvements

Manufacturers are making progress with improved systems. One newer system dispenses liquid chemical suppressant for about one minute, as usual, and then dispenses building water through system piping and nozzles, but this system is still constrained by fusible links detection.

Another system incorporates electronic detection, but it's still constrained by a fixed amount of suppressant and limited spray time. A U.K. company offers a system with electronic detection, operation, and monitoring, with battery backup. This system has approvals for the European Union, though its operation is limited by a fixed amount of suppressant.

## Advanced fire suppression systems

The most technologically advanced fire suppression systems incorporate electronic detection, operation and system monitoring, with backup power supply and optional network communications. Suppression is provided by unlimited water with surfactant added to enhance fire surface wetting.

Coating fire surfaces with water and surfactant limits fuel surface temperatures, and it deprives fire surfaces of oxygen, to rapidly extinguish fire and eliminate spread. Also, as the droplets vaporize, the increase in water vapor volume also displaces oxygen. One manufacturer's advanced system also automatically cleans the hood plenum, lower duct and lower duct detector with hot water and surfactant, as more fully described in Reference 4. Jurisdictional acceptance of fire suppression systems is based on conformance to applicable codes and standards.

## Exhaust duct issues

Applicable codes and standards also provide requirements for exhaust ducts connected to grease and smoke emitting exhaust hoods. In the U.S., for example, for buildings with three stories or less, it's common practice to install unlisted, welded-on-site ducts. These ducts are intended to conform to country standards for materials, welding, connections, slope, drains, cleaning access and other requirements, but despite good intentions, there are many fire challenges with welded-on-site ducts, such as:

- Welds not continuously liquid tight;
- Instability when exposed to high temperatures;
- Poor connections between exhaust ducts, hoods and exhaust fans;
- Insufficient duct clearance to combustibles or noncompliant duct insulation;
- Improper penetrations of fire-rated barriers;
- Noncompliance with required slope and drainage means; and
- Lack of required access panels and required spacing for cleaning.

A U.S. national standard requires that listed, factory-built ducts must be utilized with solid fuel cooking in buildings with exhaust systems of four or more stories.[5] Depending on location and application, ducts and accessories can be tested to several standards. When tested to grease duct standard UL 1978 by a large U.S. manufacturer, unlisted ducts enclosed with insulation performed poorly, collapsing from retained heat and thermal stresses.

Based on robust design, versatility and safety as a result of rigorous evaluation and fire testing, specification and installation of listed factory-built duct products makes sense, especially for solid-fuel cooking, with which combustible creosote adds to grease as fire risks.

## Clearance to combustibles

Non-compliance with code and standards requirements for clearance to combustible construction components often causes small fires to spread and cause significant losses. The most frequent non-conforming issue is appliances, hoods and ducts installed without required clearances to often-hidden wood construction. Examples are the installation of hoods against stainless steel backsplashes, mounted on a single sheet of gypsum wallboard attached to wood studs and similarly, hoods installed on gypsum wallboard mounted to wood ceiling joists.

With reference to U.S. codes and standards, neither of the preceding examples meets the general 18-inch (46-centimeter) clearance requirement. However, codes and standards provide methods for reducing clearances, such as using metal beams, joists, studs and trusses near planned locations of appliances, hoods, ducts and exhaust fans.

## Hood and duct cleaning

The U.S. National Fire Protection Association (NFPA) 96 Section 11.6.2 states that kitchen exhaust components "shall be cleaned to remove combustible contaminants prior to surfaces becoming heavily contaminated with grease or oily sludge." The "oily sludge" is likely creosote, grease or a combination of the two. Section A.4.1.6 states: "When solid fuel is burned in cooking operations, increased quantities of carbon, creosote and grease-laden vapors are produced that rapidly contaminate surfaces, produce airborne sparks and embers, and are subject to significant flare-up."

NFPA 96 Section 11.4 indicates, "The entire exhaust system shall be inspected for grease buildup by a properly trained, qualified and certified person(s) acceptable to the authority having jurisdiction and in accordance with Table 11.4," which shows a monthly inspection frequency for "systems serving solid-fuel cooking operations." On the other hand, a prominent fire investigator and writer about commercial kitchen fires suggests, "buildup from solid fuel cooking can create a serious fire hazard in as little as a week."[6]

## Mitigating risk

Solid-fuel cooking is a growing trend in commercial kitchens, and there is increasing fire risk of related creosote deposits from incomplete combustion of wood, particularly in exhaust ducts that likely have grease deposits also. Mitigation of this risk calls for improved kitchen fire suppression systems, use of listed factory-built ducts, full compliance with clearance to combustible construction, and frequent inspection and aggressive cleaning of exhaust systems. **FMJ**

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