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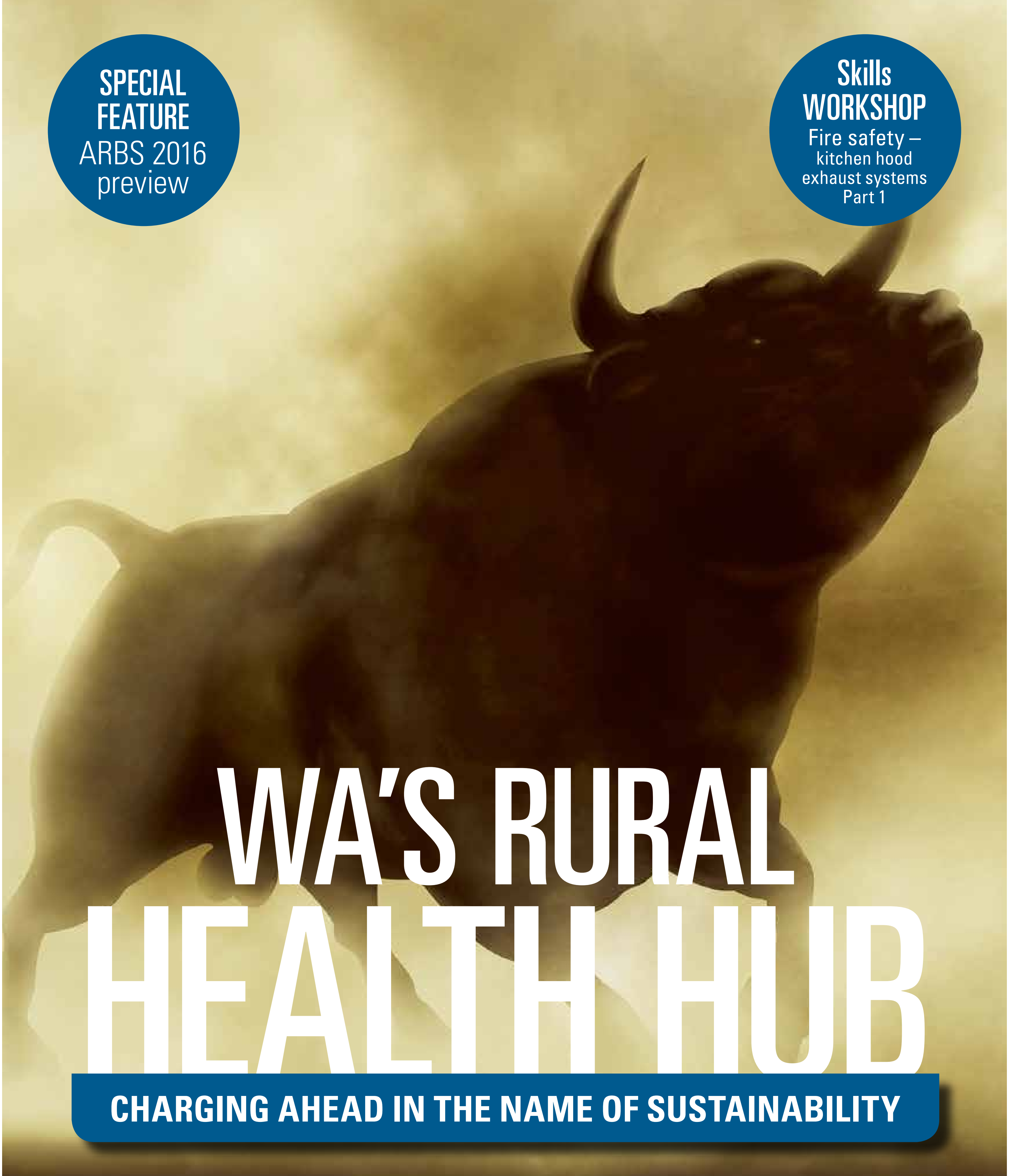

SPECIAL FEATURE
ARBS 2016 preview

Skills WORKSHOP
Fire safety – kitchen hood exhaust systems Part 1

WA'S RURAL HEALTH HUB

CHARGING AHEAD IN THE NAME OF SUSTAINABILITY

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HVAC&R Skills Workshop

MODULE 89

FIRE SAFETY – KITCHEN HOOD EXHAUST SYSTEMS

PART ONE

Given the presence of heat and high fuel loads, fires in kitchens are not uncommon. However, when the incident extends into the mechanical exhaust system, safety risks and building impacts can rapidly escalate, sometimes resulting in devastating and widespread damage. In the first of a two-part bulletin, Skills Workshop will discuss and address the special fire risks inherent in commercial kitchen ventilation systems and offer best-practice approaches to take in order to minimise the risks.

PULLOUT

WHAT IS THE PROBLEM?

Fire that take place in mechanical exhaust systems are high-intensity fires that move and spread rapidly. They are difficult to locate and extinguish, and are susceptible to remote re-ignition and break-out.

Part one of this technical bulletin aims to help raise awareness among property owners and restaurant proprietors about the fire risks and dangers associated with kitchen exhaust ventilation systems. It discusses the inherent fire risks, outlines regulatory and compliance requirements, highlights recent changes to applicable Australian Standards, looks at best-practice approaches, and emphasises the importance of ongoing effective cleaning and maintenance.

FIRE FACTS

Duct fires can be intense and reach temperatures of 1,000°C within minutes – hot enough to melt some metals and ignite surrounding combustibles. Fire statistics from Australia, the UK and the US show that fires in restaurants predominately occur in kitchens. The ignition of cooking materials accounts for almost half of all commercial kitchen fires and almost all of these (90 per cent) get into the kitchen hood exhaust system. Many restaurants never re-open after suffering a fire loss. Insurance policies may exclude claims related to uncleaned or grease-laden exhaust ducts. Insurers are aware of these fire risks – are you?

Always read the small print!

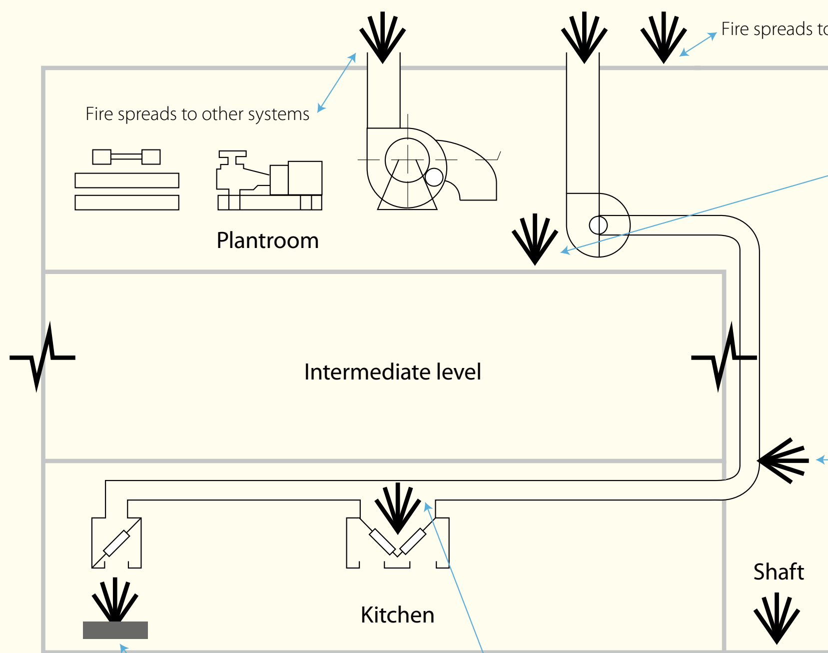


Fig 1: Fire in kitchen spreading into duct and then fire in duct spreading/breaking-out to another area.

KITCHEN EXHAUST FIRE HAZARDS

Fires are common in restaurants and typically start in the kitchen area. Cooking materials are the most frequent "first item" ignited. Experience shows that the majority of kitchen fires will involve the kitchen exhaust hood or ductwork.

Kitchen exhaust fires can spread in a number of ways. A fire that originates within the kitchen or at the hood filters can spread into and up the ductwork system, fuelled by the oil and grease within the duct. A fire within the duct can ignite combustible materials outside of the duct, via radiant heat transmission, or can ignite grease that has leaked out of duct seams, spreading the fire in the building. Because fire dampers are not allowed within kitchen exhaust ductwork, fire spread within and between ducts can compromise a building's passive fire protection such as fire-rated compartments.

Fire dampers, which are usually installed in ventilation ducts to prevent fire spread, are not permitted within a kitchen exhaust duct system. They do not work in kitchen exhaust because grease on the downstream side of the damper will ignite before, and irrespective of, damper closure. The potential for false operation of the fire damper is also greater than normal and closure, other than in a fire situation, can have serious consequences for kitchen ventilation.

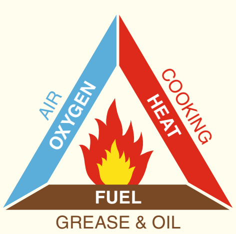
A fire within the duct can ignite combustible materials outside of the duct, spreading the fire in the building.

Restaurants in buildings are a fire hazard. When a restaurant is located in a larger building or complex, such as a hotel, hospital, mall, airport or multi-storey residential development, the risks increase exponentially. A fire in a kitchen exhaust system in Heathrow Airport shut down three terminals, delayed or cancelled hundreds of flights, and generated hundreds of millions of dollars in losses that far exceeded the physical damage bill. That fire spread through 200m of exhaust ductwork to a plantroom before it was extinguished.

IDENTIFYING THE FIRE RISKS

A fire within the duct system generally occurs due to the ignition of flammable material that has built up at the grease removal device (filters). The combination of fuel, air movement and heat can result in a strong and significant fire event.

All fire risk analysis fundamentally boils down to the three elements that are required for a fire to occur: fuel, oxygen, and ignition or the Fire Triangle. Fire prevention must disrupt one or more of these elements.



The Fire Triangle – fuel/heat/O_2 = grease/flame/air.

Without heat the fire can't begin, without fuel the fire can't grow and without air the fire can't spread.

In a commercial kitchen hood exhaust ventilation system all three of these elements are highly prevalent –

Fuel: The grease derived from cooking processes enters the system with the ventilation air. High air velocities help to entrain and entrap cooking contaminants. Grease filters will capture a percentage of this, depending on their performance efficiency, installation quality, and cleanliness management. No filter captures 100 per cent of the grease, and any grease that passes through or around the filters will build-up on the internal hood, duct, and fan surfaces. Accumulated grease can leak out through duct seams and joins, or can pool in some parts of the ductwork to provide reservoirs of warm, highly flammable fluids and vapours that are ripe for ignition. Solid fuel cooking can create volatile gases created by incomplete combustion of the wood. These gases condense in the exhaust duct and mix with water vapour to form a tar-like creosote substance that sticks to the duct.

Ignition: There are many ignition sources within commercial kitchen environments: open-flame cooking devices, flaming cooking techniques, sparks and soot from wood or charcoal burners, even the heat generated from some types of cooking appliances can provide enough energy to ignite warmed grease, which then only needs a supply of oxygen to continue burning. Flare-ups from cooking equipment are the dominant cause of ignition.

Oxygen: The primary purpose of the ventilation ducts is air movement, so there is more than enough air available within the duct system to support a large fire. Once combustion commences the duct often acts as a chimney, channelling smoke and air to ventilate the fire. If this occurs in the reverse direction, large amounts of hot toxic smoke can enter the kitchen area and building, via the hoods.

Grease, oil and fire: Frying creates grease similar to transparent creosote oil, while frozen foods with a higher water content result in a hard, glossy layer of grease. Some Asian methods of food preparation create sticky syrup-like grease. Meat cooked on a solid-fuel stove or over coals produces large quantities of rendered fat. Animal fat and cooking oil have a high energy value of around 45,000kJ/kg, similar to diesel fuel oil. Vegetable oil burns with a hotter flame than animal fat, at temperatures around 1000°C. Animal fat vaporises at 120 to 220°C, reaches flash point at 280°C and spontaneously combusts at 310 to 360°C. Modern cooking practices use more vegetable oil than animal fat, more high-energy intensity appliances, and a wider range and mix of cooking processes and fuels than previously.

Fire-related hazards in a kitchen include:

- Flames, sparks and hot gases from food preparation can ignite residues in exhaust ducts
- Food preparation equipment left without supervision during operation
- Failure to switch-off equipment, especially at the end of activity
- Overheated oils that can lead to spontaneous combustion
- Food preparation equipment based on solid fuels
- Gas blowtorches used for browning some foods
- Poorly operating thermostats or lack of thermostat or fault-detecting equipment
- Faulty or overheating electrical equipment
- Metal exhaust flues that conduct heat and ignite nearby material or debris
- Ovens without igniters/pilot lights (lit with burning pieces of paper).

ADDRESSING THE FIRE RISKS

Meeting the latest standards

Compliance with the relevant standards is very important.

The National Construction Code (NCC V1 2016) requires that commercial kitchens are provided with kitchen exhaust hoods in compliance with AS 1668.1-2015 and AS 1668.2-2012. In order for a hood to comply with AS 1668.1, the whole exhaust system must comply. These standards have been updated and it is important that designers and installers are working to the correct editions. The NCC and AS 1668.2-2012 determines where kitchen exhaust hood systems are required, the minimum ventilation rates, the construction details in terms of functionality and hygiene and, importantly, the minimum distances between the grease removal device and the heat source. The NCC and AS 1668.1-2015 specifies the design and installation precautions that need to be included to mitigate the results of any fire that occurs in the exhaust system.

Section view of a hood

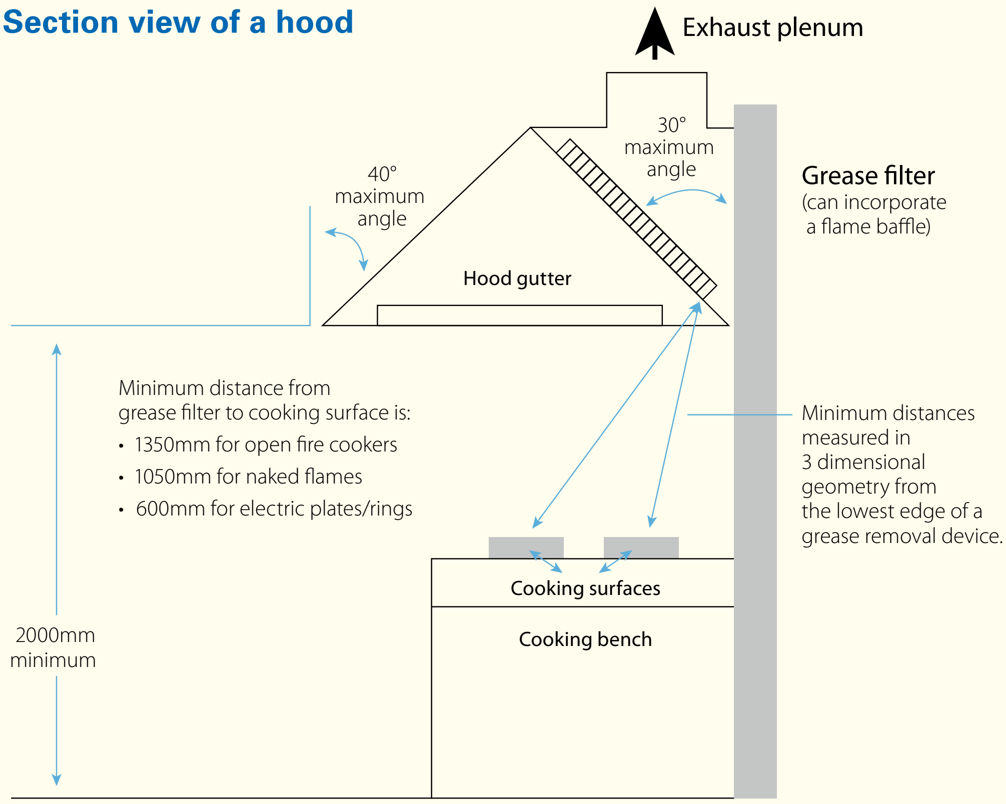


Fig 2: Minimum filter separation to cooking surface.

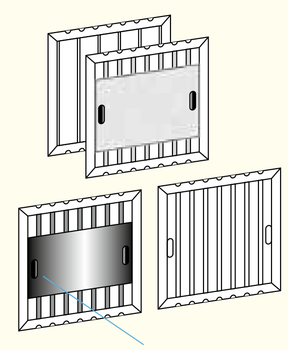
AS 1668.1 requires 300mm separation or fire insulation between ducts and combustible materials, and separate shafts for kitchen exhaust ducts from different compartments. Flame barriers (in accordance with UL 1046) are required in hoods under some circumstances, such as when the length of kitchen exhaust ductwork within the building exceeds 10m in length or where exposed flames or embers are part of the cooking process. Where appliances can produce sparks – e.g. solid-fuel ovens – a spark arrestor is required at the connection. Systems that are already operating should not shut down in fire mode.

Where located in a building required to have fire sprinkler protection to AS 2118.1-1999 or AS 2118.4-2012 kitchen exhaust systems must also be protected with sprinklers. Both standards require sprinklers to be installed under kitchen hoods and within kitchen exhaust ductwork.

Pre-engineered fire protection systems:
It is recommended that pre-engineered fire protection systems, in accordance with AS 3772-2008, be installed instead of sprinklers within kitchen hoods to protect cooking equipment such as deep fat fryers, sprinklers are still required in the ductwork. These are typically wet (water/chemical) suppressant based systems that require an alternative solution to meet the requirements of the NCC and should be maintained in accordance with AS 3772.

Grease filters

If the cooking process generates grease or oil, and most do, then AS 1668.2 requires that grease filters or grease removal devices are provided to reduce grease entering the exhaust duct. There must be a minimum distance between the grease removal filter and the cooking surface – 1350mm for open-fire cookers (charcoal or wood fires), 1050mm for naked flames (gas cooking), and 600mm for electric plates and rings. Filters should be easily accessible and removable for cleaning and be installed at an angle not less than 30 degrees from vertical.



Typical filters and baffles.

Grease particles can be broken down into three size categories: grease smoke particles ranging from 0.03 to 0.5 microns, grease steam particles (grease-covered moisture particles) ranging from 0.5 to 6.0 microns, and grease spatter, or larger visible particles ranging from 6.0 to 150 microns. Different filter designs work better for different particle size ranges and not all devices can capture all particle sizes effectively. High temperature cooking processes convert some grease into the gaseous phase which cannot be captured by filters and eventually condenses and accumulates on ductwork walls.

Grease filters can't prevent grease entry into the exhaust system but they can reduce entry and extend the length of time required between duct cleaning.

Ductwork

AS 1668.1 requires ductwork outside of dedicated fire-resistant shafts or structurally independent fire-resistant enclosures to be manufactured from 1.2mm galvanised steel, 0.9mm stainless steel, or equivalent. Ducts must be vertical where practicable. Ducts that are not vertical must be graded upwards (at least 1:200) in the direction of airflow allowing grease and moisture to drain back towards the hood.

Drainage points fitted with a grease tight tap or plug must be provided, as well as access panels/cleanout hatches at each change in direction and every 3m run of (non-vertical) ductwork.

Access panels must be airtight and not compromise the fire integrity of the exhaust duct. Joints and seals must be grease tight; fully welded, rivet and soldered, or be sealed with a liquid mastic or sealant that is unaffected by water, grease or cleaning solvents. Flexible connections must be grease tight, grease proof, fire resistant and not longer than 300mm.

Vertical ducts are safer ducts:
Horizontal duct runs should be minimised on all systems as there is a high risk of grease build-up and grease leakage in these sections. They also have the potential for the reverse flow of smoke into the kitchen during a fire event. Ducts should be vertical and take a direct route (or as short as possible) to the outside.

FURTHER INFORMATION

- AIRAH DA19 HVAC&R Maintenance - Schedule A18.2 Kitchen Exhaust ducts (and hoods)
- Australian Standards AS 1841-2007 series of standards, AS 1668.1-2015 Section 6, AS 1668.2-2012 Section 3 and Appendix E, AS 1851-2012 Section 13, AS 2118.1-1999 or AS 2118.4-2012, AS 3772-2008, and AS 4254.2-2012 Section 2
- American National Standards Institute (ANSI) and International Kitchen Exhaust Cleaners Association (IKECA)
- ANSI/IKECA C10: Standard for Cleaning of Commercial Kitchen Exhaust Systems
- Building & Engineering Services Association Guide to Good Practice TR/19 - Internal Cleanliness of Ventilation Systems
- Food Standards Australia and New Zealand the Australia New Zealand Food Standards Code
- FPA Australia Good Practice Guide GPG03 Adoption and Use of AS 1851-2012

PULLOUT

Next month: Fire safety – kitchen hood exhaust systems pt. 2