



RC36

for fire
prevention
measures for
bakery ovens

LOSS PREVENTION RECOMMENDATIONS

These recommendations are part of a series of insurer documents developed under the Insurers' Fire Research Strategy Funding Scheme (InFiReS) and published by the FPA. InFiReS membership comprises a group of UK Insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of property and business from loss due to fire and other risks. The technical expertise for the Recommendations is provided by the Technical Directorate of the FPA and experts from the Insurance Industry who together form the InFiReS Risk Control Steering Group.

The aim of the FPA Series of Recommendations is to provide loss prevention guidance for industrial and commercial processes and systems. The series continues a long tradition of providing authoritative guidance on loss prevention issues started by the Fire Offices' Committee (FOC) of the British Insurance Industry over a hundred years ago and builds upon earlier publications from the LPC and the ABI.

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Front cover shows an oven with the associated ductwork at one of Northern Foods operating sites

1 Introduction

Over the years a number of fires have occurred in bakeries, resulting in large losses. Some of these have been attributed to ovens of one type or another.

Numerous ovens of different types and sizes are likely to be found in commercial bakeries depending on the size of the bakery, variety of products and production rates. Oven types may include travelling, rack and indexing ovens and in some cases traditional wood burning ovens.

To ensure that an adequate level of protection is provided which is suited to the risk, it is important that oven installations are made the subject of a suitable fire risk assessment.

This specific fire risk assessment will be part of the more generic assessment that is carried out for the premises as a requirement of current fire safety legislation. Consideration of the ovens will also form part of the explosion risk assessment carried out in compliance with the Dangerous Substances and Explosive Atmospheres Regulations 2003 (DSEAR).

The assessments should take into consideration:

- the age, size and type and design of the oven;
- the type of fuel being utilised;
- the type of food product and the quantity being processed;
- the conditions that may result in the overheating and ignition of the food products being processed;
- ancillary processes nearby to which smouldering or burning foodstuffs may be transferred or which may be affected by a fire in an oven;
- any combustible materials or packaging nearby to which a fire could spread;
- the compartmentation of the area in which the oven is located;
- the proximity of any combustible construction such as insulated composite panels with combustible cores;
- the presence (or absence) of a fire suppression system;
- maintenance of components and fuel systems.

Improvement measures which may be implemented as a result of a risk assessment should reduce to an acceptable level the risk associated with the type of equipment in operation.

2 Scope

This document aims to provide an understanding of the types of ovens used in the baking industry; the fire hazards associated with them and the appropriate fire protection measures which should be considered. It is not the intention to address smaller ovens, which are catered for adequately in recognised codes of practice or standards such as those produced by the British Standards Institution.

3 Standards and codes of practice

Small ovens with low heat input rates are addressed by recognised standards or codes of practice. BS EN 1673: 2000 *Food processing machinery – Rotary rack ovens – Safety and hygiene requirements* is an example (ref. 1). Larger units, however, such as high volume batch ovens and travelling or continuous ovens are not dealt with by a single standard.

Research indicates that NFPA 86 *Standard for ovens and furnaces* (ref. 2) is an accepted benchmark for certain aspects of the location, design and construction of bakery ovens.

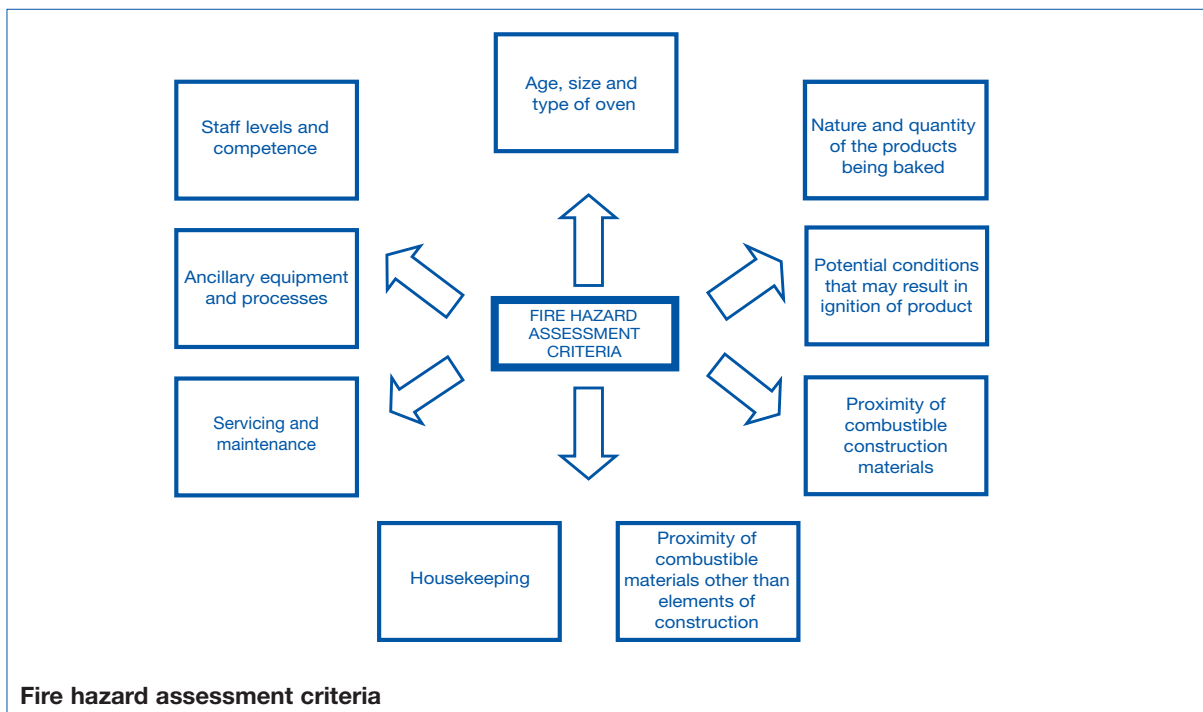
The NFPA standard does not differentiate between an oven and a furnace and makes reference to both types of equipment. The NFPA *Fire Protection Handbook* (ref. 3), however, suggests that it is an industry 'rule of thumb' to classify heating devices operating at less than 540°C (1000°F) as ovens.

NFPA 86 describes four classes of furnace. Bakery ovens fall within the definition of a Class A furnace. This is described as any 'oven or furnace that has heat utilization equipment operated at approximately atmospheric pressure where there is a potential explosion or fire hazard that could be occasioned by the presence of flammable volatiles or combustible materials processed or heated in the furnace'. The definition goes on to mention that 'potentially flammable materials such as quench oils, waterborne finishes, cooling oils, or cooking oils in sufficient quantities to present a hazard should be ventilated according to Class A standards'.

The recommendations of NFPA 86 do not apply to ovens with heating systems of less than 44kW. It is important to note that any equipment with heating systems below this figure should be listed by a suitable authority as meeting appropriate design standards or that the equipment has been tested and found to be fit for purpose.

Other documents that address fire safety for bakery ovens directly include:

- ANSI Z50.1-2000: *American National Standard for Bakery Equipment – Safety Requirements* (ref. 4).
- BS EN 1673: 2000: *Food processing machinery – Rotary rack ovens – Safety and hygiene requirements*.



4 Definitions

- 4.1 Duct: Enclosure, usually metal, constructed as a route to transfer gases and vapours from the cooking area of an oven.
- 4.2 Flue: Enclosure, usually metal, constructed as a route to remove the products of combustion from the burners in a gas or oil fired oven and the fire box of a wood burning oven.
- 4.3 Fire resistance: The ability of an element of construction to withstand exposure to a standard temperature/pressure and time regime without loss of its fire separating function. (This may be expressed in terms relating to the anticipated performance of the element with respect of BS 476: Parts 20, 21, 22, 23 or 24 or the relevant parts of BS EN 13501.)

5 Types of ovens

The types and sizes of ovens used in the baking industry will vary in relation to the type and volume of products being baked. Ovens include:

- batch type units (rack ovens) in which the goods to be baked are placed on racks that are placed or wheeled into the oven and then removed when the baking process is complete;
- continuous or travelling ovens in which the goods to be baked are placed on a conveyor and pass through the oven on a continuous basis.

Ovens can be heated electrically or be fired using gas or oil. The latter may be either directly fired where the fuel is burnt in the baking chamber or indirectly fired units where the burners are in a separate enclosure preventing the products of combustion from entering the baking chamber. Directly fired units present the greatest

explosion and fire hazard but these are fortunately the least common. Wood burning ovens may also be encountered in certain small specialist bakeries.

6 Fire hazard assessment criteria

6.1 Age, size and type of oven

There is a potential for fire and explosion in ovens using gas or fuel oil under certain conditions.

The two main types of fired ovens used are:

- Direct fired types where the fuel is burnt directly in the baking chamber.
- Indirect fired types where the burners are enclosed in such a way that the unburned gases and products of combustion do not enter the baking chamber.

Both are available as recirculating types where the combustion gases are recirculated through the system. Direct fired ovens present the greatest hazard.

Oil and gas fired units present a hazard during the burner ignition process partly due to the potential for build-up of flammable vapours. Modern burners incorporate purge systems and automatic burner management systems that reduce the risk of explosions significantly. Older units may not have such systems, in which case the explosion risk is increased.

Direct fired ovens may have combined oven and burner ventilation systems whereas indirect ovens are likely to have separate systems.

Some ovens use internal gas burners to brown products. The presence of such burners, which could ignite the product, thus present an additional hazard.

- As an alternative to fuel-fired units, ovens may be electrically heated.
- Wood burning ovens present hazards regarding the storage of wood and the removal of ash.
- A further fire hazard will arise if components of an oven's construction, such as its thermal insulation, are made of combustible material or contain combustible substances such as absorbed cooking oil.
- Similarly the build up of combustible residue in ventilation and extraction systems will also present a fire hazard.
- The effectiveness of maintenance regimes in controlling the build-up of combustible residues should be taken into account when assessing the fire and explosion risk.
- 6.2 *Nature and quantity of products being baked*
- Most baked products present a low hazard at the start of the baking process because of their essentially wet nature. This changes during baking and towards the end of the cycle the products are capable of burning if heated sufficiently.
- The fire hazard presented by the goods being baked will be influenced by the quantity of product in the oven at any one time and the nature of the product. The amount of cooking oil present in the product or used to grease pans or coat the product may influence the ease of ignition, the heat released once ignited and the potential for spread to other products in the oven. Accumulations of crumbs and the build up of oil residue on the interior surfaces of the oven and on components such as ventilation ducts will also have an effect.
- Using the oven for products of a different shape and size from those for which the process was designed may also increase the risk of fire. It is important to determine during the assessment that the loading capacities of the ovens are not being exceeded and the risk of product becoming jammed in the oven is assessed and controlled.
- The effect of any fire that may occur should be assessed fully. It is important to establish if the fire will be localised or is likely to spread and if there is sufficient access to concealed areas to facilitate manual fire suppression using portable fire equipment.
- 6.3 *Potential conditions that may result in ignition of product*
- This involves assessing the possibility of overheating of product due to the failure of the temperature control systems or, in the case of travelling ovens, a change in the speed of the conveyor.
- The effect that power failure may have on a continuous oven bringing the unit to a standstill resulting in the product overheating and igniting if left long enough should also be considered.
- 6.4 *Proximity of combustible construction materials*
- The proximity of combustible construction to the oven, such as composite panels using combustible insulation, is another hazard that requires assessment. Ventilation or extraction ducts passing through combustible construction without being suitably insulated should not be overlooked.
- Control panels should be mounted on fire-resistant boarding rather than directly on composite panels with combustible cores.
- 6.5 *Proximity of combustible material other than elements of construction*
- Examples are packaging materials or fuel for wood burning ovens stored in the immediate vicinity of the oven in sufficient quantities to ignite or spread fire.
- 6.6 *Housekeeping*
- The effectiveness of the housekeeping procedures, in keeping oven working areas, access and escape routes clear of combustible materials, trolleys and other equipment should be considered in the risk assessment (see section 7).
- To ensure operator safety, all waste or products falling onto the floor should be cleaned up without delay.
 - Where applicable, drip trays or crumb trays should be provided beneath the ovens.
 - Paper records, production sheets, staff shift rotas and similar documentation should be kept away from all ovens.
 - Staff should be prohibited from standing or walking on the tops of ovens. Where walkways are required these should be designed and installed specifically for this purpose.
 - All mixing of ingredients and similar processes that may introduce dust into the atmosphere should be undertaken well away from the ovens.
 - All packaging processes should also be undertaken well away from the ovens.
- 6.7 *Maintenance*
- The effectiveness of the servicing and maintenance regimes for the ovens and their peripheral equipment, including conveyors, should be included in the assessment of the fire risk.
- 6.8 *Ancillary equipment and processes*
- These include operations such as the preparation of the products, the freezing facilities, cooking

operations, engineering workshops, raw materials and finished goods storage, all of which need to be taken into consideration when assessing the fire hazard.

The possibility of the flames from burning product igniting plastic conveyors should be addressed. Several serious fires have resulted from burning plastic conveyors producing a rapid fire spread. This type of conveyor is often used to provide long cooling runs for certain types of product.

Where the product specification allows it, forced cooling is preferred using metal trays. This avoids the need for lengthy conveyor runs in close proximity to the oven. Loss experience shows that such runs provide routes for rapid fire spread when a product ignites within an oven and passes on to the conveyor. This is a particular hazard when the conveyors used for this purpose are made from combustible plastics.

If it is not possible to use forced cooling on metal trays due to the nature of the product, such as biscuit manufacture where cracking under forced cooling is likely, then facilities should be provided for diverting burning product away from the main production conveyor.

There are normally facilities on oven product delivery routes to divert damaged or flawed product to a waste bin as part of quality assurance, especially during start up and shut down procedures. Such facilities should be designed to safely accommodate burning as well as faulty product. To this end the waste receiving bin should be of non combustible material, be provided with a lid or other means of covering to exclude air and be emptied frequently to avoid the accumulation of large amounts of combustible waste product in the bin.

The diverting mechanism should be clearly marked and readily accessible.

Oven operators should be trained in the use of product diverters as an emergency procedure in addition to a quality control measure.

Consideration should be given to providing an automatic diverting system operated by automatic fire detectors on the oven product delivery route.

Cooling trays or cooling tunnels of combustible construction, or utilising combustible insulation, are further examples of potential routes for fire spread from burning product.

6.9 Staff levels and competence

Many operations in the food processing industry are now being carried out by fewer staff in order to increase the efficiency of the process as well as to avoid repetitive strain injuries and to increase staff job satisfaction.

The number of staff working on the baking process, or in the immediate vicinity of the ovens, is a further factor that may affect the severity of the consequences of a fire originating in an oven. Immediate intervention by experienced and well trained staff may serve to mitigate the threat to life and property, as well as minimise business interruption.

Where staffing levels are reduced, serious consideration should be given to the installation of automatic fire detection or, preferably, fixed fire suppression systems.

The fire hazard identification should include potential ignition sources, fuels, explosions and life hazards based on the above criteria. Once all the fire hazards have been identified the existing level of protection and fire safety management of the process can then be assessed and improvement measures implemented.

7 General fire safety recommendations

7.1 Oven location

- Ovens should be placed as determined by an initial installation fire risk assessment, the recommendations of the manufacturer and the risk both to and from the surrounding area.
 - Ovens should not be located in basement areas.
 - Buildings or compartments housing ovens should be of non-combustible construction.
 - Where an oven is within a larger factory building carrying out other functions the baking area should be separated from the rest of the factory by elements of construction offering at least 60 minutes fire resistance (integrity and insulation). This is often referred to as bunkering the ovens. (Further guidance for the design of new factories is given in the *LPC Design Guide for the Fire Protection of Buildings 2000* (ref. 5).)
- Any elements of construction within the fire-resisting oven enclosure should also offer this level of fire resistance.
- Where combustible construction cannot be avoided suitable separation distances or insulation should be provided to prevent the temperature of combustible surfaces exceeding 70°C.
 - Subject to the fire risk assessment, walls insulated with combustible materials should not be nearer than 2.5m to cooking areas.
 - Combustible materials such as stock and ancillary equipment should be kept at a safe distance from ovens, usually a minimum of 1m.

7.2 *Heating systems for ovens*

7.2.1 Gas and oil fired units

- A factory fitted burner management system should be installed to safeguard against fuel, air or ignition failure. Suitable safety devices and features appropriate to the type of oven should be provided. This is likely to include arrangements to shut off the fuel supply to both the pilot and main burner in the event of a failure of the pilot flame or igniter and interfaces to shut off the fuel supply in the event of failure involving the ventilation system.
- The provision of a main fuel shut off valve remotely located and accessible at all times.
- Individual manual fuel shut off valves at individual gas fired ovens.
- All tanks, vessels, oil heating facilities, piping, fittings and other associated equipment should comply with relevant British standards and codes of practice.
- Ovens should be fitted with thermostats to prevent overheating.

7.2.2 Electrically heated units

- Suitable safety devices such as temperature controls, including overheat thermostats, electrical overload protection and conveyor interlocks should be provided as appropriate to the size and use of the oven.
- All electrical equipment and installations should comply with BS 7671 (ref. 7).

7.3 *Ventilation and extraction*

- Ventilation provisions for burners appropriate to the type and size of burner should be provided in accordance with acceptable national legislation and standards.
- All ovens should be provided with a suitable ventilation system to remove excess heat, fumes and vapours through air circulation. Where flammable vapours may be present a ventilation rate to ensure that the concentration of vapours does not exceed 25% of the lower limit of flammability of the vapour components concerned is recommended.
- Ducting for oven ventilation should be of acceptable non-combustible material, well supported, capable of carrying the weight of the system and should have liquid tight joints.
- Ducts should be provided with suitable and sufficient numbers of access panels to facilitate inspection, cleaning and manual fire fighting.

- Bends or dips in the design of the ductwork where residues might collect are to be avoided and the whole of the ducting should be made accessible for cleaning. At each change in direction of the duct an opening with a grease-tight cover should be provided for inspection and cleaning.
- A clearance of 460mm should be kept between ducts and combustible construction. Where this cannot be achieved, suitable non-combustible insulation should be provided.
- Double skinned, insulated flues should be used for oven flues and manufacturers' instructions followed, particularly when flues run through insulated panels. More details are provided in reference 6.
- Oven extraction duct work should always be of fire resisting design where it has to pass through fire resisting elements of construction (fire dampers are not suitable for cooking duct work).
- Oven flues should not pass through fire compartment walls or ceilings. Ideally they should be designed to extend vertically from the oven out through the roof of the building.
- Where it is unavoidable for oven flues to pass through compartment walls they should be enclosed with fire-resisting structures to the same fire resistance as the compartment.
- Extract ducts should not discharge within 1.5m of windows or 6m of other air intake openings.

7.4 *Explosion relief*

- If the fire risk assessment indicates a risk of explosion within the unit due to the presence of flammable gases or vapours, suitable explosion relief measures should be provided. This is most likely to apply to direct fired ovens under certain conditions.

7.5 *Fire protection recommendations*

- In circumstances where:
 - the content of the oven is sufficient to sustain combustion;
 - the fire is likely to spread rapidly to combustible construction;
 - a fire may occur in inaccessible sections of the oven;
 - there is a history of the product igniting in the oven;

consideration should be given to installing a suitable automatic fire suppression system. Sprinklers, water spray or water mist systems are likely to be the most suitable.

- The type and extent of any fixed fire suppression is also likely to be influenced by the type of oven and possible consequential damage such as the sudden cooling and shattering of the tiles in continuous stone bake ovens.
- The risk assessment may highlight individual areas of an oven requiring protection as opposed to the whole unit. Examples are the lower section of an oven where crumbs may accumulate and ignite and the oven outlet where smouldering product may need to be cooled and prevented from transfer to cooling tunnels, trays or conveyors. These areas may well be adequately protected by a manually activated fixed system.
- The inside of the extract ducting should be included in the area protected by the fire suppression system.
- When a fixed fire suppression system is updated or replaced, all redundant elements of the old installation should be removed.
- Approved portable fire extinguishers of an appropriate type should be provided near ovens and related equipment in accordance with BS 5306: Part 8 (ref. 8).

7.6 *Inspection and maintenance*

- The inspection, testing and maintenance programme for the ovens and associated equipment should comply with the manufacturer's recommendations.
- The inspection and maintenance of portable fire equipment should accord with BS 5306: Part 3 (ref. 9) for portable fire extinguishers.
- Fixed fire suppression systems should be serviced and maintained in accordance with the relevant standard to which they were designed and installed, or to the suppliers' instructions.
- All safety devices incorporated in the burner, ventilation and fuel management systems should be subject to a monthly inspection by trained factory staff and to an annual inspection by an organisation approved by the oven manufacturer. Suitable records should be kept.
- Regular checks and inspections should be carried out to ensure that the build-up of crumbs and cooking oil and other deposits on interior surfaces of the ovens, including the oven flues and extraction ducts, do not reach levels that will support combustion. The inspections should also be used to verify the adequacy of the cleaning regime.
- Regular checks and inspections of the areas surrounding ovens should be carried out to prevent any accumulation of combustible materials.

8 **Specific recommendations for wood burning ovens**

8.1 *Oven location*

- Should be in accordance with relevant parts of section 7.1 of this document.

8.2 *Venting*

- Wood burning ovens should be provided with a suitable extraction/ventilation system.
- Where there is a risk of airborne sparks being produced, a suitable spark arrester should be fitted to prevent embers entering the extraction duct.

8.3 *Fuel storage, handling and ash removal*

- Bulk fuel storage should be outdoors at least 10m away from buildings or in a dedicated store separated from the remainder of the premises by 60 minute fire-resisting construction. Access to the store should only be from outside the building.
- Oven ignition should be by way of a match or approved built-in ignition device. Flammable liquids should not be used to assist ignition.
- Ash and cinders should be removed safely from the firebox regularly but at least once a day.
- A heavy metal wheeled container with a metal lid and of a maximum capacity of 75 litres should be provided for the removal of ash.
- The ash should be sprayed with water to ensure it is completely extinguished before removal and the metal removal bin kept closed while the unit is being moved out of the building.
- If cooling cannot be achieved in the oven, a suitable metal pan should be provided just outside the clean out hatch.
- Suitable tools and protective clothing should be provided. The removal of ash should be achieved without the need to reach into the oven.
- Outside the building the ash should be deposited in a suitable covered, enclosed or dedicated metal container or skip kept away from the building. Where possible the ash bin should be at least 10m from buildings and structures.
- A clear passage way should be kept from the oven to the dedicated metal container or skip.

8.4 *Fire protection*

- Suitable water based extinguishers should be provided in the vicinity of the oven in accordance with BS 5306: Part 8.
- The provision of a hose reel complying with BS 5306: Part 1 (ref. 10) near the fuel storage area and oven should be considered. Alternatively, water-based extinguishers should be provided.

8.5 *Inspection and maintenance*

In addition to any relevant recommendations in Section 7 above, the following should be implemented:

- The combustion chamber should be scraped to the original surface once a week and inspected for damage or deterioration.
- The flue or chimney should be inspected once a week for damage, deterioration and any accumulation of residue capable of burning and be cleaned as and when required.

9 **Training**

9.1 Oven operators should be given training in operation of an oven. This should include:

- Safe start up and routine shut down procedures.
- Emergency shut down procedures.
- Written operation procedures and emergency shut down procedures should be provided and preferably be on display near the oven.
- Instruction regarding the mode of operation of any fixed fire suppression system.
- Action that should be taken if flames or smoke are seen in the oven.

10 **References**

1. BS EN 1673: 2000: *Food processing machinery - Rotary rack ovens - Safety and hygiene requirements*, British Standards Institution.
2. NFPA 86: *Standard for ovens and furnaces*, National Fire Protection Association.
3. *Fire Protection Handbook*, 18th edition, National Fire Protection Association.
4. ANSI Z50.1-2000: *American National Standard for Bakery Equipment - Safety Requirements*.
5. *LPC Design Guide for the Fire Protection of Buildings 2000*, Fire Protection Association, 1999.
6. *LPC Design Guide for the Fire Protection of Buildings, Food Processing Factories 1: Design Principles*, Fire Protection Association, 2004.
7. BS 7671: 2001 (amended 2004): *Requirements for electrical installations*. IEE Wiring Regulations. 16th edition, British Standards Institution
8. BS 5306: *Fire extinguishing installations and equipment on premises: Part 8: 2000: Selection and installation of portable fire extinguishers - Code of practice*, British Standards Institution.
9. BS 5306: *Fire extinguishing installations and equipment on premises: Part 3: Code of practice for selection, installation and maintenance of portable fire extinguishers*, British Standards Institution.
10. BS 5306: *Fire extinguishing installations and equipment on premises: Part 1: 1976: Hydrant systems, hose reels and foam inlets*, British Standards Institution.

11 **Additional reference material**

National Fire Protection Association, NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapours, Gases, Mists and Noncombustible Particulate Solids*.

National Fire Protection Association, NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Equipment*.

Office of the Ontario Fire Marshal, Ontario Fire Code, Section 5.18, *Industrial Ovens for Baking and Drying Processes*.

Loss Prevention Certification Board, *List of approved fire and security products and services*. Published annually by BRE Certification, downloadable from www.brecertification.co.uk

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Recommendations