Risk Control Guide

PROCESS HAZARD – INDUSTRIAL FRYERS

Introduction and Scope

The purpose of this document is to give property risk management guidance to end-users of industrial fryers and address the inherent fire and explosion hazards associated with them.

Industrial fryers present the fire hazard of heated ignitable liquids as well as the fire and explosion hazards of the heating sources (e.g. gas burners, heat transfer fluid heaters and systems). They normally have large cooking surfaces, usually 4m² or more and can contain large amounts of cooking oil.

Industrial fryers typically have product conveyor systems (except for some batch fryers) and movable covers or hoods that can also be hydraulically operated. Product conveyor belts typically run inside the fryer and some have return belts that run beneath the fryer pan, creating additional shielded fire hazard areas.

Fryers are typically heated by one of the following arrangements:

- Direct oil or gas heating.
- Heating by heat transfer (HTF) fluid from a separate HTF heater.
- Steam.
- Electric elements.

Loss Prevention Recommendations

Construction and Location

Locate fryers and associated heating equipment in rooms of non-combustible construction. The rooms should be fire separated to/from all other building areas to a minimum standard of 120 minutes. This could be reduced to 60 minutes if the room is adequately protected by an active fire protection system.

Services breaching the fryer room should be minimised. Where services do breach the fryer room (flues, ducts, pipes, electric cables etc.) these should be fire stopped to the same fire rating as the room.

Any door/shutter openings should be protected with self-closing or other automatically operated fire doors/shutters to the same fire rating as the fryer room.

Openings for conveyors to and from the fryer room should be as small as possible. They should be protected by automatic fire shutters to the same fire rating as the fryer room. The conveyors below the openings should be designed in such a way as to allow full protection of the opening.

Do not locate fryers in below ground locations. If below ground installations are unavoidable, communicate with the local Fire Service to ensure adequate access for manual fire-fighting is achieved.

Provide containment and emergency drainage for all fryer areas. Arrange the drainage path for any individual fryer to avoid exposing any other fryers or other combustible materials located within the area.

Fryers should be fitted with high efficiency hoods designed to pick up the waste stream from the surface of the fryer oil. The extract fan should be appropriately sized to provide an exit velocity of greater than 6 metres / second or that recommended by the original equipment manufacturer. The hood should be designed so that it can be raised and lowered without impeding the extract fan assembly.

All extraction ducts should be constructed entirely of sheet steel (normally stainless steel). Ducts should be as short as possible and vertical. Major changes of direction or horizontal runs where excessive combustible deposits could generate should be avoided.

If oil fumes from fryers are sent via scrubbers (for odour abatement prior to release to atmosphere) or to incinerators, design the inter-connecting ductwork and any related equipment between the fryer and scrubber/incinerator to prevent flammable deposits or vapour from accumulating. Provide dampers to isolate any detached fume incinerator from any connected fryer. Arrange the damper(s) to close upon fire detection at the fryer or within any cooking oil exhaust fume ductwork.

If ducts do pass through combustible walls, floors or roofs (not recommended – see above), provide non-combustible insulation or clearance (or both) to prevent combustible surface temperatures exceeding 70°C. This would normally be achieved by ensuring combustible materials are cut away for at least 150mm and back filled with non-combustible mineral wool. A steel collar/sleeve should then be fitted around the duct through the full thickness of the wall, floor or roof which it passes.

Provide inspection hatches throughout the whole length of all ducts that can generate combustible deposits to allow for adequate inspection and cleaning of the interior surfaces of ducts. Ductwork should be designed to allow for easy dismantling to facilitate internal cleaning if access is difficult.

Where ducts pass through non-combustible walls, floors or partitions, the space around the duct should be sealed with non-combustible material to maintain the fire resistance rating of the barrier. The duct should have the same fire rating as the wall, floor or partition through which it passes or could also be fitted with an automatic fire damper of the same fire rating where it passes through the wall, floor or partition.

Equipment and Processes

Emergency fuel supply shut off valves or power isolation switches should be provided in safe remote locations away from the fryers. They should be readily accessible so that a fire or explosion does not prevent access to the valves or switches. A good level of signage should be provided to highlight valve or switch locations and positions.

Alarms/Interlocks

Provide and arrange a high-temperature limit switch to alarm and shut down the fryer oil heaters or burners if the oil temperature in the fryer (or any associated heat exchanger feed line to the fryer) exceeds 28°C above the normal maximum operating temperature. Also ensure the high-temperature limit switch is set at least 55°C below the auto-ignition temperature of the oil in use. Ensure these high temperature limit switches are independent of the normal heating system controls.

Fryers heated by heat transfer fluid (HTF) systems - Over temperature or fryer fire alarm should interlock the HTF system heater to shut down and divert oil to a recirculation loop and/or an emergency dump tank. A feedback signal should be provided from a 3-way valve that sends hot oil either to the fryer or to a re-circulation loop and/or dump tank. This should confirm that the HTF has been diverted from the fryer when an over temperature or a fryer fire alarm occurs. If the feedback signal is not received, an alarm should be set off to indicate that the 3-way valve has failed and heat transfer fluid is still being sent to the fryer.

Electric heated fryers - fryer temperature controls should be arranged so that a single point of failure cannot result in an “over temperature” condition e.g. single contactors which can stick. The fryer heating arrangements should be assessed at design stage to ensure that a single failure cannot result in the heat source continuing to operate.

Only use components for the over-temperature control that will fail safe (i.e., cause the same response as an over-temperature condition).

Provide and arrange a low liquid level control for the fryer to alarm and shut off the heaters or burners when the cooking oil level drops below the recommended minimum operating level.

Provide high liquid level switches for automatic filling operations to prevent over-flow of the fryer oil. Arrange the first high liquid level to sound an alarm. Provide a second switch at a higher level designed to shut down all oil flow.

Sediment removal belts should be fitted to the fryer to prevent the build-up of debris. A belt drive motion warning light/alarm should be fitted to indicate faults. This should be fitted to the belt itself and not the motor. The build-up of debris in the fryer can be swift and potentially dangerous if the sediment removal belts are not working correctly.

Many fryers are fitted with oil filters to remove fine particles and prolong the life of the oil. Warning alarms should be fitted to detect if filters have stopped and allow for operator intervention as necessary.

Minimum temperature interlocks should be fitted, from an independent fryer oil temperature probe, to prevent any fryer hood from being opened and the fryer oil from being emptied while the oil is above a safe temperature normally specified by the original equipment manufacturer (temperatures will normally range between 140ºC and 170°C). This is to prevent the sudden ingress of air across the fryer and ignition of any oil/crumb debris and to prevent the fryer from being emptied and exposing the internal heating elements at too high a temperature. Another way of achieving similar control is to have a minimum pre-set cool down period of 60 minutes.

Raising the fryer hood should automatically isolate the fryer heating systems and safely shut down the fryer operation.

Fryer conveyor belt failure should also automatically isolate the fryer heating systems and safely shut down the fryer operation.

When a fryer operates automatically without constant operator attendance, all trip interlocks would normally require a manual reset unless the interlock system includes a high-high (or low-low) redundant interlock. In those cases, operation of the high (or low) interlock may not require a manual reset provided:
- The control system is designed to automatically re-start the fryer when the trip condition clears.
- Operation of the high-high or low-low interlock means would require a manual reset.
- All trips should require operator intervention and manual reset for fryers not designed for unattended automatic operation.

Safeguards for any gas or oil fired burner systems associated with fryers should include:

- Prior to each fryer heating system start-up, provision should be made for the removal of all flammable vapours and gases that have entered the heating chambers during the shutdown period. At least four system volumes of fresh air or inert gas should be introduced during this purging cycle. Prior to the re-ignition of a burner after a burner shutdown or flame failure, a pre-ignition purge should be completed.

- Where a fan is essential for purge or safety ventilation of a fryer, fan operation should be proved and interlocked into the burner management system.

- Ensure adequate combustion air for proper operation of the burners and mixers and for subsequent combustion. Interlock each fan/blower to ensure that they are placed in operation before the fuel safety shutoff valves and electric ignition can be energized. This should also ensure that failure of any fan will automatically close the safety shutoff valves and de-activate the ignition system.

- Proof of a reliable ignition source before fuel can reach the main burner.

- A limited trial-for-ignition time for the main burner flame.

- Shutoff of fuel on flame failure.

- Provide fuel pressure interlocks, low and high gas pressure switches for gas burners, low oil pressure switches for oil burners, and low atomizing medium pressure switches (air or steam) for oil burners.

- Provide oil temperature interlocks for oil burners that require pre-heated oil. The interlocks should prevent lighting-off if the oil temperature is below that recommended by the burner manufacturer, and shut off all oil safety shutoff valves if oil is not at the recommended temperature during firing.

- Provide observation ports for each of the burners so pilots, electric igniters and flame-sensing elements of combustion safeguards can be easily observed.

The proper combination of interlocks and flame-supervisory combustion safeguards is essential. Supervision of fuel pressures, air-flow, essential air-damper positions, fans, purging, oil temperatures (if relevant), and oil-atomizing medium (if relevant) is important for anticipating the development of unsafe conditions and for initiating an automatic safe shutdown of the fryer.

Operation and Maintenance

Establish and closely supervise a preventive maintenance programme for all fryer installations. Include the following actions in the programme:

- Check daily for oil leaks, including within any fume incinerators (if applicable), and immediately repair any that are discovered.
- Inspect and clean any combustion chamber and burner system components, as necessary, during the normally scheduled fryer system clean-up/maintenance period (approximately weekly).
- Inspect cooking oil heat exchanger tube surfaces for over-heating. Unusually coloured tubes may indicate problems. Determine useful tube life and replace tubes before the expiration of that period.
- Perform internal solution cleaning of cooking oil heat exchanger tubes at least monthly to prevent excessive deterioration. Also, verify the integrity of the tubes through oil-flow testing.
- Leakage test oil heat exchanger tubes at least annually and after any opening or repair of the heat exchanger system.
- Clean, service, inspect, and repair polluted air fans as necessary.
- Any sediment belts should be checked and maintained to ensure that they are tracking correctly and that debris is being effectively removed from the fryer.
- Test all system safety interlocks in accordance with manufacturer recommendations or at least quarterly, whichever is the lesser period. Maintain records of these tests.
- Establish maintenance contracts with the equipment manufacturers, or other suitably competent and qualified fryer maintenance providers.
- Develop and implement a formal operator audit procedure to ensure compliance with established standard operating and emergency response procedures. Conduct these audits at least 6 monthly.

Inspection of Safety Controls

Test all system safety interlocks in accordance with manufacturer recommendations or as per the frequency recommended below, whichever is the lesser period.

The following inspection schedule is proposed as a guide. Details and intervals may vary according to the operation and equipment applicable. The recommended frequencies are considered best practice. Keep documented records of inspections, tests and maintenance work.

Quarterly:

- Fuel safety shutoff valves for leakage
- Fan and airflow interlocks
- Purge interlocks
- Flame failure system components
- High-temperature limit switches and alarms
- Fryer oil level switches
- Oil tank level switches
- Door and damper limit switches
- For oil:
  1) Fuel pressure and temperature interlocks
  2) Atomizing media interlocks
- For gas:
  1) High and low fuel pressure interlocks

Six Monthly or Annually:

- Igniter and burner components
- Combustion air supply systems
- Piping, wiring, and connections of all interlocks and shutoff valves
- Combustion control systems
- Calibration of indication and recording instruments
- Automatic firing checks
- Operating sequence tests, all components
- Combustible gas analysis automatic interlocks (calibrate as needed)
- Gas cleaner and drip leg
- Conveyor interlocks

Inspection and Cleaning

Develop and implement a documented housekeeping programme with detailed written inspection and cleaning procedures for all fryer installations, including the inspection and cleaning of all cooking oil exhaust fume ductwork.

Develop and implement a housekeeping audit programme and complete at least 6 monthly. Ensure senior management personnel review audit reports and take action to promptly address any deficiencies.

Clean oil residues regularly from fryers, filters, belts/conveyors, drain boards and drain board collection areas, and from the insides of all hoods and ducts. Arrange processes so that, under normal operating conditions, as little excess oil residue or crumbs/fines as possible collects on equipment and building surfaces. Duct inspection plans should be in place between cleans and photographic evidence obtained to clarify the degree of contamination.

Complete a thorough risk assessment to establish inspection and cleaning frequency. Original equipment manufacturers may be able to assist. Inspection and cleaning programmes should be continually monitored for adequacy and the frequency increased if abnormal deposits are observed. It is best practice to record volume/weight of debris removed, along with production volumes for the period; this allows comparisons and to identify any abnormal conditions which may be causing excessive debris build up.

Each 2 metre section of ductwork should have an inspection panel fitted for observation & cleaning. Inspection hatches should also be provided at critical points to allow the observation of the cleanliness of fans, bends and horizontal sections.

Provide a “clean in place” (CIP) system for fryer installations. Ensure the CIP system includes coverage for all cooking oil exhaust fume ductwork. Provide an independent piping network for any CIP system.

Where the installation of a CIP system is not possible all extract systems should be designed so that they are easily dismantled for cleaning. The sections should be in 2 metre lengths for ease of handling.

Training

Provide operators with formal training in properly operating fryer systems, emergency procedures in case of a process upset (e.g., cooking oil over-heating), fire in or around the fryer, fire in ductwork and fire in any associated heater, scrubber or incinerator system (if applicable).

Train operators in manual firefighting procedures and manual actuation of fryer system fixed fire protection systems, as necessary. Emphasize the importance of keeping the hood down in the event of a fryer fire to minimize the fire intensity and maximize the effectiveness of any fixed fire protection system.

Waste Management

Procedures to manage waste crumb/sediment both pre and post frying should be introduced. Post frying crumb/sediment should be deposited in water. The following to be considered as a minimum:

- What level of water is required and is it automatically or manually dosed?
- How is the crumb/sediment removed?
- What are the modes of storage and transport of waste crumb/sediment?
- Hot crumb/sediment in containers should to be regularly turned over with a shovel.

Metal sediment catch trays and metal 'tote' bins fitted with metal lids should be used for the storage and transport of waste crumb/sediment. They should be easily removable for inspection & emptying.

An inspection regime should be introduced to regularly check crumb/sediment levels at least every 30 minutes. This may be more frequent dependant on the site risk assessment as different products will result in different amounts of crumb/sediment. The inspections should be recorded and verified daily by an authorised person.

Consider the installation of a timed alarm/warning light to highlight when the crumb/sediment tray or bin needs to be inspected/emptied. The alarm/warning light system should automatically reset each time the box has been removed for emptying.

Any waste crumb/sediment removed from the fryer rooms should be immediately removed to safe locations in the open, away from the buildings.

Oil Management Procedures

Oil should be sufficiently cool before being pumped or transferred out of the fryer. The recommended temperature range is no higher than 150°C. This is to prevent the fryer from being emptied and exposing the internal heating elements at too high a temperature. Another way of achieving similar control is to have a minimum pre-set cool down period of 60 minutes.

Clean and waste oil storage should be in bunded tanks outdoors or in a 2-hour fire rated room.

Oil should be transferred in stainless steel pipe work, through dedicated floor channels and through low hazard, non-business critical plant areas. Avoid running pipework in roof or ceiling voids or other areas with low occupancy levels. Over temperature or fryer fire alarm should interlock the oil transfer systems to shut down and stop the flow of oil.

Overfill controls, linked to audible and visual alarms to a manned area, should be provided on **all** fresh oil and waste oil tanks.

Hot oil should only be drained to suitably designed metal tanks. Plastic tanks or containers should not be used.

Protection

Protect fryers and associated equipment with a fixed automatic fire protection system. Protection should be provided to the fryer compartment, drain board areas, filter systems, fines/crumb collection areas, extraction ductwork (whole length), fryer intake and out-take areas and any other areas where fire might spread because of the presence of oil.

The following system types are normally most appropriate for industrial fryers:

- Water mist system
- Water deluge system
- Foam-water deluge system
- Wet chemical system (note – these are normally only used to protect small scale canteen kitchen type batch fryers)

Systems should be fully compliant with any international approval standards that may be applicable. For example:

Water Mist Systems
- BS8489-1: Fixed fire protection systems - Industrial and commercial water mist systems.
- NFPA 750 Standard on Water Mist Fire Protection Systems

Provide a remote, easily accessible means of manual actuation for the fryer fire protection system as a back up to automatic operation.

Conduct a risk assessment to identify the appropriate response of critical equipment (e.g., fuel supply/heating system, conveyors, fans, dampers, etc.) on activation of any fire protection system. Factors for determining the proper response include:

- The design of the fryer.
- The source of combustible materials.
- The ability to isolate combustible sources.
- The impact of fresh air.
- The consequences of shutting the equipment down or keeping it in operation.

Provide interlocks to automatically perform these actions, as determined by the risk assessment. Normal practice would see the following interlocks provided upon operation of the fixed fire protection system:

- Shut down of the oil circulation and transfer system.
- Shut down of the fryer heating system.
- Shut down of the fryer conveyor system.
- Shut down of the fryer exhaust system.
- If the fryer has a detached incinerator for oil fumes, close the dampers in the cooking oil exhaust fume ductwork to the incinerator and open the dampers in the fryer exhaust duct to atmosphere. Ensure dampers fail safe in the desired position because power may be lost or shut off in the event of a fire.
- Shut down any hydraulic oil systems.

Whichever protection system is considered, a full risk assessment should be completed to confirm appropriateness and adequacy. We would always recommend referral to RSA for review and approval before any decision is made on the installation of fixed fire protection systems to fryers and associated equipment.