Loss Prevention Standards

Contamination Following a Fire

Introduction

Contaminants released during a fire can create problems for fire-fighters and lead to a need for decontamination before any meaningful steps can be taken to get the business back operating. This can greatly increase the resulting financial losses as well as creating additional problems for the business that are often overlooked. However, with careful planning and risk assessment, these risks can be managed and to an extent mitigated, increasing the likelihood and speed of a successful business recovery. This Loss Prevention Standards examines contamination hazards, their impact and the steps you can take to minimise their impact during a fire.

Contamination Hazards

Fire contamination hazards come in many forms but generally result from the release of substances into the building and/or surrounding area, that present a hazard to people, property or the environment.
Examples include:

Smoke, soot and acid gases are produced in nearly all fires and the hazards to the safety of persons escaping and fire-fighters are well documented. However, a further consideration is that if the smoke and soot is permitted to travel throughout a building, it can contaminate or damage surfaces which will require cleaning and contaminate furnishings and stock which may need to be disposed of and replaced. For these reasons there are clear benefits in seeking to control the spread of smoke and soot throughout a building.

Chemicals are present in many workplaces and have a variety of uses. In a fire, many chemicals will evaporate and become entrained in the smoke plume. Chemicals which are toxic pose a direct threat to fire-fighters who will need to take additional precautions to ensure their safety. Chemicals that are corrosive can disperse throughout the building, corroding any surface with which they come into contact. This hazard is particularly common as acids such as hydrochloric acid, sulphuric acid and nitric acid are found in many industrial cleaning products. Similarly, corrosive alkalis such as sodium hydroxide and ammonia are also extremely common, and if entrained in a fire smoke plume can cause significant corrosion damage.

Some chemicals decompose in the heat of a fire releasing other more toxic or corrosive substances into the smoke plume. Sometimes decomposition can even be explosive, presenting an additional threat to the safety of fire-fighters and leading to further property damage.

Chemical contaminants entrained within the smoke plume or within damaged containers or machinery can also dissolve within the fire-fighting water leading to contaminated fire-water run-off, which can run down walls, across floor surfaces, enter drains or water courses.

Asbestos is still found in many older properties and was legally allowed to be installed within buildings in the UK as late as 1999. In a fire, Asbestos-Containing Materials (ACMs) can become damaged releasing their fibres. Fibres released can not only contaminate the immediate surrounding area but can also become entrained in buoyant smoke plumes which can spread the fibre release over a wide area. Owing to the well-known and documented health hazards of being exposed to asbestos fibres, any asbestos releases during a fire requires specialist decontamination often before and during works to remove other fire affected materials from the site. This can significantly increase the cost of re-instating the building and extend the time taken to complete this work.

Plastics are often overlooked as a hazard within buildings as plastic goods are commonplace in our everyday lives. However, when plastics burn, they typically give out a high heat output. Not only does this increase the rate of fire spread and the amount of radiant heat damage, but the high temperatures experienced cause the plastics themselves to thermally decompose into other chemical substances, many of which are highly corrosive and toxic. High heat output from the fire creates a thermally buoyant plume that entrains these hazardous decomposition products and quickly transports them away from the fire.

Oils and lubricants are typically found within certain types of process machinery. Whilst some will burn or decompose during a fire as described above, for many higher oil fraction derivatives, this can be a slow process and a more common contamination hazard would be the release of these oils from machinery to the ground, where they can contaminate the ground itself and nearby drains.

The Risks

Risks to Fire-fighters

The effect on people of exposure to harmful substances released during fires can be significant. Often there is a direct toxic effect on anyone exposed to smoke caused by the products of combustion. However, in 2006 an international study on cancers linked to fire-fighting was carried out by the International Agency for Research on Cancer (IARC), which also drew attention to a possible increased occurrence in three types of cancer affecting fire-fighters, and it was postulated that repeat exposure to cancer-causing chemicals released in a fire from many modern materials such as decomposing plastics were in part responsible. As a result, fire brigades will take additional steps to prevent exposure to fire-fighters where the risk of a chemical release in a fire is identified.

Defensive Fire-fighting

A further important consideration is that where there is no risk to life and where contamination hazards are identified as posing a risk to fire-fighters, the Commanding Officer of the fire brigade may choose to adopt a defensive fire-fighting stance as a precaution to safeguard fire-fighters. Often this will involve allowing the fire to burn in a controlled manner that minimises the risks to neighbouring property, as well as safeguarding the environment. Such decisions are made after giving careful consideration to the risks involved, but this approach can often be justified. One important consequence of this is that typically the extent of property damage caused by the fire is greatly increased, as is the accompanying period of business interruption and the resultant financial impact of the fire on the business.

Corrosion

The damaged caused by the corrosive nature of smoke is often unanticipated. As already highlighted, smoke often contains many corrosive chemicals and substances, and the ability of smoke to travel long distances on buoyant thermal air currents provides a mechanism for significant property damage, even from a small fire. Possible impacts include:

Attack on metal components and structures - Metal surfaces can be pitted or even structurally weakened with ongoing corrosion processes established causing thinning. Some materials are more susceptible to corrosion than others with most carbon-based steels being prone to fairly rapid corrosion. However, even metals thought to be resistant to corrosion can be susceptible as protective oxide films can be stripped away by the heat and chemicals within the smoke. In one example, aluminium framed glazing was affected causing glass to fall out of windows for many weeks after the fire around the entire factory and also in nearby properties.

Damaged circuitry – Corrosive smoke can affect printed circuit boards causing short circuits across the board and premature failure. Smoke can also coat electrical contacts preventing them from closing or affecting heat dissipation from components. This can cause incorrect operation of the machine resulting in product defects, machine damage or even machinery overheating, which may require the replacement of affected components. In older machinery where replacement circuit boards or components are difficult to source, this can even lead to the need for the replacement of the entire machine.

Plastic softening or embrittlement – Even when plastic materials are not directly involved in the fire, their exposure to corrosive smoke can cause some plastics to discolour, soften or suffer embrittlement. This can weaken their structural integrity and subsequently their thermal insulating properties.

Sensitive Areas and Equipment

Clean rooms or machinery required to operate to a high level of precision and accuracy are particularly susceptible from deposits of soot or corrosion. Any contamination of these areas or equipment can require:

- Extensive and thorough cleaning supported with proof of cleanliness
- Re-validation of equipment and machinery
- Replacement of surfaces that cannot be adequately cleaned and equipment which no longer performs as required

Loss of Stock

Contamination of products and raw materials by smoke can be hard to remove or may leave a taint or odour that is perceptible, rendering it unsuitable for further use or sale. Such goods generally require disposal. Its not just materials in situ at the time of the fire that can be affected, as contamination of some process machinery may also prove difficult to remove and may well lead to a taint on products produced after the fire. This can lead to a high rate of product spoilage and additional disposal costs, missed orders and a delayed business recovery.

Foodstuffs and cosmetics can be particularly susceptible. Raw foods are almost always considered a total loss if exposed to smoke, soot, gaseous odours, toxic or hazardous chemicals. Even canned goods may need to be disposed of as often the cans cannot be washed, decontaminated or cleaned sufficiently to meet purity and safety standards.

Impact on Salvage

The contamination of areas by hazardous chemicals or asbestos may well prevent salvage of otherwise perfectly reusable items. Even where the risk of contamination was remote, it may be cost prohibitive to show that contamination did not actually occur.

Specialist Decontamination

Additional financial losses may be sustained through the need to engage with specialist decontamination resources to permit safe re-instatement of the premises and processes. Examples include removal of asbestos contamination or where other highly toxic materials have contaminated the building during the fire. Or in simple terms it could be the diverse routing of a ventilation system around a building.

Impact on Drains and Sewers

The run-off of fire-fighting water into drains and sewers can lead to ongoing problems. Chemical contaminants and debris can be washed into drains leading to the increased risk of pipework failure, silting up and blockage. Problems may not be noticed until sometime after the fire and could result in backing-up and even flooding, which may require the drains to be unblocked or in the worst scenarios reconstructed.

Risks to or from Neighbouring Properties

Smoke plumes escaping the property can be carried over nearby premises and this can:

- Have an impact on goods stored in the open
- Be drawn into ventilation systems through air inlet ducts and affect internal areas and processes
- Affect through corrosion the external structure of the building

An example of this occurred where a small fire in an industrial unit selling DIY supplies resulted in a smoke plume that was blown across an adjacent car dealership. The corrosive nature of the smoke required the re-spray and valeting of over 40 vehicles.

As highlighted by the above example, failure to manage the risks from contaminants in a fire can not only lead to an increased risk of material damage and business interruption but can also increase the risk of public liability claims from affected neighbours.

Risks to the Environment

The escape of contaminants from the site of the fire into the surrounding environment can cause environmental pollution, which can impact nearby watercourses, fields and affect the air quality of the surrounding neighbourhood. Such occurrences can attract enforcement action from regulators as well as public liability claims from land owners and affected individuals.

Prolonged Business Impact

From the risks detailed above it can be seen that where contaminants are released during a fire, often there is a greater impact on the outcome of a fire, from increased times for clean-up and re-instatement to ongoing problems with process machinery and litigation for public liability claims. This provides a good incentive for exploring ways in which the risk of contaminants being released in a fire can be reduced.

Minimising Risk and Mitigating the Impact

Adopting a structured approach to identifying contamination hazards and assessing the risks to your business is highly recommended and should form part of your wider approach to managing risks within your organisation. Documenting a plan to minimise risks and mitigate any residual risks can help to demonstrate to stakeholders your commitment to ensuring business continuity in the event of a fire loss.

The following step by step approach is advocated:

Step 1 – Identify sources of contamination during a fire

Consider the following:

- Inventories of chemicals, oils and lubricants
- Accumulations of high density plastics
- Delivery systems for process gases such as ammonia
- ACMs

It is a good idea to mark the locations of these materials on a site plan and provide a copy of this plan within the Fire Service information pack which should be located in an appropriate area, e.g. close to the main fire alarm panel or in a permanently manned security gatehouse.

Step 2 – Identify ways to remove or reduce the hazards

Examples include:

- Holding a smaller inventory of chemicals on site
- Using chemicals in a less hazardous form, e.g. more dilute or in aqueous solutions rather than flammable solvents
- Removing ACMs from the premises. **Note:** You may need to use a specialist contractor for this work and you should seek specialist advice before removing any asbestos from your premises
- Using oils and lubricants with higher boiling points and flash points
- Routing cables and cable trays containing plastic insulated cable through non-sensitive areas as far as possible
- Locating inventories of hazardous materials outside of the premises in specially constructed stores and only bringing into the building chemicals that are needed at that time and which will be quickly consumed within processes. This is one of the most commonly adopted and effective strategies for minimising contamination risk

Step 3 – Identify vulnerable receptors of contaminants

Identify any item that may require disposal or become irreparably damaged if it becomes contaminated and identify specific areas of the premises which could require specialist cleaning and restoration should they become contaminated. Examples include:

Raw materials	Clean rooms
Stock and finished product	Processing areas with sensitive machinery
Foodstuffs	Kitchens
Sensitive machinery and plant	Analytical laboratories
Spares for machinery and plant	Drains and sewers
Analytical instruments	Ventilation systems

Consider possible impacts on neighbouring premises and sensitive environmental receptors such as rivers, lakes, canals and adjacent agricultural land. It is a good idea to mark the locations of these features on site and local area plans and provide a copy of these plans within your Fire Service information pack.

Step 4 – Identify precautions that can be taken to prevent the spread of contamination

Fixed Fire Protection Systems - The most effective way to prevent the spread of contamination throughout your premises is to quickly extinguish the fire soon after ignition. In doing so plumes of toxic and corrosive smoke can be minimised and to a large extent avoided. This is one of the many benefits of installing sprinklers and other fixed fire protection systems within your premises.

Fire Compartmentation – The sub-division of the building into several fire-resisting compartments can be very effective in limiting the spread of fire and smoke through a building. This brings both life safety and property protection benefits. Where this is done it is important to regularly check that any penetration through a fire compartment wall has been and remains adequately fire-stopped and that fire doors remain in good condition with smoke seals fitted correctly and in good condition.

Surface Linings – The materials used to line the walls of the buildings should not be combustible and contribute to the growth and spread of the fire. However, their porosity can also be an important factor with more porous materials such as lightweight breeze block more likely to allow odour and very fine smoke to permeate through it, especially if a fire on one side of the block is creating a pressure differential across it. For this reason, the application of fine plaster or other non-combustible wall coatings or sealants may prove beneficial and limit the extent of smoke and odour permeation through walls.

Smoke Ventilation – The planned and intentional removal of smoke from a building can slow the rate of fire growth and spread, as well as improve working conditions for fire-fighters, potentially improving the likelihood of an attempt to extinguish the fire in the absence of any risk to life. It also permits the selection of a discharge location for exhausted smoke with a potential for the reduction of impact on neighbouring premises and the local area.

Design of Air Handling Units – For sensitive areas such as clean rooms or where sensitive process machinery operates, the design and operation of the air handling systems can isolate or ventilate the room upon the activation of the fire alarm system. Ideally these will be independent standalone systems not linked to other systems which may provide a pathway for smoke spread. In conjunction with good fire compartmentation this can limit the impact of a small incident elsewhere in the building.

For other process areas consideration should be given to the design and routing of make-up air and extract ducting as this can provide a pathway for smoke spread through the building. Where make-up air is routed throughout the building, limiting the number of areas common to an air handling system can limit the extent of smoke spread via that system. Make-up air should also be taken from a clean outdoor source, not from other areas within the facility.

The provision of active combination fire/smoke dampers within ducts that are linked to the fire alarm system as opposed to passive fire dampers, can hinder smoke and fire spread as soon as it is detected rather than relying on the action of heat on the fire damper itself.

Bunding – The provision of bunding around inventories of chemicals and machinery can restrict the spread of leakages and spills that are caused during a fire incident, minimising the extent of the contaminated floor area.

Gas Delivery Systems – Where process gases are used it is best to design the system such that the inventory of gas is located externally to the building and delivered via suitable pipework to the process. It is helpful to interlink the gas delivery mechanism to the fire alarm system so that unless it is safety critical (e.g. for inerting), the gas supply is isolated upon the activation of the fire alarm. This can prevent the continued supply of the process gas during a fire event.

Step 5 – Identify how you can determine the extent of contamination following an incident

Following a fire an immediate challenge is to determine the extent of contamination and damage it has caused, and to identify any equipment that may be salvageable. There is also a need to identify if the levels of contamination present risks to the health of any persons who may enter that area, for the purpose of investigation, salvage or restoration. A further consideration is the need to determine when decontamination of the area has been successful and that the affected areas are 'safe for occupancy' to permit salvage, restoration and other activities. The basis of safe re-occupancy must be based on existing knowledge of risk and guidance from regulatory bodies. A specific rationale for the safe re-occupancy should always be documented.

Many businesses are not equipped to undertake such investigations and risk assessments and will rely on the advices of a specialist contamination survey conducted by recognised experts in this area.

To minimise any delay in appointing a suitable contractor it is a good idea to identify a suitable organisation for inclusion within your Business Continuity Plan (BCP). The selection of a suitable contractor can to an extent depend on the potential contaminants within a building, and you should check that they have the necessary competencies and resources prior to their selection.

Step 6 - Identify action required to mitigate contamination or corrosion after an incident

It is helpful to develop an outline 'salvage plan' which sets out the steps that can be taken to mitigate contamination or corrosion following a fire incident. This plan can be used by salvage teams to assist in their work, and things that may be included within the salvage plan are:

- The safety rules for entering the salvage area including what personal protective equipment should be worn and where to source supplies and replacements
- How to ventilate the affected area to prevent further damage from smoke corrosion
- How to isolate electrical power to an area or process machinery and how to check it has been safely isolated to permit safe removal from the affected area

- How to remove or cover undamaged goods and equipment. Consider what equipment may be needed to safely remove items of equipment from the affected area
- How excess and undrained fire-fighting water can be removed from the area. If submersible pumps are to be used it is a good idea to identify where they can be sourced from and to identify what they will pump into and how this waste-water will be legally disposed of given that it may contain contaminants
- How the area and equipment within can be dried and dehumidified. If dehumidifiers will need to be hired it is a good idea to identify potential hirers within your BCP
- Identify if the application of a corrosion inhibitor would be beneficial for any surfaces or for items of equipment. If this would be helpful it is a good idea to identify where this inhibitor can be sourced from within a short space of time and identify contingent suppliers. Where quick application of a corrosion inhibitor is especially critical following a fire, you may wish to hold a small stock of this substance on site
- Consider how the building or area will be made secure to prevent unauthorised access and looting. Consider the security of any items salvaged and ensure that a list of all items salvaged from the incident scene is compiled as they are removed

Step 7 - Identifying suitable cleaning methods for affected building materials and surfaces

To speed up restoration of an area following a fire it is a good idea to identify suitable methods of cleaning of building materials and surfaces beforehand. Being able to clean surfaces of materials that are otherwise unaffected by the fire can be significantly cheaper than replacing them. It may be that a specialist cleaning contractor is needed to clean the building materials as they have the necessary cleaning equipment, and if so details of a suitable contractor should be incorporated within your BCP.

As an example, a laundry suffered a fire within one of it's dryer units, and the fire spread to other areas of the laundry via accumulations of lint on nearby surfaces. The building was made from composite insulation panels which had a mineral wool core. Some minor accumulations of wax from ironing machines and lint had built-up on the inside surfaces of the panels and this had discoloured badly during the fire. However, through the application of a suitable cleaning chemical and method, these charred deposits could be cleaned from the panels avoiding the need for replacement and speeding up the time taken to re-instate normal operations within the laundry.

Step 8 - Brief and train staff

Following a fire, staff may have concerns about their job security, so showing a commitment to ensuring the business recovers as quickly as possible may to an extent allay these fears. Having formulated the plan, ensuring that staff are suitably trained and briefed can aid its implementation. Staff with specific roles such as salvage, isolating power, analysis of contaminants, etc. should receive specific training on how to fulfil these roles, and other staff should have a clear understanding of their role in ensuring the survival of the business as detailed within the BCP.

Step 9 - Review and update the risk assessment and plan periodically

As with other risk assessments it should be periodically reviewed to ensure it remains valid. Issues to consider include:

- Have new contaminants been introduced into the building, e.g. new building materials, chemicals, other storage?
- Have inventories of chemicals changed and if so, what is the impact of this?
- Have any potential contaminants been removed?
- Have any additional sensitive areas or items of equipment been introduced?
- Have fire compartment boundaries been changed?
- Are fire compartment boundaries intact?
- Are fire protection systems and smoke venting systems appropriately tested and maintained?
- Are contractors and suppliers detailed in the BCP still operating and can they continue to commit to supply identified goods and services?
- Are salvage plans still valid?
- Have new building materials been introduced that require different methods of cleaning?
- Have staff fulfilling core roles received suitable briefings and training?
- Does the BCP remain current and valid?

Summary

The impacts of contamination occurring from a fire incident can be minimised through careful planning and risk assessment with the benefit of reducing the extent of damage caused and the time taken to recover the business.

Critical to this is identifying what can cause contamination within your premises and taking steps to identify:

- Ways to remove or reduce the contamination hazards
- Any vulnerable receptors of contaminants that could lead to damage and financial loss
- Precautions that can be taken to prevent the spread of contamination

Should a fire occur, mitigation of the contamination can be achieved by:

- Identifying how you can determine the extent of contamination following an incident
- Identifying any action required to mitigate contamination or corrosion that has resulted from the fire
- Implementing a salvage plan
- Identifying suitable cleaning methods for affected building materials and surfaces
- Providing suitable training and briefings for staff who will play crucial roles in the mitigation of any contamination identified
- Ensuring that plans and risk assessments for dealing with contamination risks remain up to date

Checklist

A generic Contamination Risk Assessment and Plan is presented in Appendix 1 which can be tailored to your own organisation.

Additional Information

- Aviva Loss Prevention Standard: *Preventing Pollution from Fire Fighting Run-Off*
- Aviva Loss Prevention Standard: *Smoke Contamination*
- Removing asbestos cement (AC) debris – Health and Safety Executive
- Protect yourself against contaminants – Fire Brigades Union
- Salvage Manual – San Francisco Fire Department

Further risk management information can be obtained from Aviva Risk Management Solutions

Appendix 1 - Contamination Risk Assessment and Plan

Assessment date		**Assessed by**	
Building details			
Building name			
Address/location			
1.	**Potential contaminants**	**Y/N**	**Details of inventory/location**
a	Chemicals		
b	Asbestos		
c	Large inventories of plastics		
d	Process gases		
e	Neighbouring premises		
f	Other contaminants		
2.	**Vulnerable receptors**	**Y/N**	**Details**
a	Clean rooms and high purity areas		
b	Sensitive equipment/machinery		
c	High value items		
d	Neighbouring premises		
e	Sensitive environmental receptors		
f	Ventilation systems		
g	Other		
3.	**Steps taken to reduce hazard potential of contaminants**		
4.	**Steps taken to limit spread of smoke and contamination within the building(s)**		
5.	**Arrangements for determining extent of contamination following a fire and whether safe for occupancy**		

6.	Salvage	Arrangements
a	Power isolation	
b	Ventilation of smoke affected areas	
c	Water removal and dehumidifying	
d	Items requiring corrosion inhibitor	
e	Stocks or tarpaulins, sheets and covers, mops, squeegees, etc.	
f	Tools and specialist moving equipment	
g	Ensuring building security	
h	Cleaning of building materials and surfaces	
i	Staff training and briefings	
Other comments:		