Making sense of risk
Risk engineering
Asia Pacific

Metalworking operations

Liberty Specialty Markets

Metalworking operations

Metalworking operations involve the fabrication of ferrous or nonferrous metal products, structural metal products, metal forgings and metal stampings. They also involve a range of other metal and wire products, such as scientific measuring and controlling instruments, watches, clocks, jewellery and silverware.

Although metalworking operations may appear to be innocuous, every metalworking operation presents hazards specific to its processes, which include quenching, cooling, lubrication, dipping, coating, plasma cutting and hydraulic oil systems. Fires and explosions are of major concern in these types of facilities and are well documented.

This guide is designed to assist business and property owners implement adequate protection for the building and metalworking equipment in order to help reduce loss exposure, specifically to fire.

Fire hazards and ignition sources

In most metal fabrication processes, the following present a potential fire hazard:

- Ignition of metal cuttings, chips or fines due to an external ignition source
- Spontaneous ignition of metal cuttings, chips or fines
- The use of combustible hydraulic or cutting fluids under pressure
- Oil deposits or residue on the machine, or nearby, including overhead building structural elements
- Flammable or combustible coolants, lubricants, paints, solvents, and hydraulic oils.

Ignition sources in metalworking facilities may include:

- heat from the machining process
- hot surfaces, such as on ovens, furnaces, torches or exhaust piping
- welding operations
- electrical arcing or sparks
- smoking materials
- spontaneous ignition.

It is important to keep ignition sources to a minimum and this involves using a hot work permit system (refer to the Liberty document **Minimising property hot work fire risks**), providing electrical installations in accordance with regional/national codes and appropriate hazardous area classifications, and prohibiting smoking in the process areas.

Hydraulic oil systems

Metalworking machines typically use hydraulic systems to control and drive various operations involved in the manufacturing process. Hydraulic reservoirs and pumps may be self-contained on each machine, or they may be centrally located, serving several machines. Oil reservoirs may have a capacity of up to several thousand litres, and oil lines can operate under very high pressures.

Nearly every hydraulic oil will combust under certain conditions relating to its flashpoint. The flashpoint is the lowest temperature at which a liquid's vapour forms an ignitable mixture in air. (Refer to the Material Safety Data Sheet [MSDS] for information including the flashpoint of a specific oil.)

Oil should never be used in a process where operating temperatures approach within 30 degrees Celsius of the flashpoint.

Lubricating oil systems

Most metalworking machinery requires lubrication. Lubrication oil is often petroleum based and usually operates at lower pressures. Some mist systems, however, may have higher operating pressures and may require additional protection.

The accumulation of oil near machine gearboxes, in piping trenches and at the reservoirs, or the spillage of oil in the supply system, can pose a potential fire hazard. Routine cleaning, tidying and regular inspections are critical to ensure that there are minimal oil accumulations and that all fittings are inspected regularly for leaks.

Cutting fluid

Cutting fluids are designed specifically to cool and lubricate the cutting tools used in metalworking processes, such as machining and extrusion. Nearly every type of machining process benefits from one type of cutting fluid or another, depending on the material of the work piece. These fluids include oils, oil-water emulsions, pastes, gels and aerosols (mists). Petroleum distillates, animal fats, plant oils and other raw ingredients are used to manufacture cutting oils, many of which are combustible.

Cutting oil and cooling fluids are usually applied as a jet or aerosol (mist) which can drift and settle on other equipment, surfaces, floors and building structures. Regular housekeeping and inspections are therefore critical, and the following should be considered:

- Nearby equipment and horizontal surfaces, including floors, should be cleaned regularly.
- Vertical surfaces, such as the sides of equipment and building columns, also require regular cleaning because fire can burn upwards using the oil accumulation as fuel.
- Enclosures or extraction systems can help prevent the accumulation or spread of cutting oil and fluids.
- Permanent exhaust ventilation using non-combustible enclosures or ducting can be installed to remove suspended droplets or oil mist.
- Some ventilation systems require automatic fire suppression or explosion-relief panels on their ducts.

Petroleum-based fluids

Petroleum-based fluids under pressure – whether being used for hydraulic movement, lubrication or cooling – require protection. This is because a high-pressure oil leak can cause oil atomisation. The atomised oil can easily ignite, creating a torch-like flame with heat release extending as far as 15 metres from the leak. This type of fire is difficult to control with a sprinkler system due to its intensity, the discharge of fuel under pressure and the three-dimensional configuration.

Sources of hydraulic oil leaks include:

- worn flexible hoses
- failure of piping connections (particularly where threaded connections are used)
- incorrectly specified hoses
- mechanical damage
- valve or packing gland failure.

The installation of automatic interlocks or remote manual shut-off controls helps prevent leaks that can lead to a torch-like fire. The recommended protection for this type of equipment depends on the size of the reservoirs and the operating pressure. When installed, remote manual shut-offs and automatic interlocks should be arranged to shut off the hydraulic fluid pump and the flow from accumulators in the event of a leak or fire.

Automatic activation of the interlock can be accomplished using one or more of the following:

- a low-liquid-level switch in the oil reservoir
- a pressure sensor
- flame or fixed-temperature heat detectors installed on the ceiling
- automatic sprinkler system water-flow switch.

Building protection

Buildings that house metalworking operations should be constructed of fire-resistant or non-combustible materials; a building with a wooden roof is therefore not suitable. Buildings with a large floor area should be subdivided using fire-rated construction material.

All buildings housing metalworking operations should be equipped with automatic sprinkler systems designed for the type of hazard posed by the specific metalworking operation. Certain processes may also require local application automatic fire suppression systems.

Appropriately rated fire extinguishers should be provided for each machine, and all machine operators should receive training in their use.

Housekeeping, maintenance and training

Housekeeping and preventative maintenance are of the utmost importance in the prevention of fire in a metalworking facility. Rigorous, ongoing attention should be paid to the:

- removal of chips, cuttings and fines from the work area
- removal of smaller chips and fines resulting from high-speed operations, grinding and precise finishing of hard metals, possibly requiring pneumatic conveyance
- regular inspection for accumulations of oily deposits, fine metal particles and dust
- repair of oil leaks as soon as they are detected
- timely removal of any oil accumulations

- routine cleaning of walls, floors, overhead structural members, other vertical and horizontal surfaces, such as equipment, ducts, pipes, hoods, ledges, beams and other concealed surfaces, to minimise dust and oil accumulations
- preventative maintenance of all metalworking equipment, following the manufacturer's guidelines where available. The implementation of a preventative maintenance programme is integral to any metalworking operation.

It should be noted that when cleaning an area and equipment, sweeping or blowing down with steam or compressed air produces a dust cloud and should only be permitted when the area and equipment are vacuumed beforehand.

Training is a priority and all personnel who operate equipment in the metalworking facility should undergo training. It is essential that this training includes:

- the operation of emergency shut-offs or fixed protection systems
- a thorough understanding of the protective measures in place, and their proper operation.

Any and all training should be documented, and refresher training should be provided for all staff at regular intervals.

While adherence to these minimum procedures may help a business owner or manager protect their metalworking premises from fire, they do not contemplate every potential scenario for loss or damage. It is important, therefore, that the property Fire Safety Manager should regularly review the placement, use and maintenance of all metalworking equipment onsite and ensure that the appropriate safety measures are in place. They should also take responsibility for ensuring that personnel have been adequately trained in the use of equipment.

Metalworking

Hazards and protection at a glance

- Fire is the major hazard but other potential hazards specific to processes should also be considered.
- Buildings housing metalwork operations should be constructed of fire-resistant or non-combustible material.
- Automatic sprinkler systems should be appropriate for the specific operational hazard.
- Hydraulic oil systems – avoid using in a process with operational temperatures within 30°C of flashpoint.
- Lubricating/cutting oil and coolant systems – avoid oil accumulation or spread and clean as soon as detected.
- High-pressure petroleum-based fluids – install automatic interlocks or shut-off controls.
- Rigorous tidying and cleaning of work areas and inspection and maintenance of equipment is crucial.
- All personnel should be trained in the safe use of equipment.

Want more information?

NFPA **70 National Electrical Code.**

Australian Standard/New Zealand Standard 3000 **Electrical Installations.**

Australian Standard/New Zealand Standard 2430 **Classification of hazardous areas.**

Australian Standard 2118 **Automatic fire protection systems.**

Australian Standard 1851 **Routine service of fire protection systems and equipment.**

NFPA13 **Standard for the Installation of Sprinkler Systems.**

NFPA 16 **Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.**

NFPA 30 **Flammable and Combustible Liquids Code.**

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