Loss Prevention Standards – Asset Classes

Hydraulic Oil Systems

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Hydraulic oils are normally kept under high pressure in equipment used in a range of industries. If there is a breach in the equipment, a spray of the oil can escape and be easily ignited. Using less flammable hydraulic fluid where possible and the implementation of loss prevention measures, can help to lessen the risks associated with hydraulic oil systems.

AVIVA

Hydraulic Oil Systems

Introduction

Hydraulic oils are normally held at high pressure within enclosed hydraulic systems and are used as a means of transferring power to a work process. Hydraulically operated equipment is ideal for high speed, high power applications, and is used in a wide range of industries, such as metal working, engineering, construction, plastic components manufacture and woodworking.

- Hydraulic oils are generally stable at atmospheric pressure and temperature
- They have high flash points of between 150°C and 315°C, and an auto-ignition temperature range of 260–400°C.
- Mineral oils don't corrode equipment components, and in addition to energy transmission, they also lubricate the system, remain stable and can be blended for a range of pressures and temperatures
- Mineral oils burn, and pressurised mineral oils in hydraulic systems are a considerable fire hazard – especially when ignition sources are present

A small breach or pinhole leak in pipework or equipment will cause an atomised spray or mist of small-diameter hydraulic oil droplets to be released under high pressure. These sprays can extend up to 12.2 metres (40 feet) from the breach, depending on the oil flow rate, oil operating pressure, the size of the leak and so on. The spray can be easily ignited – for example, by contact with heated work-equipment surfaces. Depending on the workplace's layout, damage may be confined to the work equipment where the fire started or could spread to neighbouring plant, work equipment and stores of combustible material. This could potentially lead to a catastrophic loss at the premises.

Hydraulic System Components

A simple hydraulic system feeding one process has three key elements:

- Pump unit
- Drives
- Piping system

A single hydraulic system can be used to power several machine processes – in which case the system and hydraulic oil reservoir may be remote from the machine lines.

Potential Impact

The consequences of a hydraulic oil release will depend on several factors, including:

- Composition of the hydraulic fluid used
- Duration of the spray
- What materials are exposed to a fire, such as equipment, storage and structural elements of the building
- System pressure and flow rate
- Design of the hydraulic oil system and neighbouring work equipment, and
- Construction of the system

Managing the Risk of Hydraulic Oil Systems

Several measures can be taken to reduce the risk of fire, this includes the:

- Design and location of the hydraulic system
- Selection of materials used
- Provision of fire control systems

The selection of the hydraulic oil itself is a key part of the design of all hydraulic oil systems. It may not be feasible to eliminate hydraulic oils from a work process, but it may be possible to use an approved or listed (e.g. FM Approved), less flammable hydraulic fluid than petroleum-based oils. All hydraulic fluids will burn under certain conditions but choosing less flammable hydraulic fluids that are more challenging to ignite if they're adequately maintained can significantly reduce the risk of fire in a well-maintained hydraulic oil system.

Categories of less flammable hydraulic fluid include:

- High water-based fluids (HFA):
  - comprise 90% or more water with soluble oil additives
  - principally used in processes with procedures less than 1,000 psi (6.9 MPa)
  - can be used within an operating temperature range of 4–48°C
  - compatible with most seals and gaskets except those made from cork, leather, synthetic fibres and paper.
- Water-in-oil emulsions (HFB):
  - contain 35–40% water dispersed in mineral oil
  - have an operating temperature range of 10–65°C
  - their stability is susceptible to excessive heating or cooling, resulting in the emulsion losing water and increasing the risk of the fluid igniting
  - compatible with most seals and gaskets except those made from cork, leather, synthetic fibres and paper.
- Water polymer (glycol) solutions (HFC):
  - a water glycol solution containing 35–50% water
  - have an operating temperature range of 18–65°C. Operations in excess of this range lead to an increased rate of water evaporation, resulting in an increase in solution viscosity and increased risk of ignition. Under such circumstances, water levels will need to be frequently topped up
  - compatible with most seals and gaskets except those made from cork, leather, synthetic fibres and paper.
- Synthetic fluids (HFD):
  - includes solvents based on chlorinated hydrocarbons and phosphate esters with an operating temperature range of 7–93°C
  - incompatible with natural rubbers and neoprene
  - require special hoses and seals if used in a hydraulic system.

For further guidance on selecting and using less-flammable hydraulic fluids, refer to BS ISO 7745:2010 *Hydraulic Fluid Power – Fire-Resistant (FR) Fluid – Requirements and Guidelines for Use*.

Operational Controls

Various loss prevention measures can be put in place to reduce the likelihood of a pressurised hydraulic oil leak occurring and becoming ignited, including those listed below:

- Location – position large hydraulic power pack units in a minimum 60-minute fire rated enclosure
- Hydraulic fluid containment – make sure there's appropriate liquid-tight, non-combustible containment around the hydraulic oil reservoir. This should ensure the fluid is managed if it leaks
- Leak/escape of fluid – make sure all leaks are cleaned up immediately and repaired. Don't use any combustible materials such as rags to soak or clean up the oil. Non-combustible materials or spill kits should be used
    - Wicking agents – most hydraulic fluids are quite difficult to ignite due to their nature. However, if they're soaked in a combustible material, it can make them much easier to ignite. If ordinary combustible materials such as rags or cardboard are used to soak up fluid leaks, they can act as a wicking agent – much like a candle. These materials shouldn't be used to clean up leaking fluid and should be stored well away from hydraulic systems and hydraulically operated equipment
- Low system pressure – to help make sure the hydraulic system shuts down safely there should be a low pressure switch fitted to the system
- Low hydraulic fluid level – to help make sure the hydraulic system shuts down safely there should be at least one low hydraulic fluid level switch fitted to the system
- Ignition source management – if there are any potential ignition sources such as hot surfaces, electrical equipment, open flames, etc. close to a hydraulic fluid-based system, they and the hydraulic fluid system should be shielded from each other to ensure that any fluid leak or mist doesn't come into contact with a potential source of ignition. This is important where smelting, extrusion, etc. take place in a building
- Automatic fire detection – this should be provided in any areas with hydraulic fluid operated machinery and signal to a constantly attended location
- Automatic fire suppression – based on the property and/or business exposures, automatic fire suppression such as sprinkler protection should be provided in any areas with hydraulic fluid-operated machinery. The hydraulic design of this system will be based on many factors, including:
    - nature of the hydraulic fluid
    - volume of the hydraulic fluid
    - number of machines/systems, etc.
- Interlocks – to help ensure the hydraulic system doesn't cause an exposure in an emergency, all hydraulic fluid systems should be interlocked to shut down on activation of the following:
    - site-wide fire alarm OR
    - local to equipment automatic fire detection, AND where provided
    - automatic fire suppression activation alarm or impairment of localised fire suppression systems
- Emergency shutdown – because of the nature of hydraulic fluid mist, a manually activated emergency shutdown switch should be provided at a safe distance in a safe area away from the hydraulic equipment. A safe shutdown sequence should be developed and implemented
- Operator training – all operators should receive regular comprehensive training in the use of hydraulic oil systems equipment, including safety controls
- Maintenance, inspection and testing – based on risk assessments and manufacturer's recommendations, put in place a comprehensive maintenance, inspection and testing regime of the hydraulic oil systems equipment and safety/protection systems using competent individuals

Checklist

A generic Hydraulic Oil Systems Checklist is presented in Appendix 1 which can be tailored to your own organisation.

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Sources and Useful Links

- BS ISO 7745:2010 Hydraulic Fluid Power – Fire-Resistant (FR) Fluid – Requirements and Guidelines for Use

Additional Information

Relevant Loss Prevention Standards include:

- Permit to Work Systems

To find out more, please visit Aviva Risk Management Solutions or speak to one of our advisors.

Email us at riskadvice@aviva.com or call 0345 366 6666.*

*Calls may be recorded and/or monitored for our joint protection.

Appendix 1 – Hydraulic Oil Systems Checklist

Location	
Date	
Completed by (name and signature)	

	Hydraulic Oil Systems	Y/N	Comments
1.	Has a formal risk assessment been carried out, incorporating a cause-and-effect analysis of hydraulic system process and work equipment processes powered by the hydraulic system?		
2.	Does the assessment cover the process and the environment that it is taking place within, including: • The number of machines? • Proximity of machines, and oil reservoirs, to one another? • Volume of oil bunds and reservoirs?		
3.	Have you evaluated the hydraulic fluids that you're using, making sure they are the least flammable hydraulic oils available?		
4.	Are your hydraulic oil systems located in buildings, or an enclosure, of non-combustible construction?		
5.	If your hydraulic system is supplying more than one item of work equipment, is the hydraulic reservoir located within an enclosure with a minimum fire resistance of 60-minutes?		
6.	Are all components used in the hydraulic system made from non-combustible materials?		
7.	Have fixed steel pipework with welded connections, and inflexible hose, been used to connect the hydraulic system where possible?		
8.	Have you considered the effect of a high-pressure spray deflecting off machinery surfaces, and the potential outcome?		

	Hydraulic Oil Systems Contd.	Y/N	Comments

9.	Is pipework secured to reduce the risk of wear from movement and/or vibration?		
10.	Does the hydraulic oil system incorporate a relief valve that will release system pressure back into the oil-reservoir for use if there's external pressure-shock? For example, if the piston is subject to sudden shock, the pressure inside the system will rise abruptly and increase the risk of pipework and hoses breaking.		
11.	Are all hydraulic pipes and hoses sited away from sources of heat – such as heated machine components – and screened-off to reduce the risk of ignition if there's a pipe/hose breach?		
12.	Has a maintenance and testing programme that's undertaken by competent individuals been established for your hydraulic systems, covering: • Inspections prescribed by the equipment manufacturer? • A formal daily inspection of the system, including leaks, worn and/or damaged components/loose connections?		
13.	Are low-level cut-offs in place on oil reservoirs and has the cut-off level been set?		
14.	Are fluid reservoirs contained within non-combustible bunding, capable of containing 110% of the capacity of the reservoir?		
15.	Has a procedure been established for clearing up spills, and are spill kits available? Note: *Ensure that spill kits do not include combustible materials such as rags, which could act as wicking agents.*		
16.	Are worn or damaged components replaced with new components made from non-combustible materials that are compatible with the hydraulic oil and rated to applicable temperature and pressure levels?		
17.	Are hydraulic fluids tested and replaced in line with manufacturers' guidance?		
18.	Is the work area where hydraulic systems are located monitored by heat/smoke detection?		

	Hydraulic Oil Systems Contd.	Y/N	Comments
19.	Is there a readily available, manually operated emergency shut-off/isolation button for the system located in a safe location? Is this at least 15m away from the hydraulic system?		
20.	Is the work area protected by an automatic fire control system such as automatic sprinklers, designed and installed to a recognised standard, e.g. NFPA, LPC and FM?		
21.	Does the hydraulic system isolate and de-energise upon activation of the: • Site fire alarm system • Local automatic fire detection system • Sprinkler flow alarm (if provided)?		
22.	Are oil pressure levels within the hydraulic system monitored?		
23.	Does the hydraulic system shut down if there's a drop in system pressure?		
24.	Is a permit to work system in place, covering works upon pressure systems?		
25.	Have formal inspection criteria been established for checking hydraulic systems, including pipework, interlocks, etc., prior to the sign-off of a permit and reinstatement of the hydraulic system?		
26.	Is the local area around the hydraulic system kept clear of combustible materials? *Note: Area of segregation will be dependent upon the potential spray distance.*		
27.	Are standards of housekeeping for areas that are used to house hydraulic equipment checked on a daily basis?		
28.	Are all areas exposed to hydraulic oil leaks or accumulation, including within the retention bund itself, maintained totally clear of all combustible materials such as cardboard, rags, etc. that could act as wicking agents?		
29	Additional comments:		

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