NEBOSH International Diploma

Unit DI3: Workplace safety issues

SAMPLE MATERIAL

RMS PUBLISHING

FIFTH EDITION

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RMS PUBLISHING

1.1 - Safe working environment

Practical considerations for a safe place of work and safe means of access and egress

SAFE PLACE OF WORK

When determining practical considerations for a safe place of work, it is necessary to take regard to where workers are located, what is there place of work. They may be standing in a warehouse determining the quantity of stock, in a sewer, in a garage or in an office. Each place of work has features that could present a hazard and would require control to enable it to be safe to work in. For example, the warehouse may have to be cordoned off whilst stock is counted to ensure fork lift trucks do not collide with workers.

In addition, it is important to consider the work being done, as this can quickly make a place of work unsafe, for example, a shop worker stacking shelves could make the workplace unsafe by leaving boxes and sealing straps in a disorganised way. When ensuring a safe place of work, it is therefore important to consider how good standards present in a workplace could diminish and what actions are necessary to ensure they are maintained. This will include arrangements for cleaning work surfaces, maintaining lighting levels, reapplying markings to identify work/storage areas and dealing with spillages.

Practical considerations in the provision and maintenance of a safe place of work will typically include:

- Provision of good ventilation.
- Reasonable temperatures.
- Suitable and sufficient lighting.
- Cleanliness and dealing with waste.
- Adequate space.
- Suitable workstations and seating.
- Condition of floors.
- Establishing traffic routes.

When considering the condition of floors, it is important to take account of the processes being conducted in workplaces. They might generate waste and spillages could occur, which can influence the arrangements to keep it free from obstructions and the type of surface required for the floor. The type of surface of floors should enable them to be cleaned properly and reduce the risk of slipping on liquid spillages. Where liquid spills are likely absorbent floors, such as untreated concrete or timber, which are likely to be easily contaminated by liquids that are difficult to remove, should preferably be sealed or coated, for example with a suitable anti-slip floor paint.

Figure 1-1: Anti-slip flooring. *Source: RMS.*

Figure 1-2: Good example of housekeeping. *Source: RMS.*

Floors should be kept free of obstructions that could present a hazard or impede access. This is particularly important in any place where an obstruction is likely to cause an injury, for example near machinery, areas for making hot refreshments, where manual handling is done and where chemicals or sharp equipment are used. Where a temporary obstruction is unavoidable and is likely to be a hazard it will be necessary to prevent access or take steps to warn people (including drivers) by, for example, the use of hazard cones/barriers.

SAFE MEANS OF ACCESS AND EGRESS

When determining practical considerations for safe means of access and egress, it is important to take regard of such matters as clearly marked gangways, walk routes that are free from obstruction, the maintenance of floors and staircases and the organisation of traffic routes (including pedestrian traffic).

Access between floors should not normally be by means of ladders or steep stairs, however, fixed ladders or steep stairs may be used where a conventional staircase cannot be accommodated, provided they are only used by people who are capable of using them safely and any loads they carry can be carried safely.

Staircases provided in workplaces should be securely fenced, which should, as a minimum, consist of an upper rail at 900 mm or higher, and a lower rail. A secure and substantial handrail should be provided and maintained on at least one side of every staircase and handrails should be provided on both sides if there is a particular risk

BOILING LIQUID EXPANDING VAPOUR EXPLOSIONS

Causes

A boiling liquid expanding vapour explosion (BLEVE) can be caused by the rupture of a storage vessel containing a pressurised liquid that has reached temperatures above its boiling point. When the vessel's integrity is compromised, the loss of pressure and dropping boiling point can cause the liquid to rapidly boil, expand extremely rapidly and convert to vapour/gas. The remaining boiling liquid could be forced through the rupture to the open air. If the contents are a flammable substance and a suitable source of ignition is present, rapid combustion of the vapours from the boiling liquid can take place, in the form of an explosion.

The conditions required for a BLEVE are:

- There must be a substance in liquid form.
- The liquid must be in a container.
- The contained liquid must be at a temperature above its normal boiling point at atmospheric pressure – the container allows the pressure inside to build up above atmospheric pressure, the substance in the container is able to remain in the liquid state, even though its temperature is above its normal boiling point. This increase in pressure raises the Boiling point of the contained liquid above its boiling point.
- There must be a failure of the container – typically due to flame impingement (for example an external fire), internal structural weaknesses (for example corrosion) or impact (for example by a vehicle or in a road accident).

A BLEVE is a type of rapid phase transition in which a liquid contained above its atmospheric boiling point is rapidly depressurised, causing a nearly instantaneous transition from liquid state to vapour state with a corresponding energy release.

Storage vessels for pressured flammable liquids/gases are designed to withstand an amount of increased pressure and have a pressure relief system to release excess pressure in a controlled way should it occur. In a situation where a storage vessel is subject to moderate heat the liquid contained in it should boil slowly allowing the pressure relief system to operate and maintain a constant pressure in the vessel until all the liquid has boiled and been released.

However, if heating of the vessel is rapid and intense (such as when exposed to an external fire) the pressure relief system may not have time to operate. The increase in temperature will mean its liquid contents will begin to rapidly revert to the gaseous state (as a vapour), with a resulting increase in pressure inside the cylinder. As the heat turns the liquid into its gaseous state the liquid level drops. Because there is less and less liquid to absorb the heat, the metal of the vessel just above the liquid level absorbs the heat and the structure of the metal starts to change and weaken. The metal melts and thins, such that it can no longer contain the pressure and ruptures, causing a sudden drop in pressure which results in near instantaneous evaporation (explosive evaporation) of the remaining liquid. The rapidly expanding vapour compresses the surrounding air, creating a blast pressure wave and sending chunks of the vessel at high velocity into the surrounding area.

Where vapours from the boiling liquid are within their flammable/explosive range and encounter a source of ignition, for example an external fire, rapid combustion of the vapours will take place, resulting in a large fireball. This is known as a boiling liquid, expanding vapour explosion (BLEVE).

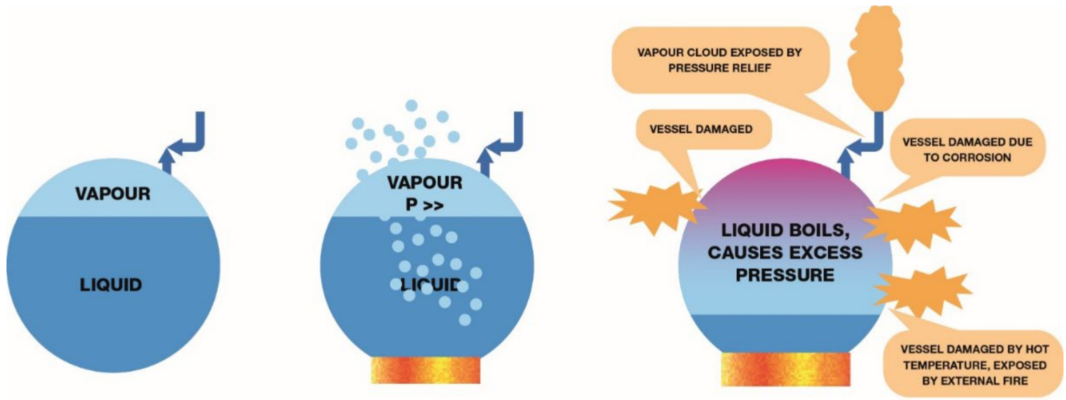

Figure 3-13: Stages leading to a BLEVE. *Source:* www.marineinsight.com/RMS.

A BLEVE will consist of:

- A blast wave (usually low pressure).
- High thermal radiation.
- Projectiles being sent long distance.

Severe burns from the high thermal radiation associated with a BLEVE can take place at a range of distances, which are particularly influenced by the size of the vessel containing the substance:

- Aerosol can. 10 metres.
- LPG cylinder. 35 metres.
- LPG rail transport. 250 metres.

Separation distances for dangerous substances depend on various factors, including how the dangerous substance is stored and whether the location is considered to be 'high risk' or not. The use of separation as a protective measure for the storage of dangerous substances is essential to reduce the combination of risk in the event of a spillage or fire.

Drums may also be damaged if the gangways between stacks are not wide enough for the method of handling used. Access ways of not less than 1.5 metres are usually adequate where single drums are handled manually or 2.5 metres for palletised drums using a fork lift truck.

In addition, it is important to ensure that drums are not unduly confined, such as by stacking them close to building walls or fire walls, it is recommended that at least 1 metre is provided between drums and the wall. Good separation will therefore assist with gaining access to the drums to place them in storage, to inspect them, to retrieve them and to deal with incidents that might occur, such as spills and leaks.

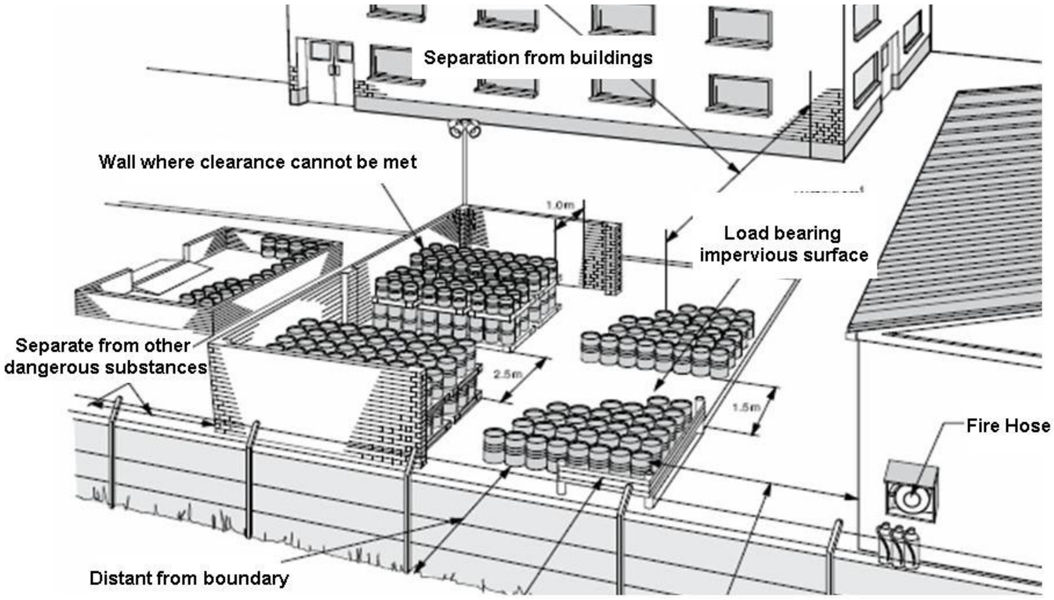

Figure 5-5: Storage of dangerous substances in drums. *Source: UK, HSE, HSG 135 (withdrawn).*

It is also advisable to restrict access to the store by unauthorised people and vehicles. This may prevent accidental damage to drums and the introduction of uncontrolled ignition sources. For outdoor storage, it may be useful to mark the extent of the storage area or erect suitable barriers. The standard of security at the store will depend not only on the nature of the dangerous substances stored, but also the conditions in the area surrounding the store and on the general level of security at the premises.

Specific locations

Dangerous substances will often need to be stored in specific locations in order to make sufficient amounts available for the use of the substances in processes and other work activities. It is usual to control the amount stored to the minimum necessary for immediate use during that day or work shift.

As with storage in other locations, it is important to ensure that incompatible substances are segregated from each other and that access to the dangerous substances is limited to those trained and competent to use them.

Figure 5-6: Safety cabinet for flammable liquids. *Source: ARCO.*

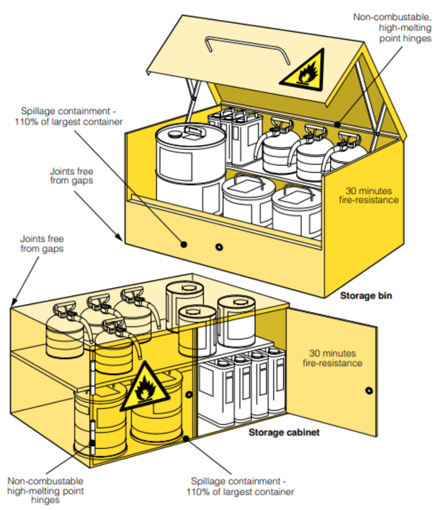

Figure 5-7: Work area flammable liquid storage. *Source: UK HSE HSG51.*

Convention C119 states that no workers will use machinery without the guards provided being in position, nor will they be required to operate any machinery without the guards provided being in position. Workers using the machinery must not make inoperative any of the guards provided nor must they use machinery where guards are inoperative. The prohibitions do not prevent the maintenance, lubrication, setting up or adjustment of machinery (or parts of machines) carried out in conformity with accepted standards of safety.

Convention 119 only applies to machinery used for industrial purposes and does not apply, for example, to machinery intended exclusively for domestic purposes. The Convention covers all categories of machinery used for industrial purposes whatever its function.

ILO Code of Practice on 'Safety and health in the use of machinery'

The ILO Code of Practice on 'Safety and health in the use of machinery' is intended to provide guidance on health and safety in the use of machinery in the workplace. Worker health and safety should be addressed from design to decommissioning of machinery. This ILO Code of Practice is based on principles established in international instruments relevant to the protection of workers' health and safety.

The division of responsibilities for securing health and safety in the use of machinery throughout its life cycle is shown in ***Figure 8-5***.

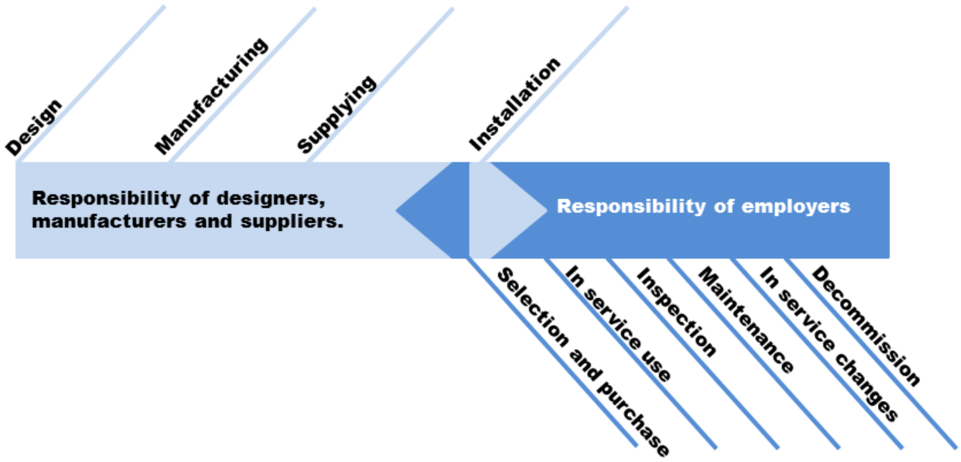

Figure 8-5: Division of responsibilities for securing the safety in the use of machinery. *Source: ILO Safety and health in the use of machinery/RMS.*

Part I sets out the scope, objectives, hierarchy of controls and definitions, as well as general obligations, responsibilities and duties of those involved in ensuring health and safety in the use of machinery. This includes competent authorities in each country, designers and manufacturers, suppliers and employers, workers and their organisations. Part II deals with technical requirements and specific measures that should be taken in order to protect workers' health and safety. The relevant sections of part II should be used by manufacturers and suppliers to ensure that machinery is designed and constructed in such a way that it is safe for use and fits the purpose for which it is intended. Part II also contains sections that should be used by employers to assess whether machinery they select and use or modify is fit for purpose and suitable for the specific working environment and conditions. Part II provides information on control systems, machinery guarding and protection against mechanical and other hazards. Guidance is provided on the marking and supplementary measures relating to specific machinery types.

The appendices provide more specific information for designers, manufacturers, suppliers and employers to supplement Parts I and II. They include information on different types of guarding for machinery and detailed supplementary technical information for certain specific machinery types.

ISO 12100

The primary purpose of the international standard ISO 12100 'Safety of machinery - General principles for design - Risk assessment and risk reduction' is to provide an overall framework and guidance for decisions during the development of machinery to enable machines to be designed that are safe for their intended use. ISO 12100 is a type 'A' standard. Type A standards (basic safety standards) give basic concepts, principles for design and general aspects that can be applied to machinery. It also provides a strategy for standards developers, assisting them in the preparation of consistent and appropriate type-B and type-C standards. Because it establishes general principles, the content of ISO 12100 would be useful to all of the parties involved in applying ISO machinery standards, including machinery manufacturers, importers and distributors, conformity assessment bodies, health and safety professionals, as well as occupational health and safety and consumer protection agencies.

ISO 12100 specifies basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective. These principles are based on knowledge and experience of the design, use, incidents, accidents and risks associated with machinery. Procedures are described for identifying hazards and estimating and evaluating risks during relevant phases of the machine life cycle, and for the elimination of hazards or sufficient risk reduction. Guidance is given on the documentation and verification of the risk assessment and risk reduction process.

10.1 – Hazards and controls for electric arcs and static electricity

Electric arcs

An electric arc is an electrical discharge between two separated conductors where the potential in one conductor (cathode) is great enough to create a high temperature conductive path (thermally ionised column of gas – called a plasma) for the current to travel through the air gap to the other conductor (anode), which is at lower potential.

If this phenomenon is controlled it has great benefits for industry, for example, in electric arc welding. However, in the workplace an electric arc involving electrical systems can be unintentionally caused by people, for example when:

- A worker touches a test probe against the wrong (electrically energised) part of electrical equipment.
- A worker's jewellery, watch or similar worn item contacts an electrically energised surface.
- Workers maintaining electrical equipment drop a metal tool/bolt across an energised conductor and a conductor at a lower potential – for example a spanner dropped across terminals on a bank of power supply batteries for a forklift truck.
- A worker attempts to work on an energised electrical system in error.
- Excavation and road digging equipment penetrate energised cables in the ground.
- A mobile crane passes too close to an overhead power line.

Apart from the hazard of electric shock posed by the energised conductors other hazards arising from electric arcs include:

a) High levels of heat.

b) High levels of light.

c) Molten metal splashes.

d) Significant pressure waves.

The heat energy and intense light released from the electric arc is called arc flash. Direct exposure to the high levels of heat emitted from an arc flash (approximately 19,500^{0}C or 35,000^{0}F) can cause severe burns and set clothing on fire.

Burns associated with arc flash from high energy arcs can be fatal, even if the person is metres from the arc, and severe burns at distances up to 3 metres are common. Clothing may also be ignited at distances of several metres. This may also be fatal, because the clothing cannot be removed or extinguished quickly enough to prevent serious burns, which might extend over much of the skin.

An electric arc flash will emit very high levels of ***non-ionising radiation***, including visible light and ultraviolet (UV).

The high levels of visible light can damage eyesight. The release of very intense ultraviolet (UV) radiation can cause burns to the skin and a condition called photokeratitis ('arc eye, welder's flash, bake eyes, corneal flash burns').

Photokeratitis or ultraviolet keratitis is a painful eye condition caused by exposure of insufficiently protected eyes to the ultraviolet (UV) rays. Photokeratitis is not usually noticed until several hours after exposure. Symptoms include increased tears and a feeling of pain, likened to having sand in the eyes.

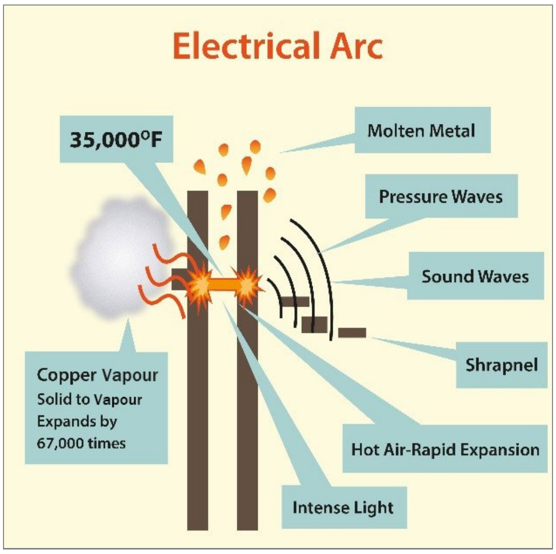

Figure 10-1: Schematic of arc. *Source: Power engineering/RMS.*

Figure 10-2: Electric arc damage in 415v swich panel - tools melted at front, hole where the left-hand panel vapourised *Source: RMS.*

Figure 10-3: Photokeratitis.
Source: www.realdoctorstu.files.wordpress.com.