

Dangerous Substances and Explosive Atmospheres

Purpose: Purpose: To provide employers with guidance on how to manage Dangerous Substances and Explosive Atmospheres.

Introduction

Background

The *Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)* came into force in December 2002. It gave the UK the opportunity to modernize such legislation and comply with the European Union Directive "Chemical Agents Directive (CAD) and the ATEX (derived from the French term- Atmospheres explosive) 137 Directive.

At the time regulation of substances that could give rise to the risks of fire and explosion had accumulated incrementally for different types of substances in different industries. Although the majority of substances covered were based on petroleum and some organic substances, there were others such as organic dust and certain grinding and mixing operations that were not. Consequently it was becoming increasingly impracticable to legislate on a substance or activity specific basis as technology used with these materials advanced. So with the introduction of the new legislation 20 or so pieces of legislation were replaced, most significant was the Highly Flammable Liquids and liquefied petroleum gasses regulations 1972.

CAD's main objective is to protect employees from fire, explosion and health risks arising from chemical agents present in the workplace. The health risk is now controlled under the control of substances hazardous to health (COSHH). The safety (i.e. fire and explosion) aspects are integrated in to the DSEAR. Thus DSEAR covers all substances that could give rise to fires, explosive atmospheres and similar energetic events and the management of places where explosive atmospheres may arise.

Another European Directive ATEX 95(94/9/EC) is associated with DSEAR and this is concerned with the supply of equipment, protective systems, components etc. where these are for use in potentially explosive atmospheres. ATEX 95 is implemented in UK law under the Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations 1996 (EPS). Please refer to the relevant Fact sheet concerning this for further information.

Thus DSEAR and EPS Regulations are complementary. DSEAR is concerned with the safe use of dangerous

substances and requires employers to zone workplaces according to the hazard and to select equipment and protective systems appropriate for that zone that meets EPS requirements. The EPS puts a duty on the manufacturer and supplier to manufacture or supply equipment that is suitable for use in the relevant zones and ensure they are marked accordingly for the different types of zone.

Typical activities that are covered by DSEAR

DSEAR applies to many types of activities commonly found at work in businesses and public services, of which the following are typical:

- Storage and dispensing petrol as a fuel for cars, motor boats, horticultural machinery.
- Handling, storage and use of flammable gases, such as acetylene for welding.
- Handling and storage of waste dusts in a range of manufacturing industries.
- Handling and storage of flammable wastes such as fuel oils.
- Hot work on tanks or drums that have contained flammable material.
- Work activities that could release naturally occurring methane.
- Mining or processing of coal producing dusts.
- Use of flammable solvents such as ether in pathology and school laboratories.
- Storage/display of flammable goods, such as paints, in the retail sector.
- Filling, storage and handling of aerosols with flammable propellants such as LPG.
- Transport of flammable liquids in containers around the workplace.
- Deliveries from road tankers, such as petrol or bulk powders.
- Chemical manufacture, processing and warehousing.
- Extraction and processing of petrochemicals - onshore and offshore.
- Blending and mixing of organic and non organic powders using articulating machinery.

The examples given in the list above are only representative of the very wide range of relevant activities. All employers and the self-employed must consider if the DSEAR 2002 could apply to them.

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Where do the regulations apply?

- (a) Where work being carried out by an employer or self-employed person.
- (b) A dangerous substance is present or liable to be present at the workplace.
- (c) The dangerous substance presents a risk to the safety of persons (as opposed to a risk to health).

Responsibility falls on the employer, or the self-employed person, who is responsible for the workplace where dangerous substances or explosive atmospheres may be present. This is normally the owner, or lessee or occupier of the workplace.

The duties extend not only to protecting employees but also to any other persons, whether at work or not, who may be put at risk by dangerous substances and explosive atmospheres in the workplace. This includes:

- employees working for other employers;
- visitors to the site; and
- members of the public.

However, when making arrangements for dealing with accidents, incidents and emergencies and the provision of information, instruction and training, employers only have duties to persons who are normally at their workplace.

Likewise the employers duties in respect of provision of suitable personal protective equipment and appropriate work clothing only need to extend to employees.

Employers should, however, ensure that the number of persons who are to be in hazardous places is minimised and that all those that are in the hazardous workplaces are suitably equipped. i.e. PPE and equipment should be of a suitable standard.

Where two or more employers share a workplace the duty to co-ordinate the implementation of measures for control and protection will fall to the owner or lessee.

What are dangerous substances?

DSEAR applies to any substance or preparation (or a mixture of substances) with the potential to create a risk to persons from energetic events such as fire, explosions, or thermal runaway from exothermic reactions etc. The definition of 'dangerous' includes all substances that meet the criteria for being explosive, oxidising, extremely flammable, highly flammable or flammable

according to the Chemicals (Hazard Information and Packaging for Supply) Regulations ('CHIP').

Substances classified under the CHIP Regulations are therefore dangerous substances for the purposes of the DSEAR.

The definition of 'dangerous' also includes other substances that are not classified under the CHIP Regulations, but meet the criteria by virtue of the way they are used or are present at the workplace. For example, the DSEAR apply to substances that decompose or react exothermically when mixed with other substances. Peroxides, wood, flour and many other dusts involved with grinding or machining can, when mixed with air, ignite and explode. While diesel (or other high flash point oils) at ambient temperature are not classified as flammable under the CHIP Regulations, if they are heated and used at sufficiently high temperatures in a process that creates a fire risk, they may become a dangerous substance for the purposes of the DSEAR.

Thus, in order to determine if a substance present is dangerous, two steps are necessary:

- (a) A check to find out if the substance has been classified under the CHIP Regulations; and
- (b) An assessment of whether the physical and chemical properties of the substance and the circumstances of its use in the workplace can create a safety risk to persons from a fire or explosion.

The DSEAR are only intended to protect persons from energetic events and the harmful physical effects from thermal radiation (burns), over-pressure (blast injuries) and oxygen depletion (asphyxiation) arising from fires and explosions.

Many of the substances will, however, also create health risks and it should be noted that the DSEAR does not address these. Many solvents are toxic as well being flammable. Health risks should be dealt with by the Control of Substances Hazardous to Health Regulations.

Notification to regulatory bodies

The Notification of Installations Handling Hazardous Substances Regulations requires that anyone who handles or stores (or intends to handle or store)

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hazardous substances in sufficient quantities to notify the Health and Safety Executive. The regulations coverage includes substances that are flammable and/or explosive, and which would be classified dangerous.

What is an explosive or potentially explosive atmosphere?

An explosive atmosphere is a mixture, under atmospheric conditions, of air and one or more dangerous substances in the form of vapours, mists or dusts in which, after ignition has occurred, spreads to the entire unburned mixture. A potentially explosive atmosphere is one that could become explosive due to local and operational conditions. These would include maintenance activities and fault conditions such as leaks of volatile substances and gases. An atmosphere that is not explosive during the course of normal operations may be potentially explosive if dangerous substances are present.

Risk assessment

Requirement and considerations

When a dangerous substance is, or is liable to be present at the workplace, the employer is required to carry out a risk assessment before commencing any new work activity involving that substance. The risk assessment required by the DSEAR is an identification and careful examination of the dangerous substance(s) that may be present, the work activities associated with the substance(s), and how the work activities might give rise to a risk of fire or explosion. The DSEAR requires that the risk assessment considers certain aspects as follows:

- a. The hazardous properties of the substance
- b. Information on safety or any safety data sheets that the supplier may provide
- c. The circumstances of the work including
 - i. the work processes and substances used and their possible interactions
 - ii. the amount of substance involved
 - iii. the risk when two or more dangerous substances are used in combination
 - iv. the arrangements for the safe handling, storage and transport of dangerous substances and waste

containing dangerous substances

- d. Activities such as maintenance where there is the potential for a high level of risk
- e. The effect of measures taken or to be taken to comply with the regulations
- f. The likelihood that an explosive atmosphere will occur and persist;
- g. The likelihood that ignition sources, including electrostatic discharges, will be present and become active and effective
- h. The scale of the anticipated effects of a fire or an explosion
- i. Any places which are or can be connected via openings to places in which explosive atmospheres may occur
- j. Such additional safety information as the employer may need to complete the risk assessment.

The requirements for a risk assessment and the management of risk are similar in principle to those required under the Control of Substances Hazardous to health regulations. A risk assessment may have already been carried out on dangerous substances under the COSHH regulations if they were hazardous to health. However, because of the different nature of the hazards of fire or explosion, the risk assessment under the DSEAR has different considerations and must be treated separately. Both pieces of legislation will have common elements, but they will also have individual elements in the management.

The degree of detail in the risk assessment needs to be commensurate with the degree of risk. For a small workshop, a table showing the substances stored and the hazards that could be created (e.g. spillages) and the precautions in place (e.g. open windows when handling), with any recommended improvements (e.g. provision of an extra fire extinguisher) would probably suffice. For a large factory with many dangerous substances, a more sophisticated risk assessment would be expected that would analyse the threats, detail the protection systems and emergency procedures and the remedial actions in the event of an emergency.

Recording your findings

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The purpose of the risk assessment is to enable employers to decide what measures are needed to eliminate, or reduce as far as reasonably practicable, the safety risks from dangerous substances. The recorded risk assessment must include:

- the measures (technical and organisational) that have been taken or to be taken to eliminate and/or reduce the risk
- sufficient information to show that the workplace and work equipment will be safe during operation and maintenance, including details of hazardous zones, co-ordination of safety in shared workplaces, arrangements to deal with accidents, incidents and emergencies and measures to inform, instruct and train employees.

After completing the risk assessment, the DSEAR require that the measures identified by the risk assessment are implemented before any new work commences.

Reviewing your risk assessment

The risk assessment must be kept up to date and the employer is required to review it regularly partially if:

- a. There is reason to suspect that it is no longer valid, or
- b. There has been a significant change in the workplace, work processes organisation of work.

When changes to the risk assessment are required as a result of the review, the risk assessment must be updated and any resulting safety measures implemented before work commences again.

Management of risks

Safety principles

DSEAR reinforces the requirements for employers to ensure that the risks to the safety of employees and others from dangerous substances are either eliminated or reduced as far as reasonably practicable.

Where it is not reasonably practicable to eliminate or reduce the risk, employers are required to take; so far as is reasonably practicable, measures to control the risks and measures to mitigate the detrimental consequences should a fire, explosion or similar event occur. The DSEAR therefore advocate the established safety

management principles of elimination, reduction, control and mitigation of risk.

Elimination and reduction of risk

The avoidance of risk by replacement of the dangerous substance with another substance or process that eliminates or reduces the risk is preferable if possible.

When it is not reasonably practicable to eliminate the risk, it may be possible to reduce the risk by replacing the dangerous substance with another that is less dangerous (e.g. by replacing a low flashpoint solvent with a high flashpoint one). Alternatively, it may be possible to redesign the process so as to reduce the quantities of dangerous substances involved. When substituting other substances or redesigning the process, it is important to take care that the changes do not create new or increased safety or health risks from other sources.

Control measures

When dangerous substances are present, the DSEAR requires employers to apply control measures, as far as reasonably practicable, consistent with the risk assessment and appropriate to the nature of the activity or operation, including the following in priority order:

- a. reducing the quantity of dangerous substance to a minimum (e.g. limit volume stored)
- b. avoiding or minimising releases (e.g. keep in sealed containers)
- c. controlling the release at source (e.g. ensure that valves and stoppers are used)
- d. preventing the formation of an explosive atmosphere (e.g. apply appropriate ventilation)
- e. collecting, containing and removing any releases to a safe place (e.g. fume extraction)
- f. avoiding ignition sources (eg sparks, naked flames etc.)
- g. avoiding adverse conditions that could lead to danger (e.g. overheating, overpressure)
- h. keeping incompatible substances apart (e.g. by segregation)

Mitigation of the risk

When dangerous substances are present, DSEAR require employers to apply mitigation measures, as far as reasonably practicable, consistent with the risk assessment and appropriate to the nature of the activity or operation, including the following:

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- a. reducing the numbers of persons exposed to the risk access
- b. providing plant that is explosion resistant (e.g. robust firmly mounted equipment)
- c. providing explosion suppression or relief equipment (e.g. pressure vents)
- d. taking measures to control or minimise the spread of fires or explosions (e.g. reducing combustible material, fire doors etc.);
- e. providing suitable equipment for the protection of personnel. (e.g. helmets, visors etc.).

General safety measures

In addition to the specific measures relating to dangerous substances and their immediate vicinity, DSEAR also specify a number of general safety measures that employers must take, as far as reasonably practicable. These measures relate the workplace and work processes as a whole and include:

- a. Ensuring the workplace is designed, constructed and maintained so as to minimise risk (e.g. use of fire resistant materials, installation of appropriate blast walls etc.).
- b. Providing work processes that are suitably designed, constructed, assembled, installed so as to reduce risk and ensuring that they are used properly and maintained in an efficient state, working order and good repair.
- c. Ensuring that equipment and protective systems meet the requirements for use in hazardous places (see EPS below), and:
 - i. can be maintained in a safe state of operation independently of the rest of the plant in the event of a power failure
 - ii. can be manually overridden when incorporated within automatic processes which deviate from the intended operating conditions
 - iii. can dissipate accumulated energy quickly and safely on operation of emergency shutdown;
 - iv. contain measures to prevent confusion between connecting devices.
- d. Applying appropriate systems of work including written instructions, permits to work and other

procedural systems of organising and controlling work.

- e. Identifying the hazardous contents of containers and pipes. Many will already be marked or labelled under existing legislation. For those that are not, 'identification' may require labelling, marking or warning signs. It could also include training, information or verbal instruction.
- f. Arranging for the safe handling, storage and transport of dangerous substances and waste containing dangerous substances.

Classification of places with explosive atmospheres

Classification scheme

Gases, vapours, mists and dusts can all form explosive atmospheres with air. The source of the gases, vapours, mists and dusts may be a consequence of the natural state of the substance (e.g. hydrogen gas), or it may be a result of the means of storage or handling (as in the case of a flammable liquid), or as a result of a work activity (e.g. grinding dust or powder processing).

Where there is any prospect of an explosive atmosphere, a hazardous area classification should be carried out as an integral part of the risk assessment and for those areas classified as hazardous, special precautions over the sources of ignition are needed to prevent fires and explosions.

In workplaces where an explosive atmosphere may occur, employers must first classify the workplace into hazardous and non-hazardous places. The criteria for deciding whether a place is hazardous is whether an explosive atmosphere could occur in such quantities as to require special precautions to protect the health and safety of workers concerned within the meaning of the DSEAR. Similarly, a non-hazardous place is one where an explosive atmosphere is not expected to occur in such quantities as to require special precautions to protect the health and safety of workers concerned.

When deciding on the classification, employers must first assess the quantity of explosive atmosphere that could be present in a particular place. The term 'not expected to occur in such quantities' is used so that employers also consider the likelihood or possibility of a release of an explosive atmosphere as well as the potential quantities of such a release. Places where it is credible that an explosive atmosphere could exist, even

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when this is not within normal operating limits should also be classified as hazardous. If, on the other hand, a release is extremely unlikely to occur and/or if the quantities released are small, it may not be necessary to classify the area as hazardous.

As an example, a dangerous substance is being carried through a seamless pipe that has been properly installed, maintained and inspected. It is unlikely that the substance will be released. An explosive atmosphere would not be expected to occur from this source and the area surrounding the pipe would be non-hazardous. However, if the pipe contained flanged joints or fittings where there was the possibility of a leak or its condition was uncertain, a release would be a credible event and the area should be classified as hazardous.

With regard to quantity, a spillage from a small bottle of solvent used in a laboratory would release so little flammable vapour that no special precautions are needed other than general control of ignition sources (no smoking, for example) and cleaning and disposing of the spillage. The area would not be classified as hazardous. If, however, the vapour released also had a strong anaesthetic effect, and spillages were known to occur from time-to-time, then the area might be classified as hazardous for that property. When deciding whether it is necessary to classify as a hazardous area with small quantities of dangerous substances, the actual circumstances of use and any specific product guidance should be taken into account.

Where dangerous substances in small pre-packaged containers are stored or are on display for sale in retail premises, for example solvents or aerosols, the area would not normally need to be classified as hazardous. An exception to this might, however, be with storage in poorly ventilated basements. When such substances are held in large quantities, as in a warehouse, with the opportunity for a build up of vapours or a larger spillage, a hazardous classification would be expected. Procedures to control ignition sources and to clean up and dispose of any spillage/release would be needed.

In identifying hazardous and non-hazardous areas and assigning zones, the following matters should be considered:

- The hazardous properties of the dangerous substances involved
- The amount of dangerous substances involved. The size of any potentially explosive atmospheres is, in part, related to the amount of dangerous substances

present. Guidance is given in industry specific codes on the quantities of dangerous substances that may be safely stored

- The work processes, and their interaction, including any cleaning repair or maintenance activities that will be carried out
- The temperatures and pressure of the dangerous substances. This will affect the nature and extent of any release. Some substances do not form explosive atmospheres unless they are heated (e.g. diesel oil), while others if released under pressure will form a fine mist that can explosive even if there is insufficient vapour
- The containment system and controls to prevent liquids, gases, vapours or dusts escaping into the general atmosphere (e.g. trays, seals)
- The possibility of an explosive atmosphere forming in an enclosed plant or storage vessel. A release of a dangerous substance into an enclosed space always increases the risk of an explosive atmosphere forming
- The ventilation (natural or a fan extract system) or any other measures designed to dilute sources of release and ensure that any explosive atmosphere does not persist for an extended time. Well-designed ventilation may prevent the need for any zoned area or reduce it so it has a negligible extent.

When considering the potential for dangerous atmospheres, it is important to consider all substances that may be present in the workplace. Waste products, residues, cleaning agents, materials used for maintenance and fuel could all be potentially dangerous. The possibility that combinations of substances could react to create an ignition source or an explosive atmosphere should not be overlooked.

The refuelling of cars or loading and unloading of petrol from tankers intended for use on public roads involve the introduction of potential sources of ignition in an area where a spill is possible. This would normally meet the criteria for being a hazardous area. In these circumstances, safety can be achieved by isolation of power sources (turning off engines) where a transfer of fuel is taking place making suitable checks before and after transfer and before and after vehicles are moved into or out of the refuelling area. Garage owners have a

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particular responsibility to monitor the forecourt and to ensure that these practices are implemented.

Zoning

For places classified as hazardous, employers are required to further classify these places into zones on the basis of the frequency and duration of the explosive atmosphere occurring. The DSEAR give the following classification scheme for mixtures with air of dangerous substances (Zones 0, 1 and 2) and combustible dusts (Zones 20, 21, and 22). In decreasing order of risk:

Zone 0 - A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of a gas, vapour or mist is present continuously or for long periods or frequently

Zone 1 - A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of a gas, vapour or mist is likely to occur in normal operation occasionally

Zone 2 - A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of a gas, vapour or mist is not likely to occur in normal operation, but if it does occur, will persist for a short period only

Zone 20 - A place where an explosive atmosphere in the form of a combustible dust in air is present continuously or for long periods or frequently

Zone 21 - A place where an explosive atmosphere in the form of a combustible dust in air is likely to occur in normal operation occasionally

Zone 22 - A place where an explosive atmosphere in the form of a combustible dust in air is not likely to occur in normal operation, but if it does occur, will persist for a short period only

Within this scheme, terms such as 'occasionally' or 'frequently' are not defined but are assumed to be that which a reasonable person would use. Normal operation is any situation when installations are used within their design parameters. Combustible dusts in the form of layers, deposits or heaps must be considered as a source of an explosive atmosphere and classified accordingly.

The basic principles of area classification are explained within the European standards, BS EN 60079/10 for gases and vapours and BS EN 61241/3 for dust. These standards form a suitable basis for assessing the extent

and type zone and can be used as a guide to complying with the requirements of DSEAR. However, the guidance must be applied to the site-specific factors to determine the extent and type of zone in any particular case. It should be remembered that an explosive atmosphere may spread into areas from the source of the hazard, for example through ducts, and these areas must also be included in the classification scheme. Various organisations have published industry specific codes and these should be used as guidance to ensuring the interpretation of DSEAR is consistent.

Area classification normally takes the form of drawings or plans identifying the hazardous areas and zones. Information about the dangerous substances that will be present, the work activities that have been considered, and other assumptions made will be given. These drawings or plans form part of the assessment record that the DSEAR require, and they should be available for examination by those affected and regulators. They become particularly important when there is a change in the work activity and/or new equipment is to be introduced into a zoned area.

Classification drawings or plans may need to be reviewed when maintenance is carried out. If the dangerous substances normally present have been removed it may be possible to treat the area as non-hazardous. Alternatively, if maintenance creates a larger than normal risk of a release of a dangerous substance, for example if it is necessary to open a normally sealed pipe system or enter a tank where vapours could exist - a larger area may need to be treated as hazardous or the area may need to be temporarily reclassified to a higher zone. It is not, however, normally necessary to create new classification drawings or plans for the duration of maintenance work, but the process needs to be carefully controlled.

Warning signs on entry

Employers are required to ensure that places classified as hazardous are marked at their points of entry with warning signs. The warning sign at entry into places where explosive atmosphere may occur is specified in the European Council Directive 99/92/EC and is:

- a. triangular in shape; and
- b. contains black letters 'EX' on a yellow background with black edging (the yellow part taking up at least 50 per cent of the area of the sign)

Verification of safety prior to first use

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Employers are required to ensure that before workplaces containing places classified as hazardous are used for the first time, they are confirmed as being safe (verified) by a person (independent or employed by an organisation) competent in the field of explosion. The person carrying out the verification must be competent to consider the particular risks at the workplace, the adequacy of the risk assessment, and the control and other measures put in place. As a result the person must have suitable experience, professional training or both.

Important Notice: Your Health & Safety Information Sheet is for guidance only. It does not replace our written Health & Safety policies and procedures and you must make sure you are fully aware of these.

Training Courses: For more details on our Health & Safety Training courses available, please contact our learning Zone department via email: learningzone@shrec.org.uk or visit our website: www.shrec.org.uk