



Guidance for implementing the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

Introduction

The Dangerous Substances and Explosive Atmosphere Regulations 2002 (DSEAR) are designed to ensure that the risks of fire and explosion arising from the use of dangerous substances in the workplace are properly assessed and controlled. The Regulations set out the minimum requirements placed on employers for the protection of both employees and other individuals who might be affected (e.g. contractors, students, visitors etc.). DSEAR is specifically concerned with the harmful physical effects of a fire or explosion (e.g. burns, physical injuries) and the effect of oxygen depletion and/or generation of toxic gases rather than the effect of the substance on the health of exposed individuals.

Employers are required to undertake risk assessments and introduce appropriate control measures to reduce both the likelihood of fire and the impact should there be an incident. The key requirements of DSEAR are given below:

- All work activities involving dangerous substances must be subject to a suitable and sufficient risk assessment. Storage of large quantities of flammable gases / liquids and any associated activities (transportation, decanting etc.) would also fall under this requirement even where the substances are not being actively handled.
- Risk assessments must identify appropriate control measures to eliminate or reduce the risk, so far as is reasonably practicable, which must be implemented before work can begin. Where it is not possible to eliminate the need to use flammable substances engineering controls, safe systems of work and/or personal protective equipment will be needed to control the risk.
- Plant, equipment and procedures should be designed to mitigate the effects of a fire or explosion and prevent these from developing / spreading beyond the initial location should they occur. In addition to this, robust emergency procedures should be developed. Where specific equipment (including personal protective equipment) is identified in emergency procedures this should be provided and relevant personnel instructed in its proper use.
- Ensure employees and other relevant individuals (e.g. contractors, students, visitors) are provided with information, instruction, training and supervision as required to minimise the risk to their safety.
- Where necessary classify areas where a flammable / explosive atmosphere may be present into zones in accordance with the guidelines given in the Regulations (see section 8 of this document for more detail). Ensure that classified areas are clearly marked with appropriate signage at the point(s) of entry.

DSEAR risk assessments usually require more detail than other risk assessments and place significant emphasis on mitigating the impact and spread of an incident. The Health, Safety and Wellbeing Department has developed a DSEAR Risk Assessment template designed to capture the necessary detail and guide users through the process. Simple DSEAR

assessments can be completed successfully by most individuals for simpler activities (e.g. using small quantities of flammable liquids in a research laboratory) more complex activities may require assistance from the Health Safety and Wellbeing Department, and on occasion there may be a need to engage specialised advisory support. The Risk Assessment Template can be found on the website:

[Risk Assessment Template \(PDF\)](#)

[Risk Assessment Template \(Word\)](#)

Note: An explosive atmosphere is defined as a mixture of one or more dangerous substances (gases, vapours, dusts, aerosols) with air that has the potential to catch fire or explode if a suitable ignition source is introduced. An explosive atmosphere does not always “explode” if ignited but where confined (e.g. in a storage tank or enclosed workspace) may burn rapidly which may subsequently cause the container or workspace to fail catastrophically due to a sudden increase in pressure.

Relevant substances

In the context of DSEAR a dangerous substance is defined as “any substance(s) used or stored in the workplace that could, if not properly controlled, cause harm to people as a result of a fire, explosion or similar incident such as an uncontrolled chemical reaction”.

This includes a wide range of chemicals found across the University that must be identified in the workplace and included in the risk assessment. In most cases the easiest way to identify dangerous substances is by looking for the hazard symbols which must be present on the container (or cylinder) in which they are supplied:

	Flammable / Highly Flammable Flammable chemicals include any substance with a flashpoint of 60°C or below which can act as a fuel when ignited. Highly flammable substances have flashpoints below 32°C and will pose a higher risk of fire and explosion. Flammable substances can be solids, liquids or gases and examples include hydrogen, acetone, petrol, cellulose nitrate and magnesium powder.
	Oxidising Agent Oxidising agents (oxidisers) are substances which can act as a source of oxygen for chemical reactions such as combustion. Oxidising agents will intensify an existing fire if they become involved and can, in some cases, ignite spontaneously when mixed with a fuel. Examples of common oxidisers include oxygen, potassium nitrate and sodium hypochlorite.

	Explosive Explosive substances contain huge amounts of stored energy and can detonate violently releasing huge heat, light energy and generating damaging pressure waves. Explosive substances can be detonated in many different ways including application of heat or friction. Some examples include nitroglycerin, trinitrotoluene (TNT) and dry picric acid.
	Compressed Gas/ Aerosol/ Cryogenics Compressed gases can be dangerous substances in two main ways. The gas itself may be flammable or explosive and act as a fuel which can be ignited (e.g. hydrogen, methane). Gas cylinders are highly pressurised and even those containing inert gases (e.g. nitrogen, helium) are relevant as any cylinder can explode when damaged or exposed to fire. Similarly inert cryogenics under pressure can also explode when damaged or exposed to fire.
	Corrosive Corrosive substances (e.g. acids) can be flammable in their own right (e.g. glacial acetic acid) and can therefore act as fuels. All corrosive substances are relevant to DSEAR even if they are not flammable as they can damage equipment, pipework, cylinders etc. which hold flammable substances or may react with other chemicals releasing flammable gases.

The hazard symbols shown above belong to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) and is displayed on chemical containers to allow easy identification of the hazard profiles of chemicals at a glance. GHS hazard labels will always take the form of a white diamond with a red border and the hazard symbol given in black in the centre. Two other systems of labelling are also frequently used in different contexts although it's worth noting that the while these differ somewhat in appearance the basic hazard pictograms used are the same:

- In the UK workspaces and storage containers (e.g. cabinets) where hazardous substances are present must be marked with signage that is compliant with the Health and Safety (Safety Signs and Signals) Regulations 1996. For chemical hazards, these will include the same hazard pictograms at the GHS system, but will be in the form of a yellow triangle with a black border.
- UN Hazard Labelling is commonly used on chemicals that are packaged for transportation. UN hazard symbols are also diamond shaped but the diamonds are colour-coded and include a numerical code indicating the UN Hazard Class. Classes may be broken down into subcategories providing more specific hazard information. For example UN Hazard Class 4 is broken down into three different subcategories; Class 4.1 (flammable solids), Class 4.2 (solids which are dangerous when wet) and Class 4.3 (solids which can spontaneously combust). A useful summary of the hazard classes can be found at:

Health and Safety Executive: hazard classes

It is worth noting that hazard pictograms alone do not cover the full range of substances which may need to be considered. There are several examples where a substance that is not normally flammable or explosive may become so under the right conditions. Two examples are covered below:

- Combustible dusts such as flour, wood dust and sulphur pose a minimal risk when stored properly in closed containers. However, when combustible materials of this type become dispersed into the air they become extremely easily ignited and can pose a very serious risk of fire and explosion. The risks of fire and explosion should therefore be considered in areas where these may be generated through cutting, grinding, sanding etc.
- Combustible oils and other organic liquids with higher flash points (i.e. above 60°C) are difficult to ignite under normal conditions but will act as sources of fuel when exposed to an external fire. Like dusts they pose a much greater risk when finely dispersed into mists and aerosols and mixed with air due to the significant increase in surface area. If a highly flammable liquid was released in the form of a mist or aerosol the risk of an explosion is increased

The physical form and chemical properties of each dangerous substance must therefore be considered along with the nature of the activity, ambient temperature, and the equipment involved to determine if there is a risk to persons from a fire or explosion in the workplace. Care should be taken to consider dangerous substances that may only arise as a result of an activity including flammable gases / vapours released during a laboratory procedure, materials which may decompose over time to release flammable gases (e.g. methane from rotting vegetation) or substances that may react exothermically when mixed with other materials (e.g. oxidisers mixed with fuels).

Note: One risk that is often overlooked is the presence of residual combustible materials stored in tanks or drums which can evaporate over time or when heated creating an explosive atmosphere within the drum. There have been dozens of documented cases of obsolete tanks or drum exploding when individuals try to cut the metal using grinders or gas torches causing significant injury or worse.

Note: Flammable waste including solvent waste, flammable silica waste etc. should also be considered dangerous substances under DSEAR and considered in the risk assessment.

Relevant activities and locations

In an organisation as diverse as the University of Edinburgh dangerous substances can be found in a wide range of areas including dedicated storage facilities, laboratories and other workspaces across the organisation where they are used daily by staff and students to undertake a wide range of range of processes and activities. DSEAR risk assessments must consider both short and long-term storage of dangerous substances as well as how they are used. This is especially relevant where large quantities of relevant materials are stored in (or adjacent to) buildings.

Some examples of activities and locations where DSEAR risk assessments are likely to be required are given in the list below. This list is not exhaustive and there will be many other locations and activities where a fire and/or explosion risk could arise.

- Flammable chemical storage areas including (but not limited to):
 - Bulk flammable chemical stores (e.g. solvent stores)
 - Main (or satellite) chemical stores
 - Chemical waste stores where flammable waste forms part of the usual inventory
 - Paint / oil / aerosol stores
 - Storage of waste combustible dusts in workshops or other facilities (e.g. sawdust)
 - Storage of pyrotechnics or other explosive materials
 - Storage of some flammable solids (e.g. cellulose nitrate film cannisters)
- Fuel storage areas including fuel storage tanks associated with back-up generators etc.
- Compressed gas cylinder storage facilities (including dedicated external cylinder pounds)
- Laboratories and other areas where relevant substances are stored and used in large quantities including:
 - Wet chemical laboratories
 - Solvent distillation / purification laboratories
 - Special operations laboratories (e.g. hydrogenation rooms)
- Laboratories undertaking research into fuel gases (e.g. hydrogen fuel research)
- Battery charging and storage facilities
- Workshops where flammable / combustible materials are used or generated including:
 - Vehicle workshops
 - Woodworking facilities (due to risk of dust generation)
 - Welding workshops where gas cylinders are used (e.g. acetylene, oxygen, propane, argon)
- Decanting and consolidation of flammable substances from one container to another (including waste)
- Transportation of flammable substances in containers around the University
- Welding, cutting or storage of used drums or containers that previously held flammable substances
- Fuelling of vehicles or other more specialist equipment (e.g. rocketry research and some student societies)
- Any work that could generate or release naturally occurring flammable gases such as carbon monoxide, methane etc. (e.g. confined space entry, flushing of pipework, silos etc.).

All areas deemed to be relevant under DSEAR must be subject to a suitable and sufficient risk assessment considering the risk of fire and explosion posed by dangerous substances stored, used or disposed of in the area and any relevant equipment that forms part of the process(es) undertaken.

Cryogenics stored under pressure such as liquid nitrogen do not in themselves require a DSEAR risk assessment. They are however an additional hazard in the event of a fire or explosion, therefore any in the vicinity of a DSEAR risk activity should be mitigated.

Risk assessment

Wherever relevant dangerous substances have been identified in the workplace then a risk assessment should be completed before any work begins with the aim of identifying what control measures will be required to reduce the level of risk so far as is reasonably practicable. Risk assessments undertaken to meet the requirements of DSEAR will focus on controlling the risk of fire and explosion in the workplace. DSEAR risk assessments follow the same five step system as other types of risk assessment based around the five-step approach shown below:

1. Identify relevant dangerous substances and activities in the workplace and how they might pose a risk of fire, explosion or other associated energetic events (e.g. spontaneous ignition of pyrophoric substances).
2. Identify who might be harmed by a fire or explosion and how. Remember to consider not only employees but include anyone who could foreseeably be harmed in the event of a fire or explosion (e.g. students, visitors, contractors, member of the public, the emergency services etc.)
3. Evaluate the risks (high, medium or low) and decide on appropriate, proportionate control measures taking into account that the risk posed to life, limb and property by a fire or explosion is significant and this should be taken into account when deciding if a control measure is justified.
4. Record the significant findings of the risk assessment and introduce the necessary control measures **before** work begins. A risk assessment template for DSEAR is available from the Health, Safety and Wellbeing website to help guide users through the process:

[Risk Assessment Template \(PDF\)](#)

[Risk Assessment Template \(Word\)](#)

5. Ensure the risk assessment is checked and approved by an appropriate person (e.g. line manager, principal investigator) and reviewed regularly to ensure it remains relevant. The risk assessment should be reviewed after an incident or following any significant changes to the activity (e.g. scaling up a process or using a different substance).

DSEAR risk assessment templates can be a little more complex than more general risk assessments and will usually include a series of questions designed to guide the risk assessor through the process ensuring that all of the relevant information is recorded. DSEAR risk assessments place significant emphasis on process design and equipment and will usually require the introduction of mitigating factors and emergency procedures designed to reduce the impact of a fire or explosion in the event of an incident. DSEAR risk assessments must capture the following information:

- Details of any control measures (both technical and organisational) that must be taken to eliminate the risk where possible or reduce it so far as is reasonably practicable.

- Sufficient information to show that the workplace (and any relevant equipment) will be safe during operation and maintenance. This should include details of any hazardous zones that have been identified (see section 8) and any special measures taken to ensure coordination of safety precautions when employers share a workplace.
- Measures taken to inform, instruct and train employees to work safely under normal circumstances and to ensure that they understand emergency procedures to be implemented in the event of a release of dangerous material, fire or explosion.

Note: Where the quantities of flammable materials is low (a few litres in total) it is unlikely that a full DSEAR assessment will be necessary and the risk can usually be considered as part of a more general (or CoSHH (Control of substances hazardous to health)) risk assessment. However, in workplaces where larger quantities of flammable material are stored (for example a wet chemistry lab where significant quantities of flammable solvents are present) a DSEAR risk assessment should be prepared. To aid in making this distinction a document, the pre -assessment checklist, has been included in the risk assessment.

Note: Most dangerous substances relevant to DSEAR will pose a risk to health as well as a risk of fire or explosion. The health effects of a substance should be considered as part of a CoSHH risk assessment, where substance(s) being used pose both a significant risk of fire / explosion and of harm to health then it is likely that separate risk assessments may be needed for each. Where one risk is relatively minor then it may be sufficient to include it as part of the larger risk assessment.

Control measures

Like other health and safety legislation DSEAR is based on the application of a hierarchy of control measures which should be considered to reduce the level of risk so far as is reasonably practicable. The hierarchy of control is based on the following five considerations in descending order of effectiveness:

Elimination

This is the most effective control measure and involves removing the hazard from the workplace entirely. In practise this can be very difficult to achieve in the workplace and may require a process to be completely redesigned. Where the risk assessment indicates the risk is very high give consideration to not proceeding with a process or piece of work at all. For example:

- Change the activity, process or equipment to remove the need to use (or generate) dangerous substances at all. A good example of this might be to move from oxy-acetylene welding to a safer technique such as Arc or MIG welding where flammable fuel gases are not required.

Substitution/reduction

Substitution (or reduction) of the hazard is the next best option after elimination and will often involve replacing a dangerous substance (or piece of equipment) with a less dangerous one or working on a smaller scale to reduce the level of risk. A good example of

this in the context of DSEAR could involve replacing a flammable solvent with a substance that has a higher flashpoint (and is therefore more difficult to ignite).

- Where practical consider replacing an extremely dangerous substances with a less dangerous substance. For example, changing a highly flammable solvent with a very low flashpoint with a less combustible solvent will significantly reduce the risk of an incident.
- Where a dangerous substance cannot be eliminated or replaced with something less dangerous, the quantity of dangerous substances stored and used should be reduced to a minimum.
 - The HSE recommend that no more than 50 litres of highly flammable liquids with a flash point below 32°C (or below the ambient temperature) should be stored in cabinets within the workplace.
 - The HSE also recommend that no more than 250 litres of flammable liquids with a flashpoint of 60°C or below should be stored in cabinets within the workplace.
- The risk can also be reduced by restricting the number and size of containers used, so far as is reasonably practicable, e.g. buying in 2.5L bottles rather than 25L drums and only permitting smaller bottles to be handled on the bench in a laboratory.
- Potential ignition sources should be avoided or controlled in areas where dangerous substances are stored, transported or used. These might include naked flames, electrical equipment, static electricity, adverse chemical reactions etc. Control measures will vary for different ignition sources but may include clear warning signage, the use of non-sparking tools, ATEX rated equipment (see section 9 equipment specifications) and clothing designed to prevent the build-up of electrostatic charges.
- Discourage higher risk techniques where they are not required. For example, the process of decanting smaller flammable waste bottles into larger drums prior to disposal introduces an increased risk of spillages and vapour releases and is no longer considered best practice.

Engineering controls

Engineering controls include equipment and barriers designed to reduce the risk to workers. They can take many forms including physical barriers (such as fire-resistant cabinets), fume extraction / ventilation systems, leak detection systems, automatic shut-offs etc. Examples might include:

- Dangerous substances in the workplace should be stored in fire resistant cabinets (or storage containers) when not in use. Cabinets should provide no less than 30min fire resistance to allow sufficient time for everyone to evacuate safely before they are put at risk of a fire from this material. However, where practical storage cabinets should be rated to give 90min protection from fire. The use of vented cabinets can help to prevent flammable vapours from building up inside a cabinet and is also recommended.
- Procedures and equipment should be designed to prevent accidental releases (e.g. leaks, spills) and minimise the impact should a release occur. Effective controls could include automatic shut-off valves, secondary containment (e.g. bunding) and

use of smaller containers when handling dangerous substances. Wherever possible leaks and release should always be controlled at the source.

- Measures should be taken to prevent the formation of an explosive atmosphere. The most effective means of doing so is to use dangerous substances in a closed system. Where this isn't achievable the risk can often be managed through effective ventilation of the workspace or use of mechanical extraction systems.
- Potential ignition sources should be avoided or controlled in areas where dangerous substances are stored, transported or used. These might include naked flames, electrical equipment, static electricity, adverse chemical reactions etc. Control measures will vary for different ignition sources but may include clear warning signage, the use of non-sparking tools, ATEX rated equipment and clothing designed to prevent the build-up of electrostatic charges.
- Provision of suitable emergency response equipment including fire-fighting equipment and spill absorbent can help to control the risk associated with dangerous substances. Where these are introduced staff and students should be trained to use them safely.

Note: Where engineering solutions (and other supporting equipment e.g. portable gas detection) is used as a control measure then provisions should be made for any required maintenance, testing or calibration in accordance with manufacturer's recommendations. Some engineered controls (e.g. local exhaust ventilation (LEV) systems) will also be subject to a regular statutory Thorough Examination and Test (TExT).

Safe Systems of Work (SSoW)

Safe systems of work (SSoW) are procedural controls designed to ensure that workers carry out procedures in a safe manner in accordance with the correct working procedures. These may include use of checklists, Standard Operating Procedures, Permit to Work Systems etc. They can be effective but rely on people following the correct processes and therefore do not always fully control the risk.

- Develop Standard operating Procedures (SOP) designed to help guide staff and students safely through tasks involving dangerous substances and ensure these are clearly communicated and regularly reviewed.
- Take the time to identify potential adverse conditions that may affect the level of risk and introduce mitigations where possible. Examples might include high temperatures in the workplace increasing the volatility of flammable solvents or vehicle movements taking place close to flammable gas manifolds.
- One of the most important control measures is to ensure that anyone working in the relevant area has received the necessary information, instruction, training and supervision to work safely. Staff and students should be trained to recognise the risks associated with flammable / explosive materials and to work safely in areas where they are stored or used.
- When a release does take place it should be effectively contained, collected and removed to a safe place for disposal or otherwise rendered safe using an appropriate method. Effective emergency plans should be developed, communicated and practiced regularly.

- Ensure that incompatible substances (e.g. flammable solvents and oxidising agents) are properly segregated to prevent unexpected, adverse chemical reactions in the event of accidental mixing. Ensure that chemical waste streams are clearly understood and incompatible substances are not mixed in waste containers.

Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) includes protective clothing, gloves, respirators and other forms of protection worn by an individual. PPE should always be considered the least effective control measure as it only protects one individual, relies on the wearer to select and use it correctly and can in some cases actually increase the risk (e.g. use of thick gloves can cause a reduction in dexterity).

- Provision of effective personal protective equipment to minimise any injury to individuals in the event of a fire or explosion. This may include the use of fire-resistant clothing (e.g. lab coats), safety spectacles or more specialist equipment where this is justified by risk assessment.
- Staff working in areas that have been classified into zones must be provided with suitable anti-static clothing and footwear to ensure that there is no risk of an electrostatic discharge acting as a potential ignition source. The clothing required will depend on the level of risk identified in the risk assessment
- Appropriate protective equipment and clothing should be provided for emergency responders who may be tasked with dealing with the incident and regular training should be provided in its correct usage clearly highlighting any limitations.

These control measures can be applied in a range of different ways and the most appropriate controls will depend on the specific activity being undertaken taking into account the scale, frequency and duration of the activity. Appropriate control measures should be identified during the risk assessment.

Mitigating factors

It is a further requirement under DSEAR to identify and implement measures to mitigate the impact of a fire or explosion in the workplace in addition to identifying emergency measures to be taken in the event of an accident. Mitigation measures should be considered in conjunction with the risk assessment and should be appropriate for the activity or operation.

- Reducing the number of people who are exposed to the risk means that in the event of a fire or explosion fewer people can be injured, it may also make evacuation of the area easier when required. This can be achieved by carrying out dangerous activities in dedicated workspaces e.g. special operations laboratories. **Note that this does not mean that lone or out of hours working should be encouraged.**
- Provide plant and equipment that is explosion resistant or in other words designed to prevent (or contain) an explosion. Examples may include using equipment that is non-sparking, designed to operate below the ignition temperature of gases or dusts. Equipment may also be designed to fully contain an explosion within the casing ensuring it cannot cause harm to anyone working in the area.

- Consider providing explosion suppression or explosion relief equipment to minimise the impact of an explosion. This may be achieved through the use of blast shielding, explosion relief systems (e.g. sacrificial rupture panels), flameless venting and other suppression systems.
- Take measures to prevent, control or minimise the spread of fire in the workplace. This could include the use of automatic fire detection and suppression systems, emergency fuel cut-off valves (automatic or manually operated), effective compartmentalisation equipment (e.g. fire doors) etc.
- Provide effective personal protective equipment to minimise any injury to individuals in the event of a fire or explosion. This may include the use of fire-resistant clothing (e.g. lab coats), safety spectacles or more specialist equipment where this is justified by risk assessment.

Where mitigating measures have been introduced in the workplace these must be regularly inspected and maintained in accordance with guidance from the supplier. Care should be taken to provide sufficient information, instruction and training to ensure that staff, students and visitors understand any relevant equipment and procedures and how they must be applied in the workplace.

Note: One common (and very effective) mitigation measure is the installation of a flashback arrestor to the regulator of a flammable gas cylinder. Flashback arrestors prevent a flame travelling back up a gas hose / line where it can enter the gas cylinder leading to significant damage or potentially an explosion. Flashback arrestors are highly effective and inexpensive and should always be fitted to flammable gas cylinder regulators where practical.

Arrangements for incidents and emergencies

DSEAR requires that employers make arrangements to protect employees (and anyone else who might be affected by their activities e.g. students, visitors, contractors) in the event of an accident or emergencies. In the context of DSEAR emergencies may include significant leaks / releases of dangerous substances, fire and explosion all of which pose a significant risk to life and/or property it is therefore imperative that effective mitigations are put in place. The scale and nature of mitigation should be proportionate to the risk but may include some or all of the following:

- Installation of detection systems that will identify potential emergencies before they occur allowing measures to be taken before there is a risk to life and property. Examples of this might include gas detection systems designed to identify hazard releases of flammable gases or vapours before there is a risk of explosion. Such systems can be linked to a range of other emergency systems that may be activated in the event of an emergency for example:
 - Emergency ventilation systems
 - Automatic (or manual) fuel supply shut-off systems
 - Automatic fire suppression systems
 - Emergency alarm systems
- Installation of suitable fire detection and (where practical) suppressions systems designed to identify a fire quickly, raise the alarm and where suppressions systems are installed to extinguish the fire before it develops.

- Provision of suitable warning systems (including visual and audible alarms) and communication systems to warn people in the workplace in the event of an emergency allowing them to evacuate the area safely or undertake other appropriate actions (e.g. activation of emergency shutdown procedures). Remember that individuals with some disabilities may require specific arrangements or equipment to ensure they are warned of an emergency and can evacuate safely.
- Provision of clearly marked and easily accessible emergency exits and other necessary escape facilities where these have been identified by the risk assessment. This may include the provision of temporary waiting spaces and/or escape equipment or support for individuals with disabilities and appropriate training to use these correctly.
- Clear procedures to be followed in the event of an emergency, these must be tested regularly and communicated clearly to staff and students who may be at risk. Contractors and visitors may not have a clear understanding of University procedures and steps must be taken to ensure their safety in an emergency (e.g. through provision of a suitable induction and / or an escort who can guide them to safety).
- Emergency plans / responses should be practiced by carrying out tabletop exercises and drills on a regular basis. Drills not only test emergency plans highlighting gaps and weaknesses but also allow employees to become familiar with what to do in an emergency in controlled conditions.
- Effective liaison with the emergency services to provide them with information on the risks present in the workplace and how they might pose a danger to emergency responders. The emergency services may request that specific information is made available to help them plan their response and may wish to visit the workplace to develop their understanding of the risk.
- Appropriate protective equipment and clothing should be provided for University of Edinburgh emergency teams who may be tasked with dealing with the incident and regular training should be provided in its correct usage clearly highlighting any limitations.

In the event that a fire or explosion does occur it is important that plans have been developed in advance to help manage a return to normality, these should be regularly reviewed and effectively communicate and will include:

- An approved plan to stabilise the situation following an emergency and minimise / mitigate the effects of the incident so far as is reasonably practicable.
- A plan for restoration of the situation to normality once the emergency phase of the incident is over. This would be to include how do to get everyone back to work safely and return to normal activities.
- An information system for employees (and anyone else who might be affected) by the explosion or fire to ensure they are effectively informed of emergency arrangements and any changes to their usual working pattern caused by the incident. This would follow the local incident management response as expected at the University.

DSEAR Classifications (Zones)

As part of the risk assessment process, areas where a flammable or explosive atmosphere might develop that might pose a risk to the safety of employees should be clearly identified and may be considered **“hazardous”** under DSEAR. This may include areas where a risk of fire / explosion is routinely present (e.g. a fuel decanting area) or where the risk arises in the event of a foreseeable spillage or release. Hazardous areas will usually require special precautions to be taken to guard against the risk of fire and explosion. If, however, quantities of material are very small such that the resulting risk of potential damage or injury is negligible then an area can be considered **“non-hazardous”**.

Where an area has been deemed a “hazardous” there is a need for areas of the workplace to be classified into zones based on the frequency and duration of the flammable / explosive atmosphere that might be formed. Under DSEAR zones are classified as follows (note that different zone classifications are given when the risk arises from the presence of combustible dusts):

Zone 0 (or 20 for dusts)

A place in which an explosive atmosphere in the form of a mixture of air with a hazardous substance (gas, vapour or mist) is present continuously, frequently or for long periods of time is designated as ‘Zone 0’. Where the hazard arises due to the presence of a combustible dust or powder it would be designated ‘Zone 20’. An example of an area which would be considered to fall into zone 0 would be the inside of a tank used to contain a flammable liquid (e.g. a petrol storage tank) where a flammable atmosphere is likely to be present all the time.

Zone 1 (or 21 for dusts)

A place in which an explosive atmosphere in the form of a mixture of air with a hazardous substance (gas, vapour or mist) is likely to occur in normal operation on an occasional basis is designated ‘Zone 1’. Where the hazard arises due to the presence of a combustible dust or powder it is designated ‘Zone 21’. An example of an area which might fall under zone 1 would be a flammable waste storage facility where flammable liquids are regularly decanted from small containers into larger ones pending disposal. This might lead to a short-lived flammable atmosphere during decanting which would not be present at other times.

Zone 2 (or 22 for dusts)

A place in which an explosive atmosphere in the form of a mixture of air with a hazardous substance (gas, vapour or mist) is unlikely to occur under normal conditions and in the event that it does arise will only be present for a short period is designated ‘Zone 2’. Where the hazard arises due to the presence of a combustible dust or powder the zone will be designated ‘Zone 22’. A good example of a workspace that might fall under zone 2 would be a cabinet or container used to store flammable solvents or fuels in closed containers. Under normal circumstances the amount of vapour released would be low but in the event of a spillage or leak due to a broken container a flammable atmosphere could arise for a short time but would not persist for long once the spill was cleared up and the area ventilated.

Note: There is no official guidance on what would constitute a “short time” or “occasionally” as noted for the classifications above. Where classification is

considered necessary and it is not immediately obvious which group a location or activity would fall into it will be necessary to consult with a competent person.

Where a dangerous area has been given a zone classification it is important that appropriate warning signs are placed at each point of entry to inform anyone entering the area. Signage should take the form of a yellow warning triangle containing the letters “EX” and may include supplementary warning text (see the example in figure 1 below):

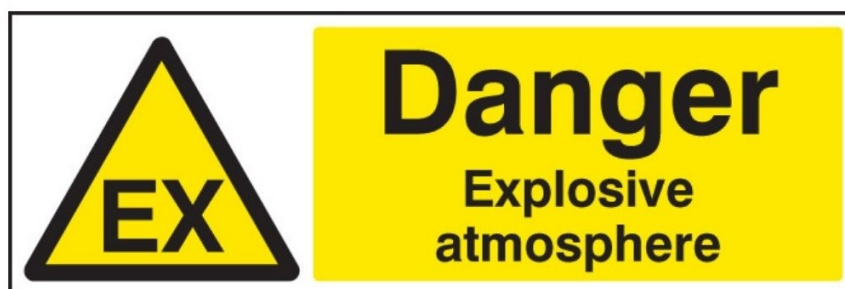


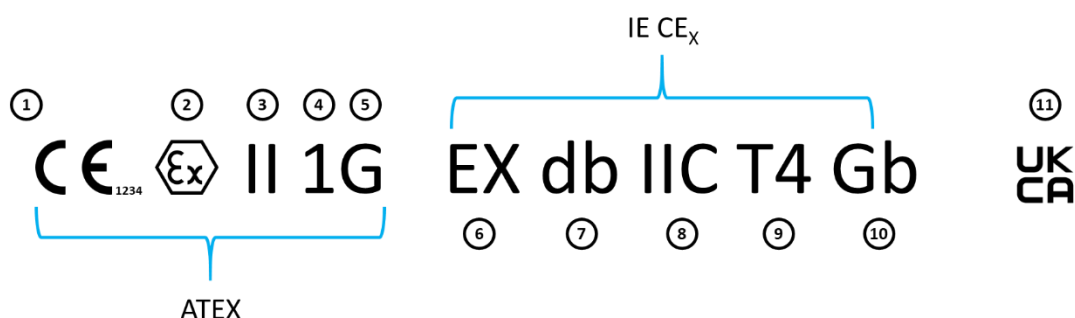
Figure 1: Example of a warning sign for an area where an explosive atmosphere may occur.

Where an area has been classified for the first time or reclassified into a zone under DSEAR it should be formally inspected. Additional support is available from the Health Safety and Wellbeing Department, and on occasion there may be a need to engage specialised advisory support.

Note: Some DSEAR zones may only be put in place temporarily during certain activities (e.g. decanting of flammable waste from smaller containers into a larger drum) or following a spill or release of a dangerous substance. The restrictions and control measures for temporary zones can be easily forgotten or misunderstood and temporary zoning restrictions are not recommended where this can be avoided.

Equipment specification

Where there is a risk of fire and explosion due to the presence of one or more dangerous substances it is vital that any mechanical or electrical equipment (whether fixed or portable) is suitable for use in the appropriate zone and does not pose a risk of igniting a flammable atmosphere. Equipment designed for use in potentially flammable / explosive atmospheres must be properly certified to confirm where it can be used safely. There are several certification systems in operation including the ATEX system, which is legally mandated for equipment used in the European Union and the voluntary international IECEx certification system. The UK also operates the UKEX system which contains similar information but will also include the UKCA marking (note that the use of CE marking for relevant equipment in the UK has been extended indefinitely and both CE and UKCA marks may be present on equipment):



1 CE Mark Indicates that the product meets EU standards (the number is the certification centre). Required for any equipment that may be used in Europe.	7 Protection Category D/db Flameproof* Eb Enhanced protection** Ec Non-sparking
2 “Ex” Marking This symbol indicates the product is Safe to use in explosive atmospheres (as certified)	8 Temperature Class*** T1 450°C T2 300°C T3 200°C T4 135°C T5 100°C T6 85°C
3 Group I Equipment suitable for mining use II Equipment suitable for surface use (non-mining)	9 Gas Group**** IIA Propane IIB Ethylene IIC Hydrogen
4 Category 0 Suitable for use in zones 0, 1 and 2 1 Suitable for use in zones 1 and 2 2 Suitable for use on zone 2 only	10 Equipment Protection Level Ga Rare failures Gb Predictable failures Gc Regular use
5 Type G Gases, vapours and mists D Dusts	11 UKCA Mark This is the UK equivalent of the CE mark (only valid in the UK) and may appear on some equipment in the UK.
6 Explosive Protection This symbol always precedes the protection category (some equipment may have more than one protection category for different environments).	

- * Equipment is designed to prevent a flame from escaping from inside the casing
- ** Designed to prevent internally generated ignition sources (e.g. static discharges / high temperatures)
- *** T1-T6 indicates the maximum surface temperature of any part of the equipment
- **** All gases / vapours used in industry are assigned to one of these gas groups

Labelling of pipework and containers

DSEAR requires that any pipework and containers used to store or distribute relevant substances is clearly identified and properly labelled so that an individual who is unfamiliar with the system can identify the contents. This means that mains supply gas pipework and

pipework used in gas manifolds or other gas supply systems must be clearly labelled with the contents (e.g. the gas contained).

Containers will include any fixed or portable, open or closed equipment designed to contain dangerous substances. These should be clearly labelled with the contents of the container and the appropriate hazard symbol. Containers may include:

- Storage cabinets
- Tanks, drums, cannisters etc.
- Silos
- Reaction vessels
- Waste receptacles
- Compressed gas cylinders and reservoirs

This requirement does not generally apply to storage vessels for bulk combustible solids which are not pose a risk of fire and explosion under normal circumstances. However, it will apply to materials that can be ignited in bulk (e.g. cellulose nitrate) reactive flammable solids (in particular those known to spontaneously ignite or undergo self-heating), explosive solids, pyrophoric materials etc.

Design considerations for storage facilities

Buildings where large quantities of dangerous substances are stored should be designed to minimise the risk of fire and explosion and to mitigate the impact should one occur. Storage facilities can take a range of forms from dedicated buildings, storage rooms within existing facilities to prefabricated containers which are designed specifically for the purpose. Careful consideration must be given to finding the best solution for the substance(s) being stored considering the location, access requirements, quantities required etc.

The following should be considered in the early planning stages when designing or upgrading a building or workspace used for the storage of dangerous substances in large quantities. Please note that this list is not exhaustive and is provided for information only to clarify some of the design considerations required for the safe storage of flammable substances. Advice must always be sought from a competent person when planning or upgrading a storage facility. The University's Estates Department must be involved in any projects involving upgrading or design of workspaces.

- Building should be constructed of appropriate fire-resistant materials and should provide fire protection from an external fire. Where practical bulk storage facilities should be separate from other buildings. Commercially available storage containers designed for this purpose can be a very effective solution.
- Building should be adequately ventilated to prevent a build-up of flammable gases / vapours. Natural cross ventilation or mechanical ventilation can be used to satisfy this requirement. Where natural ventilation is used a minimum of five air changes per hour is required and the total area of ventilation openings should be between 1 and 3% of the total wall and roof area.
- Stores should be weatherproof as required. It is common practice for gas cylinder stores to take the form of open, roofed cages to ensure that gas leaks and releases will disperse rapidly.

- Pressure relief features should be built into the structure for example louvres in door and walls, pressure relieving panels or a lightweight roof designed to fail under a sudden release of pressure.
- Suitable means of access / egress under normal usage of the store including provision for any required equipment such as manual handling aids.
- Sufficient storage space should be present to allow for segregation of incompatible substances. Where practical incompatible substances should not be stored in the same facility.
- Adequate bunding should be provided to contain any leaks or spillages. It is usually recommended that bunding is large enough to contain either 110% of the volume of the largest container stored in the building or 25% of the total volume of liquid present whichever is larger.
- Installation of intrinsically safe (flameproof) equipment and fixtures to reduce the risk of ignition. This should include lighting, ventilation systems etc. Where racking and storage drums are present earth bonding points should be used.
- Storage facilities should display appropriate warning signage at each point of entry which should be appropriate for all of the substances present and where relevant should clearly indicate any identified hazardous zones.

Note: There are significant safety and legal requirements that must be accounted for when planning a new storage facility (or upgrading an existing one). This should only be undertaken in consultation with Estates to ensure that facilities are fit for purpose and developed in accordance with relevant legislation.

References and further reading

- Dangerous Substances and Explosive Atmospheres Regulations (SI 2002/2776)
- HSE ACoP L138 Dangerous Substances and Explosive Atmospheres
- HSE Guidance HSG51 The Storage of Flammable Liquids in Containers
- HSE Guidance HSG71 Chemical Warehousing: The Storage of Packaged Dangerous Substances
- HSE Guidance HSG103 Safe Handling of Combustible Dusts: Precautions Against Explosions
- HSE Guidance HSG140 The Safe Use and Handling of Flammable Liquids
- BCGA Code of Practice CP44 The storage of gas cylinders
- BCGA Code of Practice CP52 The management of risks from gases in the workplace
- BCGA Guidance GN13 DSEAR risk assessment guidance for compressed gases.
- BS EN IEC 60079 (Equipment and Installations in Explosive Atmospheres)
- BS EN IEC 80079 (Equipment Used in Explosive Atmospheres)

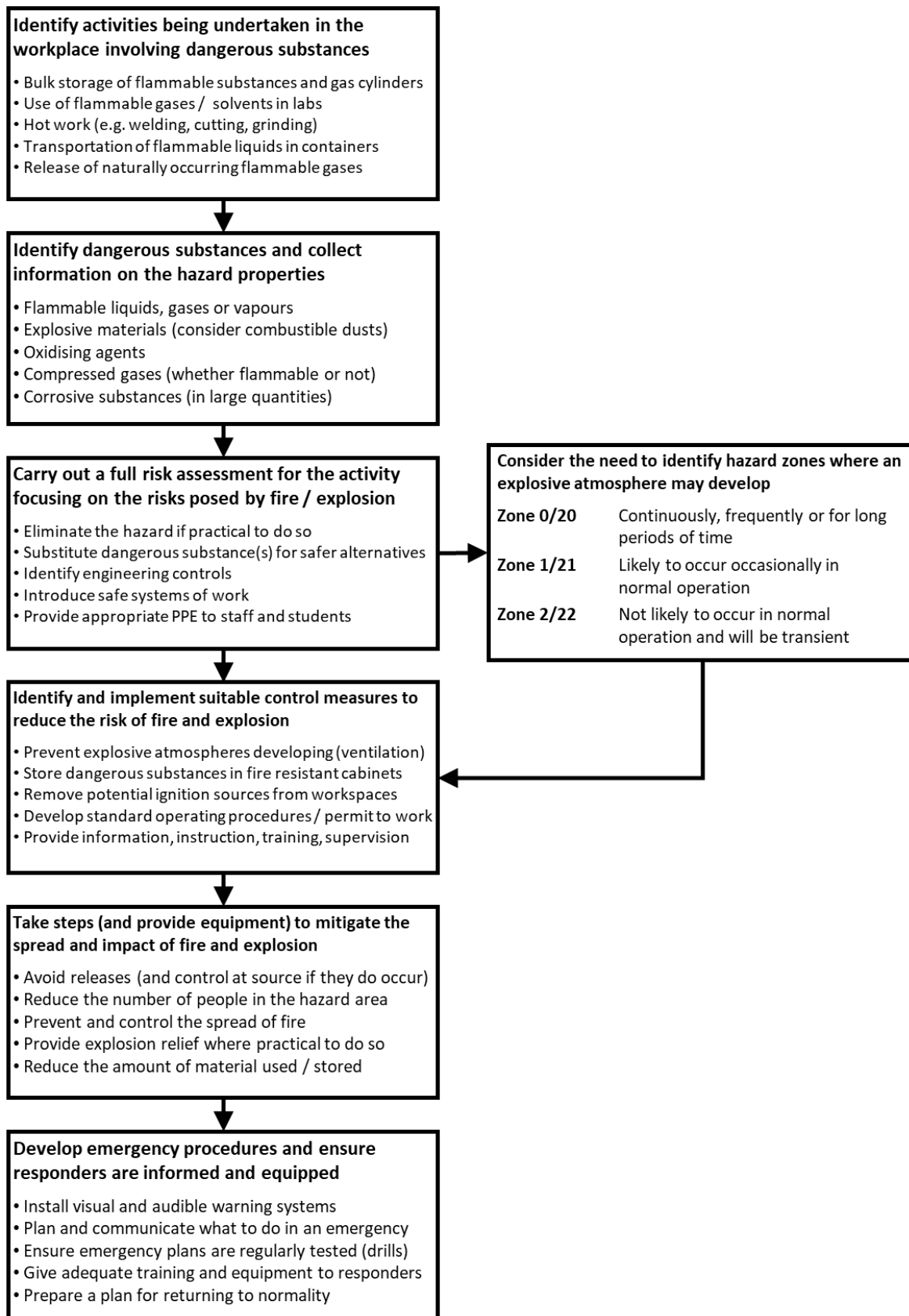
Online resources

- [HSE DSEAR Homepage](#)
- [British Compressed Gases Association \(BCGA\) Website](#)
- [IECEx Website](#)

Appendix 1 Glossary of Terms

Autoignition Temperature	The auto-ignition temperature is the lowest temperature at which a combustible fuel mixture will spontaneously ignite in a normal atmosphere without an external source of ignition such as a flame or spark.
Corrosive	A substance that causes damage to other materials, including living tissue, on contact through a chemical process (common examples include acids and alkalis)
CoSHH	Control of Substances Hazardous to Health Regulations 2002
Dangerous Substance	In the context of DSEAR a dangerous substance is one that poses a risk of fire or explosion in the workplace either directly or indirectly. Dangerous substances include flammable gases and vapours, combustible dusts, mists and aerosols. Compressed gases and corrosive substances should also be considered.
DSEAR	Dangerous Substances and Explosive Atmosphere Regulations 2002
Explosive	Explosive substances are chemicals that contain huge amounts of stored energy and can detonate violently releasing heat, light energy
Flammable	Flammable chemicals include any substance capable of being ignited and sustaining combustion with a flashpoint of 60°C or below.
Flashpoint	The lowest temperature at which a substance will ignite and sustain combustion when exposed to a suitable ignition source (e.g. a flame, spark etc.)
Lower Explosive Limit (LEL)	The lowest concentration of a gas in a compartment which when mixed with air can be ignited and potentially cause an explosion (below this concentration there is not enough fuel and the mixture is “too lean”).
Oxidising Agent	Chemicals which can act as a source of oxygen for chemical reactions such as combustion.
Pyrophoric	A pyrophoric substance is a chemical that can spontaneously ignite under certain conditions. For example when exposed to air or moisture.
Upper Explosive Limit (UEL)	The highest concentration of a gas in a compartment which when mixed with air can be ignited and potentially cause an explosion (above this concentration there is not enough oxygen and the mixture is “too rich”).
Zone	With respect to DSEAR a zone is an area identified as part of a DSEAR risk assessment where a flammable or explosive atmosphere may be present.

Appendix 2 DSEAR Safety Flowchart



Document management

Doc version

Version number	Summary of change	Date and by whom
2.0	Complete refresh after consultation	17/09/26 C Harrison

Alternative format

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