

Safety Code of Practice 24

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Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (Including Flammable Liquids)



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1 Summary

The Dangerous Substances and Explosive Atmosphere Regulations (DSEAR) apply to all workplaces where there is a risk of fire and explosion from dangerous materials. These may include all forms of flammable liquids; flammable gases; dusts from machining and sanding operations; dust from foodstuffs; substances that are corrosive to metals; gases under pressure; explosives and oxidising materials. All University members of staff who have a responsibility for or involvement with dangerous substances as defined in Section 4 must, in collaboration with the University Fire Safety Advisor, comply with the following:

- Work from this Safety Code of Practice, which represents the University standards expected.
- Complete a risk assessment of any area or store in which dangerous/flammable substances are in use that are located on their premises
- Identify the substances to establish whether they fall within the category of the DSEAR Regulations
- Review the processes or storage, to establish whether the substances are still required, or if less hazardous substances could be used
- Arrange for the disposal of waste or surplus items using the approved University procedures
- Ensure substances, including waste products, are correctly labelled
- Ensure that only compatible substances are kept within the storage area
- Ensure waste substances are located in a defined area within an approved external store
- Ensure gas cylinders, when not in use, are stored within an approved, ventilated stores and non-flammable gases are stored separately from flammable gases
- Review or organise a training programme for staff and students who will use dangerous substances
- Maintain a record of the assessments conducted and staff or students who have received training.
- Maintain and record details of safety data sheets for all DSEAR substances. Ensure these details are displayed and immediately available within the designated area
- Ensure safety signs appropriate to the risk i.e. "Highly Flammable", "Toxic" are displayed at each location using dangerous substances. In addition the "EX" sign (see section 7.3) should be displayed when a building or area of the building has been designated a 'Hazardous Place'.
- Note that most flammable stores and some other areas have been designated 'Hazardous' zones, these are listed in Section 7.4.

2 Introduction

The purpose of this Safety Code of Practice is to make University staff/users aware of the correct methods of working with and the storage of dangerous substances, including flammable liquids. There are numerous reference items available from the HSE (listed in item 12.) for the more dangerous or experimental use of these substances. Work practices must be safe for the user and others in the immediate area. This includes the need to identify the dangers by a risk assessment process and reduce the risk to acceptable levels.

Guidance:

In the case of bulk usage with the potential for major incidents, the Control of Major Accident Hazards Regulations (COMAH) 2015 apply to ensure safety measures are extended beyond the boundaries of the immediate premises. These regulations are unlikely to apply to the University because the amounts of dangerous substances prescribed in COMAH and believed to be in use at the University of Reading are of insufficient quantities to reach the threshold where these regulations apply. Where pilot experiments are being worked upon the restrictions imposed in section 9.3 of this Safety Code of Practice, would apply, prior to any practical tests.

What is a 'dangerous substance'?

Dangerous substances are substances or mixtures of substances (called 'preparations' in DSEAR) that could create risks to people's safety from fires and explosions or similar events, such as 'thermal runaway' from chemical reactions. Flammable liquids, gases, vapours and dusts, gases under pressure, substances that are corrosive to metals, oxidising and explosive materials are all substances that may be found in a workplace and that can fall within the definition of dangerous substances for the purposes of DSEAR.

What is an 'explosive atmosphere'?

In DSEAR, an explosive atmosphere is defined as a mixture of dangerous substances with air, under atmospheric conditions, in the form of gases, vapours, mist or dust in which, after ignition has occurred, combustion spreads to the entire unburned mixture.

When does DSEAR apply?

DSEAR applies whenever:

- There is work being carried out by an employer (or self-employed person)
- A dangerous substance is present (or is liable to be present) at the workplace
- The dangerous substance could be a risk to the safety of people as a result of fires, explosions or similar energetic events or through corrosion to metal

The following examples illustrate the type of activities covered by DSEAR:

- Storage of petrol as a fuel for vehicles or horticultural machinery
- Use of flammable gases, such as acetylene, for welding
- Handling and storage of flammable wastes
- Use of flammable solvents in laboratories

- Storage of flammable goods, such as solvents and paints
- Storing and handling aerosols with flammable propellants such as Liquid Petroleum Gas (LPG)
- Transporting flammable substances in containers around a workplace
- Handling, storage and use of gases under pressure
- Handling, storage and use of substances corrosive to metal.

Where does DSEAR apply?

DSEAR applies to workplaces where dangerous substances are present, used, or produced.

Workplaces are any premises or parts of premises used for work. This includes places such as laboratories, flammable stores, workshops and vehicles etc. Places such as the common parts of shared buildings, roads and paths at the university are also premises.

What does DSEAR require?

DSEAR places duties on employers; which includes those with health and safety responsibilities in particular Head of Schools/Function and Research Leaders within laboratories, to assess and eliminate or reduce risks from dangerous substances within their areas / laboratories in collaboration with the University Fire Safety Advisor. See: - *Code of Practice 2 Part A Health & Safety Management, Organisation & Responsibilities* - section 2.5, see also *Technical Services Local User Guide 1, Health & Safety Management of UoR Laboratories*.

Complying with DSEAR involves:

- **Assessing risks** - Before work is carried out, employers must assess the risks that may be caused by dangerous substances
- **Preventing or controlling risks** Employers must put control measures in place to eliminate risks from dangerous substances, or reduce them as far as is reasonably practicable. Where it is not possible to eliminate the risk completely employers must take measures to control risks and reduce the severity (mitigate) the effects of any harmful event.
- **Control measures** - Where the risk cannot be eliminated, DSEAR requires control measures to be applied such as reducing the quantity of dangerous substances in a room within a building or removing releases of flammable solvent vapours in a fume cupboard
- **Mitigation** - DSEAR requires employers to put mitigation measures in place. These measures should be consistent with the risk assessment and appropriate to the nature of the activity or operation and including taking measures to control or minimise the spread of fires or explosions such as enclosing laboratories with fire resistant construction
- **Preparing emergency plans and procedures** - Arrangements must be made to deal with emergencies such as fires, spills and leakages.
- **Providing information, instruction and training for employees** - Employees must be provided with relevant information, instructions and training including access to any relevant safety data sheets along with the findings of the risk assessment and the control measures put in place as well as appropriate emergency procedures

3 Legislation and Guidance

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) should also be read in conjunction with:

- The Control of Substances Hazardous to Health Regulations 2002 (COSHH)
- The Classification, Labelling and Packaging (CLP) Regulations 2009
- The Workplace (Health, Safety and Welfare) Regulations 1992 (Regulation 6(3)(b) Revoked)
- The Regulatory Reform (Fire Safety) Order 2005
- Petroleum (Consolidation) Regulations 2014 (PCR) HSE Guide – Portable Petrol Containers <http://www.hse.gov.uk/fireandexplosion/portable-petrol-storage-containers.pdf>
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
- The Waste (England and Wales) Regulations 2011
- Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991.

DSEAR implements the requirements of Explosive Atmospheres Directive (ATEX 137). ATEX 137: Requires employers to protect workers from the risk of explosive atmospheres. An explosive atmosphere is defined as a mixture with air, under atmospheric conditions, of dangerous substances in the form of gases, vapours, mist or dust in which after ignition has occurred, combustion spreads to the entire unburned mixture.

4 Dangerous substance

DSEAR applies to any substance or preparation (mixture of substances) with the potential to create a risk to persons from energetic (energy-releasing) events such as fires, explosions, thermal runaway from exothermic reactions.

Such substances which are known in DSEAR as dangerous substances include: petrol, liquefied petroleum gas (LPG), natural gas, paints, varnishes and certain types of combustible and explosive dusts produced in, for example, machining and sanding operations.

Many of these substances will also create a health risk, solvents may be toxic in addition to being flammable. These health risks will still be dealt with under the Control of Substances Hazardous to Health Regulations (COSHH) which has been amended to implement the health requirements of Chemical Agents Directive (CAD).

DSEAR is concerned with harmful physical effects from thermal radiation (burns); over-pressure effects (blast injuries) and oxygen depletion effects (asphyxiation) arising from fires and explosions.

4.1 Determining the presence of Dangerous Substances and Flammable Liquids

Those with health and safety responsibilities where dangerous substances may be in use should check whether the materials in use fall within the following definitions:

- a) Have they been classified under the Classification, Labelling and Packaging (CLP) Regulations 2009 as: explosive, oxidising, extremely flammable, highly flammable or flammable? Suppliers must provide safety data sheets. The safety data sheet should indicate whether the chemical is classified under the CLP Regulations. The HSE also maintain lists of many commonly used substances and their classification. This information is available on the HSE website, <http://www.hse.gov.uk/fireandexplosion/about.htm>
- b) The circumstances of use, combined with the physical and chemical properties of the substance or preparation mean that there is a safety risk to persons from an energetic event. For example diesel (or other high flash point) oils are not classified as "flammable" under CLP. However, if within a process they are heated to a sufficiently high temperature there is an increased fire risk. In these circumstances the diesel oil becomes a dangerous substance for the purposes of DSEAR. (If diesel is stored at ambient temperatures it would not be regarded as a dangerous substance under these same regulations). Other examples include substances which decompose or react exothermically when mixed with certain other substances e.g. peroxides. Wood, flour and many other dusts are, depending on the circumstances of the work, dangerous substances for DSEAR purposes. This is because when the dust is mixed in a cloud with air it can in certain circumstances be ignited and explode. Work activities involving grinding or machining are particularly prone to this risk.
- c) "Highly flammable liquid" means any liquid, liquid solution, emulsion or suspension, other than aqueous ammonia, liquefied flammable gas, and liquefied petroleum gas. That in general terms has a flash point of less than 32°C; "Extremely flammable liquid" means any liquid, liquid solution, emulsion or suspension, other than aqueous ammonia, liquefied flammable gas, and liquefied petroleum gas. That in general terms has a flash point of less than 0°C with a BP <35°C. "Liquefied flammable gas" means any substance which at a temperature of 20°C and a pressure of 760 millimetres of mercury would be a flammable gas but which is in liquid form as a result of the application of pressure refrigeration or both.
- d) "Petroleum-spirit" is defined as petroleum which, when tested in accordance with laid down criteria and has a flash point of less than 21°C.

5 Premises affected

The HSE outline the type of activity and workplace likely to be affected by the various regulations. A number of the individual categories apply to university premises, in both general work activities and small scale chemical processing.

The following list illustrates the type of activity and substances commonly found in the workplace that are likely to be covered by DSEAR:

- Storage of petrol as a fuel for cars, generators and, horticultural machinery etc.
- Use of flammable gases, for example acetylene and LPG for cutting/welding
- Handling and storage of waste dusts in a woodworking workshop
- Handling and storage of flammable wastes including fuel oils
- Hot work on tanks or drums that have contained flammable material
- Work activities that could release naturally occurring methane

- Use of flammable solvents in laboratories and workshops
- Storage of flammable goods, including paints
- Storage and handling of aerosols with flammable propellants, i.e. LPG
- Transport of flammable liquids in containers around the workplace
- Maintenance activities, where there is the potential of a high level of risk
- Handling, storage and use of gases under pressure
- Handling, storage and use of substances corrosive to metal.

6 Persons protected

The various regulations are intended to protect not only employees at the workplace but also any other person whether at work or not who may be put at risk by dangerous substances. This includes employees working for other employers, students, visitors to the site and members of the public (Relevant persons).

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

7 Safety measures

Employers are required to ensure that the safety risks from dangerous/flammable substances are assessed and either eliminated or reduced to a reasonable and practical level. Where it is not reasonably practical to eliminate risks, employers are required to take measures to control risks and measures to mitigate the detrimental effects of a fire or explosion or similar event in the following priority order:

- Reduce the quantity of dangerous to a minimum
- avoid or minimise releases of dangerous substances
- control releases of dangerous substances at source
- prevent the formation of a dangerous atmosphere
- collect, contain and remove any releases to a safe place (for example, through ventilation)
- avoid ignition sources;
- avoid adverse conditions (for example, exceeding the limits of temperature or control settings) that could lead to danger
- keep incompatible substances apart

These control measures should be consistent with the risk assessment and appropriate to the nature of the activity or operation.

Elimination of the risk is obviously the best solution and involves replacing a dangerous substance with another or a process that eliminates the risk. In practice this is not easily achieved and usually results in a dangerous substance being replaced by another that is less hazardous. (i.e. replacing a low flashpoint solvent with a high flashpoint one) The alternative is to re-design the process so that it is less dangerous. (i.e. by reducing quantities of substances in the process, known as "process intensification") However, care must be taken whilst carrying out these steps to ensure no other new safety or health risks are created or increased.

7.1 Risk Assessment

The regulations require those with H&S responsibilities in collaboration with the University Fire Safety Advisor to:

- a) Complete a risk assessment before commencing any new work activity involving dangerous/flammable substances. If there is no risk to safety, or the risk is trivial, no further action is needed. If there are risks then those with H&S responsibilities must in collaboration with the University Fire Safety Advisor, consider what else needs to be done to comply fully with the requirements of DSEAR
- b) Record the significant findings of the assessment as soon as is practicable after the assessment, to include:
 - The dangerous substances in the workplace
 - The work activities involving those substances
 - The ways in which those substances and work activities could harm people including deliberate and accidental release of the substance. (see section 7.3)
 - The measures (technical and organisational) 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 indicating:
 - details of any hazardous zones (see section 7.2 & 7.3)
 - any special measures to ensure co-ordination of safety measures and procedures, when employers share a workplace, including liaison within multi-occupied premises
 - Arrangements to deal with accidents, incidents and emergencies
 - Measures taken to inform, instruct and train employees.

The risk assessment required is an identification and careful examination of the dangerous/flammable substances present in the workplace. This would include the work activities involving those substances and how they may fail dangerously causing a fire, explosion or similar event with the potential to harm relevant persons. Its purpose is to enable those with H&S responsibilities to decide what they require to eliminate or reduce the risks from the dangerous/flammable substances. An assessment is required before commencing any new work activity, remedial measures identified and implemented before work commences.

Control measures consistent with the risk assessment and appropriate to the nature of the activity should be applied. This would include:

- Reducing the quantity of dangerous substances to a minimum
- Avoid or minimise releases
- Control releases at source
- Prevent the formation of an explosive atmosphere
- Collect, contain and remove any releases to a safe place (i.e. correct ventilation)
- Avoid ignition sources
- Avoid adverse conditions (i.e. exceeding the limits of temperature or control settings) that could lead to danger
- Keep incompatible substances apart

Other forms of control should be considered and would include:

- Reducing the number of employees exposed
- Providing plant that is explosion resistant
- Providing explosion suppression or explosion relief equipment
- Taking measures to control of minimise the spread of fire or explosions
- Providing suitable Personal Protective Equipment (PPE)
- Identification of hazardous contents of containers and pipes
- Design, construction and maintenance of the workplace
- Design, assembly, construction, installation, provision, use and maintenance of suitable work processes, including all relevant plant, equipment, control and protection systems
- The application of appropriate systems of work including, written instructions, permits to work and other procedural systems of organising work

The requirement to assess the risks from dangerous substances should not be considered in isolation. It should be carried out as part of the overall area risk assessment – see Safety Code of Practice 4 Health and Safety Risk Assessment (http://www.reading.ac.uk/web/FILES/health-and-safety/CoP_04_Risk_Assessment.pdf).

If the dangerous substances present are also a risk to the health of employees and others (such as students) (i.e. they are toxic, carcinogenic etc. there will be need to assess health risks as required by the COSHH Regulations 2002 - see Health and Safety Code of Practice 26 (The Assessment and Control of Hazardous Substances http://www.reading.ac.uk/web/FILES/health-and-safety/CoP_28_COSHH.pdf)

7.2 Places where Explosive Atmospheres can occur (Hazardous Areas)

Hazardous areas are defined in DSEAR as "any place in which an explosive atmosphere may occur in quantities such as to require special precautions to protect the safety of workers". In this context, 'special precautions' is best taken as relating to the construction, installation and use of apparatus, as given in BS EN 60079 - 10.

Guidance

For most laboratory operations there is no tradition of hazardous area classification or using ignition-protected equipment, and the risks are usually controlled in other ways such as restricting the amounts of flammable liquids to be used and handling flammable liquids within the confines of a fume extract cupboard.

Where explosive atmospheres may occur the University Fire Safety Advisor must be consulted and it must be ensured that:

- The areas are classified into zones based on the frequency and duration of the occurrence of an explosive atmosphere.
- Areas classified into zones are protected from sources of ignition by selecting equipment and protective systems meeting the requirements of the Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996. It should be observed that equipment in use before 1 July 2003 can continue indefinitely provided the risk assessment confirms it is safe.

- Where necessary, areas classified into zones are marked with a specified "EX" sign at their points of entry;
- Where employees work in zoned areas they are provided with appropriate clothing that does not create a risk of an electrostatic discharge igniting the explosive atmosphere;
- Before coming into operation for the first time, areas where explosive atmospheres may be present are confirmed as being safe (verified) by a person (or organisation) competent in the field of explosive protection. The person carrying out the verification must be competent to consider the particular risks within the area and the adequacy of control and other measures put in place. (Seek advice from the Health & Safety Services, Fire Safety Advisor)

Guidance:

Before undertaking work in a room or building designated as a 'Hazardous Area' University managers should seek the advice of Health and Safety Services for verification that the risk assessment and related control measures are suitable and sufficient. Depending on the circumstances Health and Safety Service may be required to engage the services of external contractors.

7.3 Classification of Hazardous Places

7.3.1 Basic Principles for Laboratory Operations

Area classification analyses the sources of gas and vapour release, looking at those that arise in normal operation, (primary sources) and those which only occur as a result of some foreseeable equipment failure or operator error (secondary sources). Clearly, not all laboratory hazards will be covered by such an analysis, but it should be part of any overall risk assessment. The aim should always be to minimise releases into the general atmosphere of the laboratory.

On a laboratory scale, a primary source might be the vapour released when a volatile solvent is poured from one container to another, while someone knocking the container off the bench onto the floor creates a secondary source. Primary sources should normally be so small they can easily be controlled by adequate ventilation, and to the extent of any explosive atmosphere is negligible

Hazardous places are classified in terms of zones on the basis of the frequency and duration of the occurrence of an explosive atmosphere.

Zone 0

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

Various sources have tried to place time limits on to these zones, but none have been officially adopted. The most common values used are:

- Zone 0: Explosive atmosphere for more than 1000h/year
- Zone 1: Explosive atmosphere for more than 10, but less than 1000 h/year
- Zone 2: Explosive atmosphere for less than 10h/year, but still sufficiently likely as to require controls over ignition sources.

Strictly, area classification takes no account of the consequences of a release, whether this is a fire or explosion, but selection of the necessary precautions must take the consequence factor into account and this approach is recognised in DSEAR.

For further reading go to HSE at: <http://www.hse.gov.uk/comah/sragtech/techmeasareaclas.htm>

Guidance for laboratories

If precautions already used are adequate to prevent fire and explosion risks to laboratory workers then there is no need for zoning and 'special precautions' in terms of the ignition risk from equipment will not be necessary.

Zone 20

A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently.

Zone 21

A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.

Zone 22

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

Notes:

- 1 Layers, deposits and heaps of combustible dust must be considered as any other source which can form an explosive atmosphere.
- 2 "Normal operation" means the situation when installations are used within their design parameters.

7.3.2 Warning signs

Warning signs must be displayed on or in all areas where explosive atmospheres may occur.

The distinctive features are:

- Triangular shape;
- Black letters "EX" on a yellow background with black edging (the yellow part to take up at least 50% of the area of the sign)

Warning signs displayed in areas where an explosive atmosphere may occur



7.4 Criteria for the Selection of Equipment and Protective Systems

Equipment and protective systems for all places in which explosive atmospheres may occur are defined by the ATEX Equipment Directive, set out in UK law as the Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996, unless the risk assessment finds otherwise.

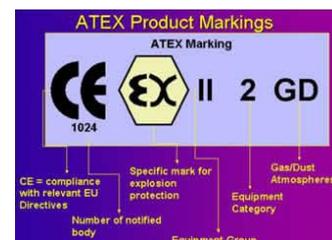
The following categories of equipment must be used in the zones indicated. They must be suitable for gases, vapours, mists, dusts or a combination of each source, as appropriate.

In Zone 0 or Zone 20, category 1 equipment

In Zone 1 or Zone 21, category 1 or 2 equipment

In Zone 2 or Zone 22, category 1, 2 or 3 equipment

Equipment designed to be used in a 'hazardous place' must carry an appropriate ATEX Product Marking Label similar to the one shown opposite:



The 'equipment category' must be appropriate for the designated Hazardous Area Zone e.g. for a Zone 1 category 1 or 2 equipment is required.

Further information about ATEX equipment can be found at the following website:

<https://www.gov.uk/guidance/european-commission-product-directives>

7.5 Essential safety

Smoking is against the law in all university buildings. 'No smoking' also applies around external areas where dangerous substances are used or stored. In these areas "No Smoking" signs must

be clearly displayed on the entrance doors and in prominent positions on the outside of an installation or store.

Persons who operate equipment in areas using dangerous substances should be trained in the use of that equipment, the associated dangers with dangerous substances and flammable liquids. Individuals should be made aware of:

- The properties of dangerous substances and flammable liquids present in the workplace and the risks they present including access to any relevant safety data sheets and information on any other legislation that applies to the dangerous substance
- The findings of the risk assessment and the control measures put in place as a result (including their purpose and how to follow and use them)
- Emergency procedures
- Use of correct containers and processes
- Not allowing hot work close to or within areas using dangerous substances
- Correct design of equipment, installation and maintenance
- Control of ignition sources and heating materials above their auto-ignition point
- The safe disposal and dismantling of equipment containing flammable liquids
- Correct storage and limited quantities kept in the area
- Correct decanting, dispensing or movement of dangerous substances
- The correct method of dealing with spillage
- The contents of pipes, containers, etc. must be identifiable to alert employees and others to the presence of dangerous substances. If the contents have already been identified in order to meet the requirements of other law, this does not need to be done again under DSEAR

Guidance

Information, instruction and training need only be provided to other people (non-employees) such as Post Graduate Researchers, Masters Students and visiting contractors where it is required to ensure their safety. It should be in proportion to the level and type of risk.

7.6 Emergency response

Those with health and safety responsibilities in collaboration with the University Fire Safety Advisor must make arrangements to protect employees (and others who are in the area) in the event of an accident/emergency incident. These measures would include the following:

- Suitable warning (including visual and audible alarms) and communication systems
- Means of escape facilities-as required by the risk assessment
- Emergency procedures to be followed in the event of an emergency
- Equipment and clothing for essential personnel dealing with the incident
- Practice drills
- Making information on the emergency procedures available to employees
- Contacting the emergency services to advise them that information on emergency procedures is available (and providing them with any information they consider necessary)

The scale and nature of the emergency arrangements should be proportionate to the risks.

University staff should receive training on the emergency procedure for dealing with fires, spills or leaks and should include the following:

- raising the alarm
- calling the emergency services
- When and how to initiate the University of Reading Major Incident Plan – follow this link: <https://www.reading.ac.uk/internal/businesscontinuity/mip/bc-majorincidentplanning.aspx>
- tackling the fire or controlling a spill or leak (when it is safe to do so)
- shutting down the plant safely
- evacuating the plant safely

It is good practice to rehearse emergency plans through safety drills and exercises.

Guidance:

Heads of School/Function are to ensure for their areas of responsibility that there are effective emergency response procedures and staff and students are made aware of the actions required of them in the event of an emergency.

7.7 Personal protection

Appropriate protective clothing including eye and hand protection must be worn by all persons operating/working with dangerous and flammable substances. The provision of eye wash facilities and medical first aid should be made in the immediate area. It will also be necessary to consider the provision of emergency decontamination/deluge showers. The latter items are normally considered at design stage of the premises. Where these are not provided and new processes are being considered these provisions should form part of the risk assessment process.

8 Storage

DSEAR require risks from the indoor storage of dangerous substances to be controlled by elimination or by reducing the quantities of such substances in the workplace to a minimum and providing mitigation to protect against foreseeable incidents.

It is recognised that for practical purposes where flammable liquids are used, there is likely to be a need for a limited quantity to be stored in the laboratory/working area. It is the responsibility of those with health and safety responsibilities when carrying out their risk assessment, to justify the need to store any particular quantity of flammable liquid within a laboratory/working area. However, the guiding principle is that only the minimum quantity needed for frequently occurring activities should be present in the laboratory/working area. Clearly actual quantities will depend on the work activity and also the organisational arrangements for controlling the fire risks in the laboratory / working area.

8.1 Laboratory and workroom storage

Substances in daily use on the work bench/shelving should be kept in approved containers not exceeding 500ml capacity. Duplication of the substance should be avoided and the area regularly assessed to remove and store low usage items and place in approved storage cabinets.

All containers should be clearly labelled and relevant hazard identified i.e. Highly Flammable or Corrosive.

Guidance

When not in use, containers of flammable liquids needed for current work activities should be kept closed and stored in suitable cabinets or bins of fire-resisting construction and which are designed to retain spills (110% volume of the largest vessel normally stored in it). These should be located in designated areas that are where possible away from the immediate processing area and do not jeopardise the means of escape from the laboratory/working area.

8.2 Storage cabinets

There are various types of approved storage cabinet for dangerous substances and flammable liquids. In general terms they should be of fire-resisting construction, offer a secure latched door, lipped shelving to prevent spillages and be clearly identified. The identification should indicate the type/class of Dangerous Substances stored i.e. "Highly Flammable Substances" "Corrosive".

It is dangerous to mix storage i.e. oxidizing agents, halogenated solvents (non-flammable) with flammable solvents. A regular assessment of the contents of the storage cabinets is needed. Inappropriate storage should be removed and re-located to a suitable store.

Assistance with identifying the correct type of storage cabinet can be obtained from the University Fire Safety Advisor.

A maximum of 50 litres (as recommended by the HSE) of Dangerous Substances/Flammable Liquids is permitted in an individual area/workplace. However, in large areas/workplace i.e. teaching laboratories an increase in the number of cabinets will be considered. This will be subject to the completion of an appropriate risk assessment and approval of the Health & Safety Services Fire Safety Advisor. For quantities in excess of the permitted maxima employers/duty holders may find cabinets with enhanced fire performance helpful in making their risk assessment demonstration. These will be constructed to comply with BS EN 14470-1:2004 'Fire safety storage cabinets – Part 1: Safety storage cabinets for flammable liquids'; Factory Mutual, Underwriters Laboratories and ANSI/NFPA 30 standards.

Location of storage cabinets is strictly forbidden in circulation corridors or adjacent to fire exit routes. This should form part of the risk assessment process and means of escape standards maintained.

8.3 Low temperature storage

Hazardous substances that produce a source of flammable vapour must not be stored in refrigerators, freezer cabinets or other closed container having internal sources of ignition, i.e. electrical contacts.

Spark-proofed equipment, specifically designed and built for this purpose should be used. These units must be clearly indicated "Spark-Proofed" on the outside of the door.

In areas/workplace where flammable sources are in use, non-proofed refrigerant appliances, should be clearly indicated "Explosion Hazard-Not Suitable for Use with Highly Flammable Substances"

8.4 External storage

The construction of external stores must comply with a very specific standard, detailed below. This standard applies particularly when stores are sited adjacent or close to other buildings. In remote locations there are additional considerations, specifically the provision of lighter roof construction. This would encourage any fire or explosion hazard to vent vertically rather than horizontally, providing a form of explosion relief. This principle relies upon the definition of what is considered "remote". The advice of the University Fire Safety Advisor should be sought when considering the installation of these units.

External storerooms should be constructed with a concrete impervious "bund" floor (152mm), brick walls (114mm), and concrete cast roof (102mm). Cross flow ventilation is required using high and low level vents fitted with internal flame gauzes. A minimum 1 hour fire resisting, self-closing fire door (outward opening) is required. All electrical fittings should be flameproof to comply with Category 1 equipment. Shelving should be constructed of slatted non-ferrous metal or wooden shelves. To assist in preventing spills the shelves should be provided with lipped edges. "No Smoking" "Highly Flammable" signs must be displayed in a prominent position on the outside of the access door. Fire Extinguishers normally dry powder and a sand bucket should be provided.

The following general points will apply:

- An emergency switch to isolate the electrical supply to the building should be provided on the outside of the store clearly indicated "electrical isolation switch"
- All substances kept within the storeroom must be accurately and clearly labelled. Where emptied chemical containers are used to store waste substances, all inappropriate labels to the present contents must be removed to avoid any confusion.
- Explosives, oxidising agents, radioactive substances and cylinders should not be stored with general flammable substances.
- The cross flow vents should be cleared of all obstructions to ensure a clear airway. Regular checks should be made to ensure storage or plant growth around these units is cleared.
- Unnecessary combustible storage, cardboard boxes, wood shavings and packaging materials should be removed and disposed of in an approved manner.
- Vehicle parking or storage items should not be allowed within 5metres of the storeroom door. The area should be clearly indicated with cross hatched yellow lines.

Attention should also be given to clearing the area around vent grills.

Appendix "A" Lists the approved external stores available within the University.

9 Working practices

The main hazards from the use of dangerous substances and flammable liquids are fire and explosion, involving either the substance or the vapour given off from it. Fires and explosions are

likely to occur when the normally controlled environment is subjected to the introduction of an unusual ignition source, or the product is released to an uncontrolled area. Section 7.5. outlines the requirements of a training package for staff/students that will use these products. This will help reduce the risk due to operational error. There are numerous publications available from the HSE to offer guidance upon the training to be provided.

9.1 General considerations for laboratories

In many laboratories there are health risks associated with exposure to gases and vapour, and laboratory work will be designed to minimise releases, and control concentrations in the air people breath e.g. by the use of fume extraction cupboards. The concentrations needed to control the health risk are far below the levels at which an explosive atmosphere can form, so precautions designed to protect the health of laboratory workers may also help prevent the need to designate and zoned areas. **Nevertheless very localised areas with an explosive atmosphere will often exist, and to prevent an ignition followed by a fire or explosion, the risk must be understood, and suitable controls adopted.**

Guidance:

The volatility of the product is also an important factor, but this must be considered in the context of the temperature at which it will be used. If you are pouring a solvent from one open container to another at a temperature below its flash point, there should be no hazardous area, because too little vapour is present. If you then distil the same solvent and the condenser cooling fails, vapour will be released, and the risk is much greater. Consequently, the comments on flammable liquids apply whenever they are used or stored above their flash point.

The degree of supervision of any continuous process should be considered. Would someone be constantly available to take action, if cooling water flow failed, a flask cracked, or a process boiled over? Would it be possible to isolate all electrical equipment quickly from a safe place? Turning off switches that are in the immediate vicinity of a release might create the spark that we need to avoid. Familiarity with an operation carried out many times should not be the basis for leaving the equipment unsupervised, if some simple problem could create a risk to others.

Laboratories/workplaces that have a significant fire risk should be assessed to reduce the potential fire loading. Gas cylinders should not be stored in these areas. Where protracted operations involving gases are considered essential "piped gases" should be used.

The correct use, location and maintenance of fume cupboards will play an essential part in ensuring the safety of high risk areas. Refer to Safety Code of Practice 49: Part 1 *User guide to safe use of laboratory fume cupboards* and Safety Code of Practice 49: Part 2 *Fume cupboards : Selection, installation, maintenance and decommissioning*.

The flow rates of the fume cupboards should be tested every 14 months and the results displayed in a suitable position on the cabinet. The recommended flow rate into the openings of the enclosure is can be found by referring to Safety Code of Practice 49: Part 1 – User Guide to safe use of Laboratory Fume Cupboards – follow this link:

http://www.reading.ac.uk/web/files/health-and-safety/CoP_49_Part_1_User_guide_to_safe_use_of_lab_fume_cupboards.pdf

The ventilation to booths, cabinets and other enclosed equipment should normally be designed to maintain the vapours at below 25% of their Lower Explosion Limit (LEL).

9.2 Conditions for use

Quantities of the various dangerous substances/flammable liquids must be kept to a minimum, handled carefully and transferred over trays. Containers should be of an approved type, clearly labelled and re-capped immediately after use. Winchester and other 500ml containers, after use, must be returned to the approved storage cabinet provided in the area/workplace.

In multi-function areas the use of open flame sources must be assessed to ensure the potential danger of flammable vapours reaching these units is avoided. Where the use of larger quantities i.e. over 500ml of dangerous/flammable substances are to be considered a full risk assessment in collaboration with the University Fire Safety Advisor, including a written report is required. The use of a separate room or large fume cupboard should be considered a high priority. Larger scale experiments should only be carried out in the purpose built room 1.07 in the Chemistry Building which is fitted with a fire detection system, explosion proof electrical equipment and automatic fixed fire suppression.

The School Health and Safety Co-ordinator and University Fire Safety Advisor should be consulted where the aforementioned quantities of substance are being used or there are concerns over the experiment being conducted.

General points:

- Only one experiment should be in progress in any one fume cupboard.
- The immediate area should be clear of chemicals other than those directly involved in the experiment.
- Work area must not be left unattended
- Experiments must not be conducted outside of normal working hours. Approval for any longer time scale experiments must be obtained from the School Health & Safety Co-ordinator in collaboration with the University Fire Safety Advisor.
- Evacuation lines from experimental equipment should be fitted with a suitable trap to prevent product from entering the mains drainage.
- Glassware must be inspected during assembly to ensure there are no cracks present.
- Glassware must be firmly clamped, taking into account the centre of gravity will move during the course of the experiment.
- Glassware components produced in-house must be annealed and checked for stress/strain using a polarised light viewer.
- Where decanting product ensure operators are aware of the dangers of static electricity. Suitable earth clamps must be provided and used in an appropriate manner.

9.3 Heating flammable substances

Where it is necessary to heat flammable substances/liquids the following general points will need to be considered:

- If the nature of the experiment or process is new, a risk assessment must be conducted and agreed with the School Health & Safety Co-ordinator. Where larger quantities of substances/liquids are being considered. It is essential that the approval of the School Health & Safety Co-ordinator is obtained. Only approved heating methods to be used in conjunction with the correct electrical fittings.
- Cooling water circuits to be assembled using approved connectors and in conjunction with a flow indicator. The latter item clearly indicating that water is flowing through the cooling circuit of the equipment.
- Provision of remote isolating points for electrical equipment.
- If regarded as an experiment likely to be left un-attended for short periods, an alarm system must be provided i.e. flow of cooling water
- The operator must always ensure that the equipment is operating to equilibrium conditions before leaving the room. This practice will form part of the considerations during the risk assessment.

10 Disposal of dangerous substances and flammable liquids

Dangerous/flammable substances must be disposed of safely and in a manner that minimises environmental risks. At all times the Hazardous Waste (England and Wales) Regulations 2005 must be observed as well as all university procedures and guidance such as:

- Information found on the University of Reading 'Clean and Green' web page: <http://www.reading.ac.uk/cleanandgreen/Whatcanyoudo/RecyclingandWaste/cag2-whatcanyoudo-recyclingandwaste-allhazardouswastes.aspx>
- University of Reading Health and Safety Services Safety Code of Practice No 48 – HAZARDOUS WASTE: http://www.reading.ac.uk/web/FILES/health-and-safety/CoP_48_Hazardous_Waste.pdf

Guidance:

How you assess waste to check if it's hazardous changed on 1 July 2015. Refer to Technical guidance WM3: Waste Classification – Guidance on the classification and assessment of waste: <https://www.gov.uk/government/publications/waste-classification-technical-guidance>

10.1 Disposal methods

Waste products will generally need to be stored and handled according to the same standards as the products from which they were derived. They will also be subject to the same legislation, unless their properties have been significantly altered by the processing.

Laboratory waste is to be segregated according to hazard type and disposed of in accordance with local guidelines (Tech services ref to waste TS: 401)

In some circumstances liquid waste may be disposed of via laboratory sinks subject to certain criteria:

- Waste must not be harmful to humans or the environment.
- Must not be flammable (contain more than 24% alcohol)
- Reactive chemicals, e.g. chemicals that may cause an explosion or release toxic gases.
- Not be corrosive and contain a pH between 5 and 9.
- Biological material is to be inactivated by autoclave or disinfectant.

Further information is available from your HSC, Technical Services the sustainability team or H&SS.

Do not mix waste materials collected from different processes before disposal unless the various components are known to be compatible. Consideration will need to be given to the eventual disposal techniques at the early stages of the risk assessment.

10.2 Waste containers

Liquid waste must not be stored in glass Winchester bottles as they cannot expand and may explode leading to personal injury or environmental damage.

Liquid waste should be stored in appropriate HDPE (high density polyethylene) containers supplied by Technical Services and segregated according to hazard group. All waste containers must be labelled with the contents, laboratory (or owner if shared facility) and the date it has been created.

When not in use, containers of waste product should be securely closed to prevent leakage and should be returned to storage areas. When full, waste containers should be removed from the laboratory to the appropriate external storage area as soon as reasonably practicable.

Waste products must not be decanted into containers within a storage area; the container should be taken to the designated work area.

11 Vehicle use

The use of motorised vehicles within or close to areas containing dangerous or flammable substances on University premises should be avoided. If this situation arises vehicles should be protected to an appropriate standard. A review of the type of traffic movements in the vicinity of areas containing dangerous substances should form part of the assessment process. Increasingly the pressure from Manual Handling Regulations, to introduce small motorised or battery powered units should not be overlooked and appropriately assessed. For further information go to HSE webpage: <http://www.hse.gov.uk/comah/sragtech/techmeasareaclas.htm>

11.1 Transportation of Dangerous Substances

The transport of dangerous substances using University vehicles should be avoided. Where considered essential, Winchesters should be contained in crates and together with drums secured within the vehicle. Appropriate labelling should be provided on the containers and the transporting vehicle. **The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009** apply. Safety data sheets applicable to the load being conveyed must be available on the vehicle. Approved Suppliers to the University will be familiar with these Regulations and their services used whenever possible.

Guidance:

For further information on the transportation of dangerous substances – see SCOP No 52 Driving for Work Purposes: http://www.reading.ac.uk/web/files/health-and-safety/CoP_52_Driving_for_Work_Purposes_issue_3_May_2016.pdf

11.2 Transportation of Petroleum

See Safety Note 71 – Transportation, Storage and Use of Petroleum:

http://www.reading.ac.uk/web/files/health-and-safety/SN71_Petrol.pdf

12 References

1. Statutory Instrument 2002 No. 2776 The Dangerous Substances and Explosive Atmospheres Regulations 2002
Safety Policy Directorate (Health & Safety Executive)
Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
Implementing the Chemical Agents Directive 98/24/EC (CAD) and the Explosive Atmospheres Directive 99/92/EC (ATEX 137)
2. Health & Safety Booklet
The safe use and handling of Flammable Liquids. HSE Books. ISBN 07176 09677
3. Health & Safety Booklet
Fire and Explosion: How safe is your workplace?
A short guide to the Dangerous Substances and Explosive Atmospheres Regulations. HSE Books. ISBN 0717625893
4. Health & Safety Booklet
7 Steps to Successful Substitution of Hazardous Substances. HSE Books. ISBN 0717606953
5. HSE Approved Code of Practice and Guidance "L134"

- Design of plant, equipment and workplaces. HSE Books. ISBN 0717621995
6. HSE Approved Code of Practice and Guidance "L135" Storage of dangerous substances. HSE Books. ISBN 0717622002
 7. HSE Approved Code of Practice and Guidance "L136"
Control and mitigation measures. HSE Books. ISBN 0717622010
 8. HSE Approved Code of Practice and Guidance "L137"
Safe maintenance, repair and cleaning procedures. HSE Books. ISBN 0717622029
 9. HSE Approved Code of Practice and Guidance "L138"
Dangerous Substances and Explosive Atmospheres. HSE Books. ISBN 0717622037
 10. Health & Safety Executive Website: <http://www.hse.gov.uk/fireandexplosion/dsear-regulations.htm>

Appendix 1: Designated Hazardous Areas

By the nature of their use the following buildings, rooms and structures have been designated 'Hazardous' Areas at the university:

LOCATION	USE	ZONAL RATING	JUSTIFICATION
Chemistry Building Room No 107	Distillation of highly flammable solvents	Zone 2	Risk of leak, spill and failure of process causing flammable atmosphere
W20 TOB1 External Flammable Store	Storage of highly flammable solvents	Zone 2	Risk of secondary leak or spill causing flammable atmosphere
W136 Chemistry Store No 2	Storage of highly flammable solvents	Zone 2	Risk of secondary leak or spill causing flammable atmosphere
W254 Harborne External Store No3	Storage of highly flammable solvents	Zone 2	Risk of secondary leak or spill causing flammable atmosphere
W270 AMS Solvent Store Rear of Knight Building	Storage of highly flammable solvents	Zone 2	Risk of secondary leak or spill causing flammable atmosphere
W294 Russell External Solvent Store	Storage of highly flammable solvents	Zone 2	Risk of secondary leak or spill causing flammable atmosphere

Appendix 2: Version Control

VERSION	KEEPER	REVIEWED	APPROVED BY	APPROVAL DATE
1	H&S	Every 4 years		05 Apr 2004
2	H&S	Every 4 years	UHSWC	10 th May 2018