Health and Safety Guidance
Chemical Hazard and Risk Assessment

GUIDANCE/22/CHRA/05

Chemical hazard and risk assessment is a requirement of University Hazardous Substances Policy (UHSP/15/HS/03). A chemical hazard and risk assessment is intended to fulfil explicit assessment requirements in two separate sets of legislation: The Control of Substances Hazardous to Health Regulations 2002 (as amended) and The Dangerous Substances and Explosive Atmospheres Regulations 2002.

This guidance explains the features of a chemical hazard and risk assessment and how it is carried out, taking into account the explicit statutory requirements.

This document supersedes the former University Safety Policy, Making a Chemical Hazard and Risk Assessment USP/90/CHRA/16.

Further information and advice may be obtained from the Health and Safety Unit.
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Chemical Hazard and Risk Assessment

INTRODUCTION

What is a Chemical Hazard and Risk Assessment

Many of the substances that we encounter in our work, not only in laboratories but also in offices and other not so likely places, can cause ill-health or fire and even explosion. The properties that cause these effects are called hazards. In some activities we do not start with a hazardous substance but one is produced from the process as a fume or residue.

In most cases, the harm is not caused by the substance alone but by an unsafe condition arising from:
- the way a substance is used or produced; or
- incorrect storage.

In many instances the substances must be released in some way for an unsafe condition to arise:
- as a gas, vapour, fume, dust, aerosol;
- from a liquid spill.

Unsafe conditions include:
- an atmosphere contaminated with gas, dust, vapour, fume, aerosol;
- oxygen deficiency;
- spills or splashes of liquids;
- mixing of incompatible substances;
- overheating, excess pressure, exposure to source of ignition.

An unsafe condition may cause:
- personal exposure by inhalation or eye or skin contact;
- asphyxiation;
- spills or splashes of liquids;
- violent reaction and/or release of further hazardous substances;
- ignition or detonation leading to fire or explosion.

The likelihood that an unsafe condition will actually arise is called the risk. In order to determine whether an unsafe condition may arise and what to do about it, we need information about both the substances and the processes involving them. That is, we need to do a chemical hazard and risk assessment of the activity.

Chemical hazard and risk assessment involves:
- identifying the substances used or produced or released in an activity;
- gathering information about the hazards, the harmful or adverse effects of the substances;
- considering whether and how harm or adverse effects could actually arise from the way the substances are used or produced, the risk to health and safety;
- identifying the people whose health and safety may be endangered;
- considering what methods of prevention or control and any other measures are needed;
- identifying the need for monitoring:
  - performance of control measures;
  - workplace conditions,
• personal exposure,
• health;
• determining the management of foreseeable emergencies;
• identifying the information, training and instruction needs of those who may be affected.

In addition to these general principles there will also be the need to consider what else may need to be done to satisfy specific requirements of relevant health and safety law. In some instances, explicit legal requirements will apply to parts of this process. For example, fume cupboards must be thoroughly checked every 14 months and undergo simple checks every week; a health record must be maintained for anyone whose work involves a carcinogen.

The purpose of a chemical hazard and risk assessment is therefore to provide the information and evaluations necessary to allow decisions to be made about the measures needed to ensure no personal harm or adverse effects will arise from activities involving hazardous substances.

What it is not

A chemical hazard and risk assessment is not:

7 a list of the hazards of a substance;
7 a collection of substance safety data sheets.

Scope and Application

Chemical hazard and risk assessment is required by University Hazardous Substances Policy (UHSP/15/HS/03). This has been developed to ensure compliance with relevant legislation, in particular, The Control of Substances Hazardous to Health Regulations\(^1\) (COSHH) and The Dangerous Substances and Explosive Atmospheres Regulations\(^2\) (DSEAR). Both sets of regulations are quite specific about what must be included in a risk assessment.

The requirement for risk assessment applies to all work activities, catering, cleaning, maintenance, research, teaching, etc. that use or that may produce or release hazardous substances. However, separate arrangements apply for substances that are hazardous solely because of radiation or biological hazards.

Assessment Strategy - Generic Assessment

This is not a bureaucratic exercise. In many instances the assessment may have been largely or even wholly completed at University level. In such cases all that is required is to confirm local arrangements conform with University Policy. For example, Hazardous Substances Policy specifies the requirements for the storage of highly flammable solvents. Hazardous Substances Policy is developed from hazard and risk assessment. The assessment does not need to be repeated for a particular storage if the University's requirements are fully met and this is stated in the local arrangements. This is known as generic assessment. There are many examples of generic assessment. Following a generic assessment is the easiest option, provided that local conditions do not invalidate it.

GUIDANCE

THE SUBSTANCES

What is involved?

All the substances used or produced by an activity must be identified. Percentage compositions will be required for mixtures. It will be necessary to know what form the substance(s) will be in: gas, vapour, liquid, fume, dust, mist, aerosol, solid. The form of a substance may change during an activity.

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\(^1\) The Control of Substances Hazardous to Health Regulations 2002 SI 2002/2677, as amended.
\(^2\) The Dangerous Substances and Explosive Atmospheres Regulations 2002 SI 2002/2776
because of the effect of temperature. For example, the flux used in soldering electronic components becomes liquid and therefore volatile and also fumes during the soldering process.

**Physical and chemical properties**

Physical and chemical properties are very relevant to hazard and risk. Especially important to risk are physical properties such as boiling point, vapour pressure, evaporation rate and particle size which influence the mobility of a substance. In addition to the hazardous properties mentioned below, stability and incompatibility or reactivity with other substances are important chemical properties.

All of this information should be available in suppliers' catalogues and on suppliers' *Material Safety Data Sheets*. Information about substances produced during or from an activity may be available in the University's HAZDAT Hazardous Substances Database or from other standard reference sources.

**Is it hazardous?**

A substance is hazardous if it is:
- listed under the labelling regulations or has properties similar to listed substances;
- listed in the COSHH regulations;
- assigned a Workplace Exposure Limit;
- a dust of any kind;
- any other substance, such as an asphyxiants, that because of its properties or the way in which it is used or is present can cause a risk to health and safety.

The **statutory labelling** that appears on containers is very useful for identifying the hazards of a substance.

![Statutory Labelling](image)

Additionally, labelling will display explicit risk phrases such as:
- Spontaneously flammable in air
- Contact with water liberates extremely flammable gases
- Causes severe burns
- May cause cancer

The statutory hazard classifications of substances are included in the University's HAZDAT Hazardous Substances Database. This information may also be found in suppliers' catalogues and on suppliers' *Material Safety Data Sheets*. 
Other sources of information about substances which are acquired or which may arise from work activities include the Health and Safety Fact File on the University's Health and Safety Web pages. Of particular concern are substances that may cause cancer and sensitisers. Safety Services may also be consulted directly for this information.

In the COSHH Regulations certain substances that cause cancer, heritable genetic damage or asthma are identified as particularly hazardous. See the Appendix for more information about these substances. These substances are also identified in HAZDAT

Dust, even if not a toxic substance, may still be harmful to health if inhaled in excessive quantity. Dust, even if not a flammable or combustible substance, may form an explosive atmosphere. In both cases particle size is important. The particle size for respirable dust is defined in BS EN 481 1993. The range for explosive atmospheres may be many times greater up to about 400 micrometres.

Asphyxiants are gases which, even if inert, present a risk to health if present in sufficient amount to significantly reduce the proportion of oxygen to other gases in the air.

Harmful and adverse health effects
Toxicity and other health effects data will be needed to determine what amount of substance would harm health, whether the risk is acute or chronic or both and whether it is additive:
- acute, from a single contact causing serious effects or death, either immediate or delayed;
- chronic, from repeated contacts, even at low level, causing harmful effects or even death;
- whether both short term or long term effects could occur;
- additive either from mixed or from consecutive contacts to different substances.
Some health effects are considered serious at all levels of contact because of the nature or irreversibility of the consequences:
- mutagenic, capable of changing the genetic material that determines the heritable characteristics of living cells;
- carcinogenic, can cause uncontrolled cell growth to give rise to a cancer;
- reproductive, may impair fertility or cause developmental damage before conception, during pregnancy or after birth;
- allergenic, can cause hypersensitive condition.

Reactivity and Instability
Will the substance readily set on fire or explode or produce a flammable mixture with air? Data such as FLASH POINT, EXPLOSIVE LIMITS, AUTOIGNITION TEMPERATURE, SELF-ACCELERATING DECOMPOSITION TEMPERATURE will be needed. Is the substance sensitive to heat or shock? Are any of the substances incompatible or react with air or water?

THE ACTIVITY
The risk of harmful or adverse effects usually arises from the activity, that is, the way in which substances are used or produced. Thus the assessment must consider what happens during an activity.

Important features include:
- how much substance is used;
- are two or more substances mixed;
- procedures used, such as pouring, mixing, spraying, abrading, etc;
• experimental conditions such as temperature, pressure;
• containment or otherwise of the equipment, that is, the ability of the equipment to prevent a release of the substance.

The assessment must also consider:
• any potential for change in the activity that would alter the risk;
• what could go wrong.

**RISK ASSESSMENT**

The likelihood that an unsafe condition will actually arise is called the **risk**.

Unsafe conditions include:
• excessive personal exposure to a substance, sufficient to cause harm to health;
  
  Contact with a substance can be brought about in a variety of ways and circumstances:
  • working with it directly so as to touch it or to inhale it after discharge to air;
  • the inadvertent mixing of incompatible substances that produces a harmful product (e.g., the release of chlorine gas from the mixing of hypochlorite with an acid);
  • being near to where it is handled, transported, used, worked upon, collected, packed, stored, disposed of, discharged or given off etc.;
  • entering an enclosed space where it might be present;
  • disturbing deposits of the substance on surfaces (e.g., during cleaning or maintenance) and making the substance airborne;
  • failure of controls;
  • wearing previously contaminated clothing or protective equipment;
  • coming into contact with contaminated surfaces;
  • having a substance passed on from someone else, e.g., from another person’s contaminated clothing or from personal contact.
  • creation of an explosive atmosphere;
  • exposure of a flammable substance or explosive atmosphere to a source of ignition;
  • mixing a substance with one with which it is violently incompatible;
  • exposure of an unstable substance to shock, heat or flame;
  • loss of control arising from a miss-hap or equipment malfunction.

**Criteria for determining excessive personal exposure**

Harm to health can only arise if there is exposure to a substance, that is, contact with it that could lead to its absorption into the body.

Is the substance likely to be present in a form in which it could be:
• inhaled;
• swallowed (either directly or by settling on food or from putting contaminated fingers to the mouth);
• absorbed through the skin or eyes (either directly or from contact with contaminated surfaces or clothing);
• in contact with skin or eyes;
• injected into the body by high pressure, equipment or contaminated sharp objects?
Exposure is judged excessive if the level exceeds a set standard, such as the Health and Safety Executive's Workplace Exposure Limit\(^3\) for airborne substances or oxygen deficiency in the case of inert gases. Exposure may also be judged excessive according to the severity of the effect, such as destruction of tissue by a "corrosive" substance.

Especially in research where small amounts of novel or little known substances may be used there may be no official classification or standard applied to particular substances. In these cases, data from the literature or supplier should be used in conjunction with the official criteria for hazard classification to determine appropriate in-house standards.

**Exposures to airborne substances**

Exposure to contaminated atmospheres will need to be controlled so as not to exceed the Workplace Exposure Limit (WEL). However, where a substance causes cancer, heritable genetic damage or asthma, then the requirement is to control exposure to a level as far below the limit as is practicable. See the Appendix for more information about these substances.

To predict whether the WEL is likely to be exceeded during an activity it is necessary to estimate the scale of evaporation or release of substance into the air and the resulting airborne concentration. Alternatively, compare the amount that may become airborne with the amount needed to produce the WEL. For example, 0.67 cm\(^3\) of chloroform evaporated into 100 m\(^3\) of air will produce the WEL vapour in air concentration of 2 ppm. In some cases, there is also a risk from skin absorption. This information is contained in the HAZDAT database.

**Oxygen deficiency**

Oxygen deficiency may arise when inert gases such as nitrogen and helium displace atmospheric oxygen. The normal concentration of oxygen in air is 20.9% and should not be allowed to fall below 18%. The release of about 17% of the room volume of an inert gas will lower the oxygen concentration to 18%.

**Exposures to substances absorbed through the skin**

Any exposure to hazardous substances that can be absorbed through the skin is excessive and should be prevented. Such substances include those assigned the skin (sk) notation in EH40\(^4\) and those labelled with the specific risk phrases.

**Exposures judged excessive by severity of effect**

The emphasis will be on preventing exposure. The classes of hazard to which this category applies are:

- corrosive;
- carcinogenic;
- mutagenic;
- allergenic;
- toxic to reproduction.

**Criteria for excessive risk of fire or explosion**

As with excessive personal exposures, there is scope for assessment by comparison with an appropriate standard and also by severity of effect.

**Flammable/explosive atmospheres and flammable substances**

Three components are usually needed to cause fire and/or explosion:

- a flammable gas or vapour or a dust;
- oxygen;

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\(^3\) EH40 Workplace Exposure Limits Health and Safety Executive (revised annually)

\(^4\) EH40 Workplace Exposure Limits Health and Safety Executive (revised annually)
• a source of ignition.

Controlling any one of these components should control the risk. In the case of gases, vapours and dusts it is usual to control the release of the substance because many flammable substances are also harmful to health. The limits for the control of flammable/explosive concentrations in air are at percentage levels, thousands of times higher than WELs.

Where it is possible for an explosive atmosphere to form the DSEAR regulations require the place to be classified “hazardous” or “non-hazardous” according to whether this may occur in such quantities as to require special precautions.

Some solid substances readily catch fire on brief contact with a source of ignition. Here the emphasis would be on control of contact with air and the source of ignition.

Certain very unstable substances can catch fire/explose in the absence of an external source of oxygen or ignition energy. This may be as a result of auto-oxidation as can happen with cellulose nitrate. The decomposition of acetylene can continue in the absence of oxygen.

Unstable substances
Some substances explode on brief contact with heat or flame or are sensitive to pressure change. Here the emphasis will be on controlling the condition that invokes the instability.

Incompatible substances
Some substances react violently with air or water. Some combinations of substances are incompatible.

Frequency or duration of unsafe condition
The frequency and duration of an unsafe condition are also important considerations in the evaluation of risk and the actions required for control. Some adverse effects may be time-dependent and may not occur if the duration of the dangerous condition is too short. Some adverse effects from brief exposure are less serious such as simple reversible irritation that is not likely to cause long term harm. Similarly for infrequent events.

PEOPLE WHO MAY BE AT RISK FROM THE WORK ACTIVITY

Risks to health and safety from a work activity involving hazardous substances may endanger not only the person performing the activity but colleagues working nearby and a variety of other people who may be in the vicinity at some time or other. The risk assessment must identify the people who are performing the activity and also assess the extent to which any others from the following categories may be at risk:

• research staff;
• technical staff;
• students;
• supervisors;
• office staff;
• maintenance and cleaning staff;
• security staff;
• contractors, including service engineers;
• visitors;
• persons living or working nearby;
• persons using public footpaths on University property;
• emergency service personnel.

Also, certain groups of people could suffer more than others, e.g., pregnant women and nursing mothers.

CONCLUSIONS ABOUT RISK

Possible conclusions are:
• an unsafe condition is not likely under any circumstances - no further action required unless there are specific statutory measures for substance/activity (e.g. health record for work with carcinogens);
• an unsafe condition is not likely during normal operation but could arise from potential changes in the activity - define potential changes and specify criteria for review of assessment;
• an unsafe condition is not likely during normal operation but could arise from mishap or equipment malfunction - assess emergency measures;
• an unsafe condition is likely during normal operation - assess and specify measures for prevention/control of risk.

PREVENTION AND CONTROL OF RISK

Both COSHH and DSEAR specify the measures required and in order of preference, see appendix

Prevention

The law places the emphasis on prevention. Elimination of a risk is the most effective form of prevention.

Elimination of risk may be by:
• not performing the activity;
• a change in the way the work is done;
• substituting a less hazardous substance; or
• removing one of the risk factors, e.g. source of ignition.

Good Chemical Practice

Good Chemical Practice (See Hazardous Substances Policy, Schedule 3.1) sets a minimum standard for ensuring the protection of people against the adverse effects of chemical substances encountered at work. Work with all substances should at least meet this minimum standard. However, work with many substances presents a higher risk because of the hazard and/or the level of risk and will demand a higher standard, Enhanced Good Chemical Practice. Whether Good Chemical Practice is sufficient or whether there may be a significant residual risk can be easily determined by reference to Criteria for Enhanced Good Chemical Practice (See Hazardous Substances Policy, Schedule 3.2). A Chemical Hazard and Risk Assessment may specify GChP for basic control measures.

Control

Both COSHH and DSEAR are explicit about methods of control (see appendix) and the order of preference in which they should be considered. Some controls are inherently more effective than others. Choice should be of the most effective and reliable controls that minimise the escape and spread of substances.

The most effective and reliable is eliminating the substance. If a substance is not used it cannot be a risk to health and safety. Especially for more dangerous substances, an assessment should include a brief statement of why it could not be eliminated.
Amounts of substances and release rates should be restricted and residual risk must be controlled at source by appropriate engineering measures. Examples include a totally enclosed system so that the substance is not released or local exhaust ventilation to contain or capture the substance, before it is released to air.

Local exhaust ventilation performance varies according to type and individual specification. The assessment will need to identify the specification needed to control risk to an acceptable level. However, a COSHH principle of good practice is that control measures should be proportionate to the risk. If potential exposure is 100 times the WEL then the performance of control measures will need to be much greater than if the potential exposure were only twice the WEL. However, if a particular measure is more convenient or acceptable it does not matter if it reduces exposure more than is strictly necessary.

However, where there is potential exposure to a carcinogen or mutagen, and it is not reasonably practicable to prevent, it additional measures required by COSHH include:

- total enclosure
- designation of areas that may be contaminated.

All the requirements of DSEAR Regulation 7 must be fulfilled (See Appendix) for an area classified "hazardous".

**Further Measures**

Information, instruction and training will always be needed. Do the basic arrangements need to be supplemented because of specific features of the activity or control measures.

**Personal protective equipment** may also be needed in addition to all other control measures if the combination of all control measures fails to achieve adequate control of exposure.

The performance of personal protective equipment varies according to type and individual specification. For example, no single glove material will give protection against all substances. The assessment will need to identify the specification needed to give adequate protection and whether personal fitting is required. Personal fit testing of tight fitting respirator facepieces is a specific requirement for compliance with COSHH. The performance of such respirators depends on a good contact between the wearer's face and the face seal of the mask.

**MONITORING**

**Performance of Control Measures**

Are special arrangements needed for checking the performance of controls? COSHH requires that controls are kept in efficient working order, good repair and clean and that they are visually checked at least once a week. Engineering controls and respiratory protective equipment have to be examined and, where appropriate, tested at suitable intervals. The assessment will need to indicate whether the standard checking procedures will be adequate, if not specify what extra needs to be done.

**Workplace Conditions**

Monitoring workplace conditions might be necessary if there is a risk of a dangerous condition arising unexpectedly. Examples include toxic, explosive or oxygen deficient atmospheres. How will this be done? By installing sensors linked to alarms? Will any interlocking of sensors and control measures be needed?

**Personal Exposure**

If the work will cause people to be exposed to a substance, and either it is not known whether the exposure will be excessive or exposure is expected to be close to the limit, personal monitoring may be required. Personal monitoring may also be necessary if exposure could occur unexpectedly from a failed control. The type and frequency of monitoring should be specified. However, personal
exposure monitoring may not be necessary if, for example, workplace monitoring gives advance
warning of potentially unacceptable personal exposure.

**Health**

Some form of health surveillance is mandatory for specified activities or work with certain substances
and if it is believed likely that exposure may give rise to observable health effects (See Hazardous
Substances Policy Schedule 4).

Relevant examples of substances for which health surveillance is required:

- Substances of recognised systemic toxicity (e.g. carcinogens, substances labelled "may
  cause cancer" or "may cause cancer by inhalation" (see Hazardous Substances Policy
  Schedule 3.3 for further identification of carcinogens) or heavy metals such as lead, cadmium)
- Substances labelled "May cause sensitisation by inhalation" and other substances known to
  cause occupational asthma
- Substances labelled "May cause sensitisation by skin contact" and other substances known to
  cause severe dermatitis.
- Soldering using rosin flux

Many of these substances are identified in the University's HAZDAT database.

The appropriate Health Surveillance should be determined in consultation with The University's
Occupational Health Physician.

**EMERGENCY MEASURES**

What could foreseeably go wrong?

- Equipment failure or malfunction
- Spills and leaks
- Other loss of control

What hazards and risk would arise from foreseeable emergencies

- fire/explosion
- contamination of the workplace
- personal exposure to hazardous substances
- contamination of water courses/sewers.

What arrangements will be needed to:

- stop the incident and bring the hazards under control
- protect people,
- provide first aid to people exposed to hazardous substances
- decontaminate/clean up/return to normal.

Who to contact in an emergency.

In particular, are special arrangements indicated, such as the need for hydrofluoric acid burns gel or
not using water on a fire involving water reactive substances.

Health and Safety Guidance is available for dealing with emergencies (See Hazardous Substances
Policy Schedule 8).
RECORDING THE ASSESSMENT

The results of an assessment should be recorded using the pro forma in Hazardous Substances Policy, Schedule 2 and following the attached guidance notes. The pro forma and notes are designed to help ensure that vital information is recorded and in sufficient detail for it to be clear why decisions were made.

REVIEW OF THE ASSESSMENT

The need for review is indicated if there is any reason to suppose that the original assessment is no longer valid, or if any of the circumstances of the work should change significantly.

For example, if there are any significant changes in:
- the scale of the activity, quantities of substances involved;
- the substances;
- the equipment;
- control measures.

It is also necessary to be alert for the need of review if, for example:
- ill health related to work is reported;
- there are fire or explosion incidents;
- there is new evidence about the hazards of the substances;
- monitoring or health surveillance results show any loss of control;
- new or improved techniques of control become feasible.

Hazardous Substances Policy specifies that risk assessments are reviewed at least annually to ensure that they remain relevant.
APPENDIX

Substances Identified under COSHH as being Particularly Hazardous

Those classified:
May cause cancer
May cause heritable genetic damage (mutagens)
Danger of serious damage to health by prolonged exposure
May cause cancer by inhalation
May cause sensitisation by inhalation
May cause sensitisation by inhalation and skin contact

Those listed in COSHH Schedule 1, other substances classified as carcinogens
See "Carcinogens" [https://www.intranet.bham.ac.uk/university/hsu/documents/factfile/chem6.pdf]

Those listed in Section C of the HSE’s Asthmagen document
See "Respiratory sensitisers" [https://www.intranet.bham.ac.uk/university/hsu/documents/factfile/occhea1.pdf]

COSHH Requirements, Regulation 7 Prevention or Control of Exposure to Substances Hazardous to Health

Exposure to substances hazardous to health must be prevented or, where this is not reasonably practicable, adequately controlled using protection measures including, in order of priority:

1. the design and use of appropriate work processes, systems and engineering controls and the provision and use of suitable work equipment and materials;
2. the control of exposure at source including local exhaust ventilation and work procedures; and
3. as a last resort where adequate control cannot be achieved by other means, in addition to the above, personal protective equipment.

The measures referred to above to include:

- safe handling, storage and transport , including waste
- suitable maintenance procedures;
- reducing, to the minimum number of employees exposed
- restricting level and duration of exposure, and quantity of substances
- control of the working environment, including appropriate general ventilation;
- appropriate hygiene measures including adequate washing facilities

Control of exposure will only be regarded as adequate if:

- the principles of good practice set out in Schedule 2A to the regulations are applied;
- any workplace exposure limit is not exceeded;
- for carcinogens, mutagens and asthmagens, exposure is to as low a level as is reasonably practicable.

Principles of Good Practice for the Control of Exposure to Substances Hazardous to Health (COSHH Schedule 2A)

(a) Design and operate processes and activities to minimise emission, release and spread of substances hazardous to health.

(b) Take into account all relevant routes of exposure- inhalation, skin absorption and ingestion- when developing control measures.

(c) Control exposure by measures that are proportionate to the health risk

(d) Choose the most effective and reliable control options which minimise the escape and spread of substances hazardous to health.
(e) Where adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable personal protective equipment.

(f) Check and review regularly all elements of control measures for their continuing effectiveness.

(g) Inform and train all employees on the hazards and risks from the substances with which they work and the use of control measures developed to minimise the risks.

(h) Ensure that the introduction of control measures does not increase the overall risk to health and safety."

**DSEAR Requirements, Regulation 6 Elimination or Reduction of Risks**

- Risk must be either eliminated or reduced SFARP.
- Preference should be given to risk reduction by substitution.
- Otherwise:
  - use controls including, in order of priority:
    1. the reduction of quantities to a minimum;
    2. avoidance or minimising of release;
    3. control of the release at source;
    4. prevention of the formation of an explosive atmosphere, including the application of appropriate ventilation;
    5. any release which may give rise to risk is suitably collected, safely contained, removed to a safe place, or otherwise rendered safe, as appropriate;
    6. avoidance of
       (i) ignition sources, including electrostatic discharges, and
       (ii) adverse conditions that could cause harmful effects;
    7. segregation of incompatible dangerous substances;
   and
   - mitigate effects of fire/explosion or dangerous substances, including these measures:
     - reduction to a minimum number of employees exposed;
     - the avoidance of the propagation of fires or explosions;
     - explosion pressure relief arrangements;
     - explosion suppression equipment;
     - equipment able to withstand the pressure likely to be produced by an explosion;
     - suitable personal protective equipment.
- Arrive for the safe handling, storage and transport of dangerous substances including waste
- Risk reduction conditions must be maintained;
- Use the following general measures:

**Workplace and Work Procedures**

- Workplace designed, constructed and maintained so as to reduce risk
- Designing, constructing, assembling, installing, providing and using suitable work processes so as to reduce risk
- Maintaining work processes in an efficient state, in efficient working order and in good repair
- Ensuring that equipment and protective systems meet the following requirements
  - where power failure can give rise to additional risk, independent supply needed for equipment and protective systems

* The Dangerous Substances and Explosive Atmospheres Regulations 2002 SI 2002/2776
See also HSE DSEAR homepage [http://www.hse.gov.uk/fireandexplosion/dsear.htm]
• manual override operated by employees competent to do so,
• on operation of emergency shutdown, accumulated energy must be dissipated or isolated as quickly and as safely as possible
• necessary measures must be taken to prevent confusion between connecting devices

Organisational Measures
• appropriate systems of work including -
  • the issuing of written instructions for the carrying out of the work; and
  • a system of permits to work,
where the work is carried out in hazardous places or involves hazardous activities.

DSEAR Requirements, Regulation 7 Places where Explosive Atmospheres May Occur
• Classify places where an explosive atmosphere may occur into hazardous or non-hazardous, and hazardous places into zones in accordance with Schedule 2.
• Equipment in hazard zones must conform to Schedule 3.

• Hazard zones must be signed.
• Before place used for first time, explosion safety verified by a person competent in explosion protection.
• Work clothing used in hazard zones must not give rise to electrostatic discharges.

REFERENCES


Fit Testing of Respiratory Protective Equipment Facepieces (http://www.hse.gov.uk/pubns/asbestos.pdf)

Personal Protective Equipment [https://www.intranet.bham.ac.uk/university/hsu/documents/hspolicy/19ppe.pdf]

Compressed Gas [https://www.intranet.bham.ac.uk/university/hsu/documents/hspolicy/20cg.pdf]