Safe Storage of Hazardous Substances

Introduction

Improper storage of hazardous substances may create serious risk, not only to University staff and students, but also to emergency services personnel, the general public and the environment. The aim of this guidance is to reduce the risk to people's health and to property from the hazards associated with the storage of such substances.

This guidance uses transport classification and signage as an aid to explain what hazards certain chemicals possess, their compatibility and storage requirements. Transport signage consists of diamond shaped signs of differing colours and differing pictograms dependant on the hazard presented by the substance during storage and transport, they are to be found on the external of materials packaged for transport and in some cases on the external of vehicles carrying the substances.

They should not be confused with Hazardous warning pictograms applied to packaging under the Classification, Labelling and Packaging Regulations (CLP Regs) which are there to give users an indication of the hazards of the container/package content. These have a white background with a red border and black interior. This style of signage has replaced the old style which had an orange background and contained black pictogram which were replaced in June2015 (http://www.ed.ac.uk/schools-departments/health-safety/guidance/hazardous-substances/ghs-clp for more information).

Examples of the old style and new style;

	
CHIP Hazard pictogram	CLP Hazard pictogram

Hazardous Substance

A hazardous substance can be defined as any substance classified as hazardous by the following Regulations:

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004
- Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972
- The Control of Substances Hazardous to Health Regulations 2005 (as amended)
- Dangerous Substances and Explosive Atmospheres Regulations 2002

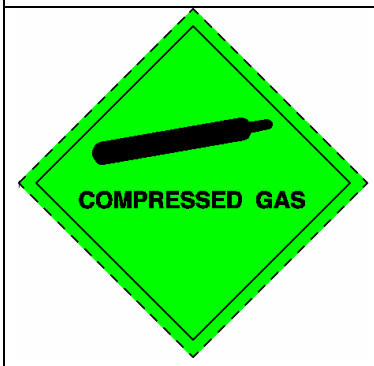
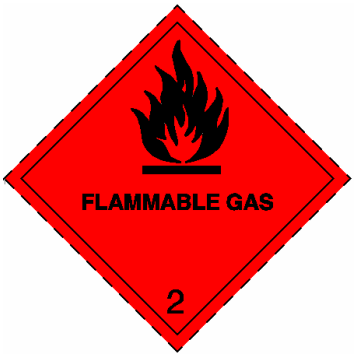
Hazard classifications include:

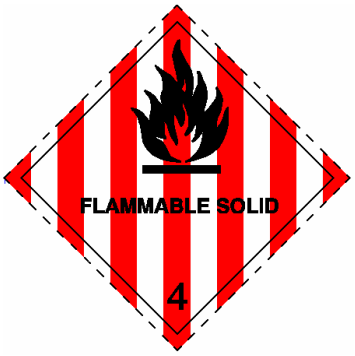
Flammable gas	Compressed gas
Toxic gas	Flammable liquid
Flammable solid	Spontaneously combustible
Dangerous when wet	Oxidising agent
Organic peroxide	Toxic, Harmful
Corrosive, Irritant	Dangerous to the environment

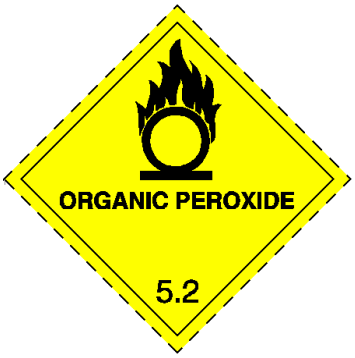
Hazards

Loss of containment and accidental combination of incompatible substances may result in extremely serious violent chemical reactions. The highest risk incidents however are those involving fire where in addition to the actual fire there is risk from radiated heat, missiles from explosions, harmful smoke and chemical containing fume, significant incidents may also result in harm to the environment through distribution of contaminated water that has been used to fight the fire or by fallout from contaminated smoke and fume.

Common hazards:

Transport Sign	Classification	Hazard
	Compressed Gas	Gas cylinders may explode if exposed to intense heat, even if the cylinder contents are non-hazardous, causing a risk of impact to people and property in the vicinity. Acetylene cylinders in particular are liable to explode without warning, during or for some time after exposure to heat, this because of the self-decomposition of the product. Where flammable or toxic gas cylinders are stored in buildings, good ventilation is needed to ensure that minor leaks will disperse safely. When considering storage locations and determining ventilation design criteria, your assessment will need to consider the densities of the gases involved, for example whether they are heavier or lighter than air. In this University at all new builds or during refurbishment of buildings provision must be made for storage of compressed gases outwith the building and the gases piped into the building via a gas manifold. Minor leaks from cylinders of compressed gases will disperse more readily if the cylinders are stored in the open air and in the event of fire the cylinders are not involved in the fire and gas supplies can be turned off from the external of the building. Cylinders of compressed gases must be stored in an upright position.
	Toxic Gas	
	Flammable Gas	
	Flammable liquid	Flammable liquid fires can grow rapidly once the integrity of the container is breached, the fire spreading quickly as the escaping liquid flows from the stored material. If the fire comes into contact with other flammable or oxidising materials, it will increase significantly in size. Sealed

		containers may explode if exposed to intense heat. Depending on ground conditions liquids may travel some distance while a leak remains undetected. Precautions to be taken include storing flammable liquids in a purpose built flammable resistant cabinet, on drip trays. Large quantities must be stored in a purpose built flammables store with a bund equal to, or more than, 110% of the largest container. Quantities of flammable liquids must not be left on the open bench overnight.
	Flammable Solid	These are readily combustible solids that can be ignited by brief contact with a source of ignition or be sensitive to friction, and will continue to burn after removal of the source of ignition. Examples are matches, fire lighters, nitrocellulose and sulphur. Self-reactive substances are included in this classification. These may decompose with the evolution of heat and fumes at moderate temperatures. Examples include various azo compounds. Also included in this classification are desensitised explosives. These are explosive substances which are wetted, diluted, dissolved or suspended with a phlegmatiser in order to suppress their explosive properties care must be taken that the phlegmatiser does not dry out during long term storage. Examples include picric acid, urea nitrate and 1-Hydroxybenzotriazole (Hobt).
	Spontaneously Compustible	Spontaneously combustible (Pyrophoric) substances have packaging which is designed to exclude air. If air enters a damaged package the substances may start to burn at room temperature. Examples include yellow phosphorus and some metal alkyls. Oxidative self-heating substances may react with the air, and so raise the temperature to the point at which spontaneous combustion takes place. This is normally a slow process which can be controlled by restricting the pack size, limiting storage duration, monitoring temperatures or excluding air. Examples include some types of carbon dust and oily

		natural products.
	Dangerous when wet	These substances react with water and evolve flammable gases. Examples include calcium carbide, metal hydrides, powders of reactive metals such as magnesium or aluminium, and the alkali metals such as sodium. Fire involving, or in the vicinity of, such materials must not be tackled with water.
	Oxidising Agent	These are substances which, although not generally in themselves combustible, can assist other materials to burn rapidly even if air is excluded. When heated in a fire, many of these substances decompose and give off oxygen which can cause an increase in the rate of burning with possible catastrophic consequences. Most oxidising substances are extremely reactive. They may be solids or liquid form. They need to be stored separate from flammable materials, so preventing any contamination or the possibility of them becoming an accelerant if involved in a fire. They may be stored with other similar strong oxidising agents provided they are compatible.
	Organic Peroxide	Organic peroxides are a particularly reactive type of oxidising substance. They may be solids, liquids or pastes, and have one or more of the following properties: • are liable to explosive decomposition; • burn rapidly; • are sensitive to impact or friction; • react dangerously with other substances; • decompose at comparatively low temperatures. Some organic peroxides may need to be marked with a subsidiary explosion risk label. Organic peroxides must be stored separately from flammable, corrosive and toxic materials. Specific advice and information on particular organic peroxides can be obtained from the Safety Data

		Sheets (SDS) or the supplier.
	Toxic	The main risk from toxic substances during storage is failure of containment. Appropriate pre-planning can minimise the consequences of isolated punctured drums or burst packages. However in the event of fire, such protection is likely to be compromised by the failure of containers due to the effects of flame and/or heat. As well as posing a threat to anybody in the immediate vicinity e.g. fire fighters, the toxic substance may also be spread over large distances in the smoke plume, or they may be washed into water courses by fire fighting water operations. The precautions necessary to minimise these risks depend on the quantities of toxic substances involved, their degree of toxicity, and their persistence in the environment. Toxic substances vary widely in the hazard they create. During storage, the acute hazards arising from short-term exposure, e.g. from spillage/breakage of a bottle/package, are more likely to arise than the chronic effects from low-level long-term exposure. Labelling under the Carriage of Dangerous Substances (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 2004 will give basic advice on the primary hazards and precautions, but Safety Data Sheets (SDS) will need to be consulted for comprehensive information.
	Corrosive	Hazardous substances may be classified as corrosive because they burn the skin on contact, or burn the mucous membranes of the respiratory tract by inhalation. Many corrosive substances will also react with incompatible unsuitable packaging or metals, for example shelving. Leaking corrosive substances may damage the packaging of other dangerous substances, thus creating further leaks.

Risk Assessment

A risk assessment must be carried out for all hazardous substance storage locations. If fire/explosion is the main hazard a risk assessment in compliance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) must be undertaken, if the main hazard is release of a toxic, harmful, irritant or corrosive substance then a risk assessment in compliance with the Control of Substances Hazardous to Health 2005 (COSHH) must be undertaken.

For the majority of areas storing hazardous substances the following events, both individually or jointly, have the potential to cause significant harm or damage and must be considered during the risk assessment process:

- fire;
- explosion;
- release of a toxic substance;
- release of a corrosive substance

Heads of School/ Support Units are responsible for ensuring that risk assessments are undertaken, significant findings documented and any necessary measures to minimise risk completed. Whilst they cannot transfer responsibility, Heads of School may nominate/delegate sufficient staff to help them undertake this. They must ensure that these staff are trained and afforded sufficient time to undertake the risk assessment process.

Information and training

Adequate training and knowledge of the properties of hazardous substances is essential for their safe storage. All relevant staff must be informed of the risks allied to the storing of hazardous substances, and the precautions necessary to safely store substances which have different hazards. Those responsible for safe storage of hazardous substances need specific training in emergency procedures. Periodic refresher training will normally be required. The training should include the following topics:

- The types of hazardous substances stored, their properties, incompatibilities and hazards, including hazard label recognition and understanding of the contents of Safety Data Sheets (SDSs);
- General procedures for safe handling;
- Use of protective clothing and respirators;
- Local procedures for dealing with leaks and spillages;
- Housekeeping and record keeping;
- Reporting of faults and incidents, including minor leaks and spills;
- Emergency procedures, including raising the alarm and the use of appropriate fire-fighting equipment.

Labelling of containers

Suppliers of hazardous substances must comply with the requirements of the Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation). Compliance ensures that:

- The hazard of the substance has been classified;
- The substance is suitably labelled with both hazard pictograms and specific risk and safety phrases, packaged accordingly; and
- Information, in the form of a Safety Data Sheet (SDS), is available.

If an SDS is not supplied with the first order of a hazardous substance this should be sought from the supplier who is legally obliged to supply an SDS at no cost. In the case of many reputable chemical suppliers (e.g. Fisher Scientific, Sigma Aldrich) the SDS for chemicals that they supply is available online.

Containers containing hazardous substances must be clearly labelled at all times. It is especially important to label containers that hazardous substances have been decanted into with at least the name of the chemical and the white/red hazard warning pictogram. Hazard warning pictogram labels are available in differing sizes, to suit container size, from your normal laboratory suppliers.

Flammable substances (excerpt from University Code of Practice P5CL2.12):

- In order to minimise the risk of a serious laboratory fire, the maximum amount of flammable reagents and solvents etc., stored in any one laboratory must not exceed 50 litres.
- Reasonable quantities of flammable reagents and solvents may be kept in the open laboratory in suitable closed vessels of volume not greater than 500ml; these small quantities are excluded from the 50 litre storage limit suggested for each room.
- All chemicals, other than those small amounts in use, must be stored in proper fire resistant chemical storage cupboards on drip trays and the external of the cupboard appropriately signed with a hazard warning sign(s) (black on yellow) relevant to the hazardous properties of the stored chemicals. Storage cupboards or bins must be constructed of materials that ensure that the sides, top, bottom, door(s) and lid are capable of providing 30 minutes fire resistance. These storage cupboards must not be sited adjacent to doors or other means of escape from the laboratory.

Toxic substances (excerpt from University Code of Practice P5CL 2.12):

- Regulations governing the storage and labelling of toxic and other hazardous materials must always be observed. Schedule 1 Poisons (e.g. arsenic compounds, mercury compounds, sodium and potassium

cyanide) Highly or Very Toxic substances and Cytotoxic substances must always be kept in secure storage, access to which is available only to nominated key holders. Accurate records of chemicals issued from a secure store must be kept by a nominated person. Lists of chemical substances within the above categories is available via the School of Chemistry's website at:
http://www.chem.ed.ac.uk/safety/notices/index.html

Corrosive substances

Many corrosive substances in Class 8 (see table 1) are incompatible. These may react together to produce heat or toxic gases. Examples are:

- Acids/hypochlorites - generate chlorine gas;
- Acids/cyanides - generate hydrogen cyanide gas;
- Acids/alkalis - generate heat;
- Acids/sulphides - generate hydrogen sulphide.

All of the above mentioned incompatible substances must be stored in separate steel cabinets and on drip trays of resistant material. The segregation of acids from other substances will go some way to ensuring incompatible substances are not stored together. The extent of such incompatibility problems may be reduced if damage to two packages must occur before any reaction can take place.

Storage and segregation

All substances must be stored in securely closed containers specifically designed for the purpose and clearly labelled in order to determine the hazards of the material and how it should be stored.

Table 1 (below) gives recommendations for the segregation of hazardous substances according to their hazard classification. The table excludes Class 1 (explosives), Class 6.2 (infectious substances) and Class 7 (radioactive substances). In the case of Class 6.2 substances the University Biological Safety Adviser, and in the case of Class 7 substances, the University Radiation Safety Adviser should be contacted to obtain guidance for the storage of these classes of hazardous substances.

Following the guidance in Table 1 may not achieve safe storage conditions in all situations. SDS's must be consulted for reactivity data to determine whether substances are incompatible.

Table 1 available as a PDF version only -
http://www.docs.csg.ed.ac.uk/Safety/general/safe_storage_haz-subs_table.pdf