Health and Safety Office

Chemical Storage

Topic:	**Safe storage of chemicals**
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Legislation:	**Health and Safety at Work etc. Act 1974** **Management of Health and Safety at Work Regulations 1999** **Control of Substances Hazardous to Health Regulations 2002 (COSHH)** **Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)**
Status:	**Guidance Note**
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1.0 Introduction

Of the accidents or incidents that have been reported in the HE sector as occurring in areas where chemical products have been stored, most could have been avoided with foresight and planning for both normal working situations, and emergency conditions.

The causes of such accidents could mainly be attributed to inappropriate packaging materials and/or storage cabinets, and general neglect where substances had been hidden away and forgotten about.

The primary way to control storage is to only purchase the amounts that are absolutely necessary, and discard materials that are no longer needed as soon as possible.

2.0 Scope

This Guidance Note is intended to give direction to those who may work with or be responsible for chemically hazardous materials. This is appropriate for all areas, including laboratories, workshops, housekeeping cupboards and even offices.

3.0 General

Products are referred to as “chemicals” usually because they are reactive in some way, and we are able to harbour that reactivity to our advantage using their reactive properties.

Although many chemicals have very specific properties, most fit into generic categories or ‘families’ that, to an extent, exhibit similar characteristics. For example, these may be acids, alkalis, or solvents, of which most people will understand the general action (ie corrosive or flammable) without needing to be too specific.

There are, however, further properties that many are less familiar with; for example what are ‘oxidising’ materials? Also, do we know that the vapour above a flammable liquid will form an explosive atmosphere? It is for these reasons that when we are presented with chemicals in the

workplace, someone competent should take managerial control, and ensure that a full range of risk assessments has been adequately completed. One such assessment should be on the storage conditions required for each material, taking into account other materials in the same location.

4.0 Hazards

Information about the hazards of chemical materials can be found in a number of ways including:

Labelling according to the CHIP Regulations [1]
Material Safety Data Sheet (MSDS) supplied from the Manufacturer upon request
R and S (risk and safety) phrases referred to on both of the above
Trade web-sites
HSE web-site [2]

5.0 Types of Store

5.1 Flammable cabinet:

Should be of metal construction built to EN 14470, and should be lockable, with trays/lips for bottles to sit inside should breakage or spillage occur. This also stops bottles from inadvertently being pulled or knocked out of the cabinet when accessing another. Within each operational room one such storage cabinet can be kept to hold a maximum of 50 litres of Highly Flammable materials (Flash Point $<21^0$C), or 250 litres of Flammable substances (FPt. 21-55^0C)[4]. The cabinet should be positioned away from any door especially on a fire-escape route. If there is a requirement to store larger quantities of any such materials, then a more specific risk assessment should be carried out under DSEAR [3]. This will be needed in petroleum stores for example, which used to be licenced by the local Fire Authority. The location of flammables must be recorded on a site plan, either centrally for the building, and/or on the door of the room involved.

5.2 Bench storage:

In a laboratory it is common practice to store standard chemicals on dedicated lipped shelves behind the work bench. This is only deemed satisfactory if these are limited to the original labelled containers, or clearly labelled (with hazard signage) made-up reagents. This must only constitute working-stock, and should not be used as a substitute for safe dedicated storage areas. Corrosives should not be stored above eye-level, and solvents should only remain in place if in bottles of 500ml or less. All this must be subject to a risk assessment taking account of all relevant factors eg accessibility, vulnerability, and of course, sources of ignition.

5.3 Acid storage:

These materials should be kept on an acid-resistant surface in a well ventilated space. The surface should have a lip or tray capable of withholding any spillage and made of a resistant material eg plastic. Ideally this should be within a cabinet. If this is not practical, then the storage should be in such a space as to not be vulnerable to damage from passing persons or trolleys etc. These must never be stored above eye-level.

5.4 Toxic materials (poisons) or drugs:

Special cabinets should be acquired for such materials, and should be designed to cope with any other significant properties other than just the toxicity. Clearly the major concern for all these materials is of security and must take account of accessibility of the area and the materials themselves to staff, students, and members of the public. This access may be either accidental or malicious, so each aspect should be guarded against. This may also be appropriate for storage of materials such as pesticides and fertilisers. Access must be managed by a robust system of key control.

5.5 Outdoor storage:

Such dedicated stores are preferential from a primary safety viewpoint, but can present secondary problems that may well outweigh the benefits eg accessibility for vandalism or the area being remote from the responsible person. Such external stores might be gas or cryogenics storage cages, or dedicated brick-built solvent stores. Any bulk tank or drum storage for liquids should be inside a bunded compound capable of holding 110% of the largest vessel eg fuel oil.

5.6 Gas cylinders [4] and cryogenic vessels [5]:

Where practicable these should be stored outdoors, and then preferably plumbed into the building so that they do not need further handling. If this is not feasible, then cylinders can be safely transported into the building to be used locally, but must be subject to a risk assessment and subsequent training eg. the manual handling of the cylinders, and the safe fitting of regulators. It is unacceptable to leave a gas cylinder free-standing: they should be clamped into position, and held secure by a strap or chain.
If it is planned to leave the cylinders in place, either attached and 'working' or not, then the risks must also be assessed and some infallible method of safety controls instigated; this may include extra fail-safe ventilation, or monitoring/alarms with all the associated documented procedures in case of emergency. The length of any pipework must be kept to a minimum.
The permanent location of all hazardous vessels must be recorded on a site plan, either centrally for the building, and/or on the door of the room involved.

5.7 Waste storage:

Should address all the aspects of safety mentioned above, but must also ensure that substances are prominently labelled as waste, with the hazardous information clearly displayed, and must be kept away from new materials.

5.8 Refrigerator:

Domestic type fridges are not designed to hold flammable materials. They contain electronic components that will cause a spark; the thermostat and the light and its switch are unprotected. If such a spark occurs and there has been any leakage or evaporation within the sealed fridge, it can cause a very powerful explosion, and possibly a fire too, with the clear risk to personnel and property.

- Before storing any flammable or explosive materials at low temperature, a full risk assessment must be carried out taking account of the physical properties. This will identify the most appropriate type of storage; on no account is it acceptable to store highly flammable products in a domestic type fridge. There is a wide range of suitable laboratory fridges available that are deemed spark resistant as they do not have any internal electronics.
- Fridges kept for domestic purposes close to a technical environment (lab or workshop) should be labelled to clearly state their purpose.
- Please also note that domestic fridges not used for food/drink must also have a risk assessment before being used to store other materials and should be labelled accordingly so there is no risk of confusion ie "No food or drink to be kept in this fridge"

6.0 Incompatibility and Instability

6.1 Incompatibility:

6.1.1 Where practicable, materials should be stored like-for-like in areas separate from other groups. This is not always possible, so if not the following advice should be applied.

6.1.2 All significant incompatibilities should have been established on the MSDS (data sheet) as R and S phrases [1] as part of the COSHH / risk assessment, but there are certain rules-of-thumb to follow:

- **Acids:** keep away from water, alkalis (bases), and reactive metals, products containing Chlorine or Cyanide. NB store Acetic Acid as a flammable solvent.
- **Alkalis:** keep away from acids and aluminium products.
- **Flammable solvents:** store away from sources of heat, sparks, Oxidisers and strong inorganic acids (Sulphuric, Nitric)
- **Oxidisers:** Keep separate from any organic product or material, including combustibles (paper, wood)
- **Chlorinated solvents:** Can (but do not need to) be kept with flammable solvents, but must be away from Aluminium and some other metals.
- **Gas cylinders [4]:** Although each cylinder will be stored safely in its own right, in the event of accidental release of gas, or in a fire, then there are advisory minimum storage distances to avoid violent reactions. See Appendix 1

6.3 Instability:

6.3.1 Some chemicals are unstable and so have very specific storage requirements that are designated either for safety purposes or for the preservation of the material itself (possibly with no safety implications). These may involve specifics of temperature, air or water (inclusion or exclusion) and should all appear in the specification as issued by the supplier / manufacturer. Requirements will appear as "S" (safety) phrases under CHIP[1] on the MSDS if the material could degrade to an unsafe derivative, and this advice must be strictly followed.

6.3.2 Other materials may have a designated "shelf-life" after which they have the potential to become unsafe. A typical example of this is Ether (diethyl ether) that can form explosive peroxides with elongated storage. Others might be pre-polymers (eg varnishes or glues) that may expand as they auto-polymerise thus carrying the risk of splitting or shattering their container.

6.3.3 For any of these materials, it is imperative to firstly know the hazards of the materials, and secondly to be able to perform a suitable and sufficient risk assessment and act on the findings to adequately control the risk. They will inevitably call for a robust system of stock control.

7.0 Emergency arrangements

7.1 Fire

7.1.1 You must account for the effects of a fire when considering selection of the storage type and the materials. If incompatible materials are kept at storage distances considered safe under normal working conditions, a fire might cause further complications ie subsequent mixing of incompatible materials following plastic containers melting or even igniting. The consequences should be subject to a risk assessment.

7.1.2 The position of any special storage facility should be marked up on a departmental plan, and held both locally and centrally ie on room door, and at the main entrance to the building in the Fire Manual (former Log Book). NB if there are obvious security issues with any details being displayed, then an assessment must be carried out and agreed by both the Health and Safety Office and Security.

7.1.3 Included in the above should be all gas cylinders with contents identified, flammables, toxics/poisons, acids, Toxins, and Radioactive materials.

7.1.4 The departmental positioning of fire detection and fire fighting equipment should take account of where storage facilities are, and not just where materials may be used. Conversely, if a new storage facility is to be installed, then the proximity of these measures should be considered before finalising the plans. Special precautions (sprinklers or other suppressants) may be deemed necessary after performing the (fire) risk assessment.

7.1.5 The name of the responsible person and their contact details should be included on these.

7.2 First aid:

7.2.1 First Aid kits, including eyewashes must be held in a place that is not only suitable for persons using hazardous materials, but also close enough to the storage facility should there be a breakage.

7.2.2 The kits must include special provisions if their need has been identified on the risk assessment because of the local use of particularly hazardous materials eg Hydrofluoric Acid, Phenol, or Cyanide.

7.2.3 It may be necessary to have emergency showers local to the storage facility, dependent on the risk assessment.

7.3 Spillage:

7.3.1 There should be a kit readily available that contains appropriate spillage treatment materials so as to avoid unnecessary release of chemicals to the environment eg drains. There are many products that may claim to act as ubiquitous soak-up granules or pillows, but this claim must be investigated before purchase as part of the storage assessment specific to the materials held.

7.3.2 Any materials that have been used for such spillages should be disposed of in a safe manner through the Health and Safety Office.

8.0 Safety Management

It has been established that there is the potential for significant levels of risk to be posed by storage of the chemical products held, even after the amount of materials has been kept to a practical minimum by good stock control. Adopting the following aspects of safety management will demonstrate best practice.

8.1 **Risk Assessment of materials/ facility:**

If this is done to a suitable and sufficient standard, then all potential risks should have been identified and estimated; all the controls as follow should be adopted to reduce the risk.

8.2 **Inspection:**

To confirm continuing efficiency of the storage facility, the responsible person must instigate a suitable inspection régime to take account of the nature of the materials stored, and the potential impact on the structure or fittings of the store eg rusting metals, rotting wood, warping shelves etc. This inspection must also address the current state of the container material itself, as long-term storage can seriously affect some containers; this is particularly relevant to plastic materials that become brittle with UV light or slow degradation by the contained substances.

8.3 **Signage:**

Appropriate signs as designated in the regulations[6] must be attached to the outside of storage compartments, and also if it is felt necessary for the safety of occasional visitors (cleaners, porters, security, or the Emergency Services) on the outside door of the room. However these must not be overpowering or confusing, so the door must only describe the primary safety concern within that room.

8.4 **Monitors:**

Some materials may be so dangerous that an accidental release during storage may produce a hazardous or even lethal condition. Your assessment should identify the extent of this risk, and if necessary may call for monitors to be installed to alert people of a dangerous condition. A typical example of this is where liquid Nitrogen is stored. As it warms up, large volumes of inert gas are

emitted that cause oxygen depletion: an oxygen monitor will alarm in these circumstances where otherwise the condition is undetectable to our senses until it is too late. The escape of inert gases from cylinders or fixed gas lines will have the same effect. Other gases or vapours may be so toxic that specific monitors for each substance will be required which will react and alarm at a pre-set level before the condition becomes too hazardous.

8.5 **Access restrictions:**

8.5.1 The storage area may need to be locked with restricted secure access to the key, or may be linked to the University's electronic identity card system. This will be identified on the risk assessment.

8.5.2 There will be some circumstances where some substances **must** be secured out of general accessibility because of statutory requirements. Bound by various regulations, the University specifically requires that Explosives, Scheduled Drugs, Drug Precursors, Chemical Weapons precursors, Toxins and Radioactive materials are kept secure. (Please note that such materials need to be readily accounted for by inventory and audit.)

8.6 Ventilation:

After total containment, this is the best way to control accidental or fugitive release of airborne chemicals; it must be properly designed, fitted, and maintained according to the potential risks encountered. See "Environmental" above
Instruction and Training: Once all the systems are in place, anyone using the facilities must be trained to an appropriate level so as to maintain the planned and instigated good standards.

All storage areas should be well ventilated according to the potential for release or emissions. These may be toxic, or corrosive, but at best may just cause a noxious odour. It is rarely appropriate to store hazardous materials that are not currently being used inside the sash of a fume cupboard. These are operational areas, and other ventilated cabinets should be used eg underneath a fume cupboard. Stores on outside walls could be ventilated passively with air-bricks, but otherwise some form of forced ventilation is necessary.

9.0 Location of stores

9.1 Storage facilities are provided to ensure the health and safety of persons working with or requiring access near to hazardous materials, and as such the store should be located safely so as to not present any increased risk. For this reason, a flammable store should not be kept on a fire exit route.

9.2 Security of hazardous materials is paramount, and because the storage facilities need to be prominently and appropriately signed, their location should be assessed and thoughtfully selected so as not to attract undue attention.

10.0 Conclusion:

Although most chemicals have inherent hazards, the risks involved with using, storing, and disposing of them can usually be controlled to acceptable levels using the guidance listed.

If the assessment shows that there is still an unacceptable residual risk, then please contact the Chemical Safety Advisor (Andy Macquiban) at the Health and Safety Office, for further advice.

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11.0 References:

1. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP)
http://www.hse.gov.uk/pubns/indg350.pdf
2. http://www.hse.gov.uk/chemicals/guidance.htm
3. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance **L138** HSE Books 2003 ISBN 0 7176 2203 7 (DSEAR)
http://www.hse.gov.uk/fireandexplosion/storageflammliquids.htm
4. BCGA **GN2** Guidance for the Storage of Transportable Gas Cylinders for Industrial use.
5. BCGA **CP27** Transportable Vacuum insulated containers of not more than 1000 Litres volume.
6. Safety signs and signals: Guidance on Regulations - The Health and Safety (Safety Signs and Signals) Regulations 1996 HSE Books, 1996 ISBN 0717608700
http://www.hse.gov.uk/pubns/indg184.htm

12.0 Further Information

DSEAR

- Design of plant, equipment and workplaces. Dangerous Substances and Explosives Atmospheres Regulations 2002. Approved code of Practice and Guidance. **L134** HSE Books 2003 ISBN 0 7176 2199 5

- Storage of dangerous substances. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance **L135** HSE Books 2003 ISBN 0 7176 2200 2

- Control and mitigation measures. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance **L136** HSE Books 2003 ISBN 0 7176 2201 0

- Safe maintenance, repair and cleaning procedures. Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance **L137** HSE Books 2003 ISBN 0 7176 2202 9

Other guidance on flammable substances

- Chemical warehousing: The storage of packaged dangerous substances HSG71 (Second edition) HSE Books 1998 ISBN 0 7176 1484 0
- Energetic and spontaneously combustible substances: Identification and safe handling HSG131 HSE Books 1995 ISBN 0 7176 0893 X
- Fire safety in construction work: Guidance for clients, designers and those managing and carrying out construction work involving significant fire risks HSG168 HSE Books 1997 ISBN 0 7176 1332 1
- Lift trucks in potentially flammable atmospheres HSG113 HSE Books 1996 ISBN 0717607062
- Safe handling of combustible dusts: Precautions against explosions HSG103 (Second edition) HSE Books 2003 ISBN 0 7176 2726 8

- Safe use and handling of flammable liquids HSG140 HSE Books 1996 ISBN 0 7176 0967 7
- The storage of flammable liquids in containers HSG51 (Second edition) HSE Books 1998 ISBN 0 7176 1471 9
- The storage of flammable liquids in tanks HSG176 HSE Books 1998 ISBN 0 7176 1470 0
- The spraying of flammable liquids HSG178 HSE Books 1998 ISBN 0 7176 1483 2

Appendix 1

GAS CYLINDER MINIMUM RECOMMENDED SEPARATION DISTANCES

TYPICAL TYPE OF EXPOSURE (Note 9)	**FEATURES TO BE SEPARATED**	**MINIMUM SEPARATION DISTANCE (Metres)** (Note 1)			
		Inerts, oxidising and CO_2	**Flammable(s)** (Note 11)	**LPG and other liquefiable flammables** (Notes 1 & 2)	**Toxics** (Note 14)
Smoking, naked flames	Storage area	3	3	3	3
Bulk storage of flammable gases and liquids (Note 4)	Storage area	3 (Note 10)	3	3	3
Unprotected electrical equipment	Flammable gases	n/a	3	3	n/a
Site boundaries (Note 13)		1	3	3	3
Air compressors and ventilator intakes (Note 12)	Storage area	3	3 (Note 5)	3	3
Bulk storage of cryogenic liquids (Notes 4 and 7)		1	3	3	1
Transportable cryogenic containers	Bulk storage	1	1	3	1
Building openings, cellars or pits	Other gas cylinders	1 (Note 6)	1	3	3
Pyrophoric gases in separate storage area (Note 3)	Other gas cylinders	2	2	3	2
LPG gases (Note 2 and 8)	Other gas cylinders	3	3	n/a	3
General combustible materials e.g. paper, wood etc.	Storage area	3	3	3	3
Toxic gases in store	Other gas cylinders	1	1	3	n/a

Note 1: In some cases physical partitions or barriers may be used to reduce the required separation distances. Conversely, there may be a requirement to increase the separation distance if storing large quantities and it becomes a requirement of a hazard assessment.

Note 2: This guidance refers to quantities of LPG between 400 - 1000 kg. For quantities outside this range refer to HSE Guidance Note CS4 (5). For quantities between 50 kg - 400 kg the distance can be reduced to 1 metre.

Note 3: Reference shall be made to BCGA Code of Practice CP18 (4) for the requirements for the storage of pyrophoric gases and very toxic gases.

Note 4: Bulk storage of liquid gases are defined as static vessels of a capacity greater than 1000 litres into which product is delivered or bulk flammable gases such as trailer hydrogen.

Note 5: Generally the separation distance is 3 metres but special consideration should be given to the density of gas, e.g. if the gas is lighter than air, consider windows above the storage area.

Note 6: The separation distance for carbon dioxide should be 3 metres as escaping product will be heavier than air and can enter low lying areas or drains.

Note 7: The distances from bulk storage are to be taken from the nearest point of the tank including the filling line or vaporiser.

Note 8: The term LPG includes products such as propane, butane and propylene. For a comprehensive definition see HSE Guidance Note CS4 (5).

Note 9: When siting cylinders near another hazard it is advisable to check that there is no specific legislation concerning that hazard which requires specific measures beyond those stated above.

Note 10: Separation distances for bulk storage of flammable gases and liquids is 3 metres for oxidising gases, e.g. oxygen, and 1 metre for inert gases, e.g. nitrogen.

Note 11: Flammable gases in column 2 refers to permanent gases only (non-liquefiable gases).

Note 12: Storage area shall not be directly below an air intake.

Note 13: The distance from site boundaries is a minimum 1 metre unless protected by a suitable barrier such as a brick or concrete wall, which would offer greater protection than chain fencing.

Note 14: Where flammable toxics are concerned the greater distance (from the Flammables column) shall apply.