UNIVERSITY OF SUSSEX

Safety Procedures & Guidance number 39
Safe Storage of Chemicals in the Laboratory
SPG-39-11

Introduction

The typical science research laboratory is home to a considerable range of chemicals requiring safe storage. The following information offers guidance on the basic principles of safe chemical storage and segregation in the laboratory, where chemicals are used. However, the guidance is not a definitive guide nor is it intended to be exhaustive, and users of chemicals are reminded of the importance of consulting other sources (e.g. specific Material Safety Data Sheets (MSDS)) for more specific and detailed information.

There is a range of storage facilities suitable for chemicals in the laboratory environment. Many of these are expressly designed for the safe storage of specific types of hazardous substances. It is important to understand what substances can be safely stored in which storage container.

Regardless of the type of storage facility being used the following should be followed at all times.

1) All cabinets should be clearly labelled with the appropriate hazard warning sign or signs.

2) The contents should be listed together with maximum quantities on the outside of the cabinet.

3) Shelving provided for storing chemicals should be suitable and fitted to an appropriate standard by a competent person. If you are unsure about correct use of shelving please seek advice. The following principles should be followed in relation to storage on shelves:

- Chemicals should not be stored above shoulder height
- Do not overload shelves – if they are bowed they are overloaded.
- Chemicals should be stored so that they are easily and safely accessible without having to move excessive numbers of other chemicals or risking knocking them off the shelf. As a general rule chemicals should not be stored

more than three rows deep; there should be clear spacing between containers so that labels are easily seen.

- Store breakable containers, particularly of liquids and hazardous chemicals, below shoulder height.
- Store large heavy containers at low level.
- Lips on shelves may be helpful to ensure that chemicals stored on shelves over the centre of the bench, cannot be pushed back and fall off the far side.
- Where shelves are located in circulation areas they should be enclosed.

Types of Specialised Storage Available

Acid Cabinets

These are made of acid resistant materials and bottles should be stored in a plastic tray to contain any leakage or spillage.

Flammable Solvent Cabinets

Only approved fire resistant metal cabinets offering fire resistance of a minimum of 30 minutes to British Standard 476 may be used. Containers must be placed on a metal spill tray which is compatible with the solvents to be stored to contain spillages.

Note: flammable solvent cabinets must not be used to store other solvents or chemicals.

Ventilated Cabinets

These are cabinets fitted with forced ventilation and may be free-standing with their own extract system or positioned beneath a fume cupboard and attached to its duct.

These cabinets are designed to safely store chemicals that give off noxious fumes and smells. These fumes are removed by forced ventilation. They should be used to store materials such as mercaptans and amines that have a strong smell. If you do not have a ventilated cabinet, containers of these noxious chemicals can be stored in sealed secondary containers that should only be opened in a fume cupboard but be aware that previously opened bottles of such chemicals may leak sufficiently for liquid to condense and accumulate in the secondary container.

It should be noted that **fume cupboards** are not designed or intended for the storage of chemicals. Materials stored in fume cabinets may disrupt the airflow resulting in a less efficient fume cabinet and compromising the safety of users.

Fume cupboards may be used for chemical storage only where the fume cupboard is used solely for storage.

Some Basic Principles of Chemical Storage

- **Labelling**. All chemical containers must be appropriately and clearly labelled with the following information:
    - Name of substance
    - Hazard warning sign e.g. corrosive, flammable, oxidising, toxic.

  In situations where there may be very small vessels or sample vials containing hazardous substances, such that individual labelling is not practicable, these should be secured within a secondary container such as a rack or tray which should then be labelled as above.
- **Store like materials with like**: It is essential to segregate incompatible substances to prevent dangerous interactions. All newly purchased chemicals should have a label on them identifying their hazard category (e.g. flammable, corrosive, oxidising, toxic etc.). A list of commonly used chemicals that should be segregated is listed below to assist storage.
- **Store the minimum stock levels of hazardous chemicals in the laboratory**: Don't buy more than is reasonable for the level of use within the laboratory. This is particularly important where flammable solvents are used –see below.
- **Dispose of hazardous chemicals that are no longer required**:
  Regular collections are made of waste chemicals for specialist disposal; if you need assistance in disposing of hazardous waste please ask.
- **Maintain good stock control** and be aware of time-sensitive compounds such as ethers which once opened and exposed to the air can produce peroxides which are highly explosive. Pay particular attention to expiry dates and the date when a bottle is first opened should be clearly shown on the label.
- **Store large breakable containers, particularly of liquids, below shoulder height**
- **Ensure containers and bottle tops are sealed properly to avoid unnecessary leakage of fumes / vapours**

Storage of Different Chemicals

1) Acids and Alkalis

Stocks of concentrated acids and alkalis must be safely stored inside separate suitable cabinets as accidental mixing of concentrated materials will generate large quantities of heat and fumes.

Consideration must be given to the effects of acid fumes on any metal in the fittings and construction of the cabinet. All containers/bottle tops must be suitably sealed to

avoid unnecessary leakage of fumes. Fuming acids, acids chlorides should be stored in ventilated enclosures.

2) Flammable Solvents (those with a flash point below maximum ambient temperature) **- *e.g. methanol, ethanol, toluene, hexane***

Vapour above the liquid represents the main source of danger from flammable liquids. This vapour is can be ignited by naked flames, sparks from electric switches (e.g. thermostats) electric motors or from sparks produced electrostatically by friction. Precautions must therefore be taken to prevent contact between any of these and concentrated vapours of flammable liquids. Fridges used for flammable substances **must** be spark-proof to avoid the possibility of an internal light or thermostat control unit providing a source of ignition should a container containing flammable substances leak or break.

Flammable solvents must be stored in specialised metal flammable solvent containers, clearly labelled and positioned away from doors or other means of escape from the laboratory. As described above these cabinets must meet as a minimum British Standard 476. To reduce the risk of a serious laboratory fire HSE guidance is that no more than 50 litres of flammable solvent may be kept in any one laboratory room. If projects require a larger quantity of flammable solvents to be kept in the laboratory a specific assessment will be required to justify this increased hazard. In this instance higher rated flammable cabinets Type 90 – BS EN 14470-1 must be used for storage. Reasonable quantities of flammable solvents may be kept in the open laboratory in suitable closed vessels of volume not exceeding 500 ml.

Flammable solvents must never be stored with oxidising agents (e.g. hydrogen peroxide, nitric acid), reducing agents (e.g. sodium borohydride, lithium aluminium hydride) and concentrated acids (e.g. hydrochloric and sulphuric acids).

A list of commonly used chemicals which should be segregated is listed below to assist storage. The MSDS should always be consulted if further information is required on storage and chemical incompatibilities of a particular chemical substance.

Peroxide formation A number of laboratory solvents can undergo auto-oxidation under normal storage conditions to form unstable and potentially dangerous peroxide by-products. The following commonly used laboratory solvents can produce organic peroxides that are significantly less volatile than the solvent in which they are formed,

as a result, evaporative concentration or distillation can produce dangerous levels of peroxides.

- diethyl ether,
- 2-propanol or isopropanol
- cyclohexene,
- decalin
- 3-methyl-1 butanol or isoamyl alcohol
- tetrahydrofuran,
- glycol ethers,

These solvents are sufficiently reactive with oxygen that multiple openings of a single container can result in significant and dangerous peroxide concentration. The following precautions should be taken in relation to these materials:

- All peroxide-forming solvents should be stored in brown bottles away from sunlight and heat with tightly secured lids and labelled with dates of receipt and first opening.
- Peroxide-forming solvents should be purchased in limited quantities and older material in inventory should be preferentially selected for use
- All peroxide-forming solvents should be checked for the presence of any peroxides prior to distillation or evaporation.
- Solvents containing low levels of free radical scavengers such as the antioxidant Butylated hydroxytoluene []BHT] should be used whenever the presence of the stabilizing species does not interfere with intended application.
- Uninhibited materials should be stored with care and frequently checked for peroxide formation.
- Peroxide-forming solvents should be purchased in limited quantities and older material in inventory should be preferentially selected for use. Some solvents may contain significant amounts of peroxides after 12 months even if unopened and should be tested after this time.
- Periodic testing to detect peroxides should be performed and recorded on previously opened material.

For further information please follow link:
http://www.sigmaaldrich.com/chemistry/solvents/learning-center/peroxide-formation.html
http://www.docstoc.com/docs/39215789/Standard-for-Storing-and-Using-Peroxidizable-Organic-Chemicals

3) Chlorinated solvents - *e.g. chloroform, dichloromethane, trichlorethylene*

Chlorinated solvents should be stored separately from flammable solvents, preferably in ventilated cabinets; metal bins may be used if ventilated storage is not available. This is because violent reactions can result from the mixing of certain flammable and

chlorinated solvents. They should not be stored with alkali metals such as lithium, potassium or sodium, since any mixing can cause an explosion.

4) **Solvent waste**

It is very important to keep halogenated waste solvents in separate containers from other solvents as they can react violently with some non-halogenated solvents; e.g propanone and trichloromethane. Solvent waste containers must be clearly labelled as to their contents and must be of appropriate material. The quantity of flammable waste solvent stored in fume cupboards or ventilated cabinets should be kept to a minimum. Full containers should be removed to the waste store as soon as possible to minimize the fire load within the laboratory. Don't forget that waste flammable solvents count towards the 50 litre limit.

5) Oxidisers - *e.g. peroxides, perchlorates and nitrates*

Oxidising substances should be stored in a metal cabinet and away from organic matter such as wood and paper and must **never** be stored with flammable solvents, since fires and explosions can result after any spillage, even without a naked flame or heat.

Perchloric acid is an extremely strong oxidising agent (especially in the concentrated form) which can react explosively with organic materials. It should be stored separately on a metal tray of sand within a cabinet, away from organic materials or dehydrating agents such as sulphuric acid.

6) Noxious chemicals

These include materials that are lachrymators, as well as mercaptans and amines which have a strong smell. These can be stored within fume cabinets if in small quantities such that the flow of the cabinet is not disrupted and they are compatible with other procedures that may take place within the cabinet. If you do not have access to storage within a fume cabinet, containers of these noxious materials can be stored in sealed secondary containers which should only be opened in a fume cupboard.

7) Novel /experimental substances.

Where research work involves the synthesis of novel substances, the properties of which are not fully known, the responsible PI must undertake a risk assessment of the likely hazardous properties and hence the precautions that need to be taken. Where

there is doubt the 'precautionary principle' should be applied until such time as the exact properties of the substance have been determined.

8) Poisons, Dangerous drugs and medicines and drug precursors.

Please read this in conjunction with **SPG-09-09**

http://www.sussex.ac.uk/hso/documents/control_of_poisons_regulated_chemical_spg-09-09.pdf

These materials must be stored in a locked cupboard or refrigerator and a list kept of the contents. Access to these chemicals is restricted to authorised persons only. Any poison removed must be signed for and the amount used recorded. It is also good laboratory practice to store other dangerous substances labelled toxic / highly toxic (includes substances that are also carcinogenic / mutagenic / toxic to reproduction) in a locked cupboard, even though they do not appear in Schedule 1. They may stored in the same cabinet as schedule 1 poisons provided that they are compatible. Chemical suppliers should indicate whether a substance is a Schedule 1 poison at the time of purchase and will normally have a special order procedure for such materials.

Incompatible Chemicals

A wide variety of chemicals react dangerously when mixed with certain other materials. Some examples of widely used incompatible chemicals are given below (substance in the left-hand column should not be mixed with substance(s) in right hand column!). These substances should be stored and handled so as to avoid accidental mixing. Please note that the absence of a chemical from the list does not mean that it is necessarily safe to mix it with any other chemical! You should always check with the MSDS if in doubt.

Chemical	Incompatible with
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric acid and sulphuric acid mixtures
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury(e.g., in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)

Ammonium nitrate	Acids, powered metals, flammable liquids, chlorates, nitrites, sulphur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic compounds	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, powered metals, sulphur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol. Alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulphide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic and inorganic)
Cyanides	acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen sulphide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia

Acknowledgement – Geoff Ward and Dr Teresa Knapp 31.03.2011

Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids and gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, and gases
Perchloric acid	Acetic acid, anhydride, bismuth and its alloys, alcohols, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium chlorate	Sulphuric and other acids
Potassium perchlorate (see also chlorates)	Sulphuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulphuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Methanol, ethanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulphides	Acids
Sulphuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metal, such as sodium, lithium)
Tellurides	Reducing agents