Chemical Safety Guidance

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Laboratories using Chemicals:
Infrastructure Recommendations

Occupational Health and Safety Service
HSD085C (rev 1)

UNIVERSITY OF CAMBRIDGE

Contents:

Introduction

This guidance outlines the basic infrastructure requirements expected by the University when operating a Laboratory working with chemicals. Many of the principles will also apply to other areas where chemicals are used. These principles should be applied to new, refurbished or updated laboratories across a range of disciplines. Consideration should also be given to these principles whenever new equipment is purchased for existing laboratories.

All equipment should also comply with the relevant regulations. Wherever there is a relevant British Standard, it must be followed, unless the specifications of alternative equipment exceed that standard.

1. Fabric of the Laboratory

1.1 Floor Covering

Floors should be covered with a 'non-slip' impervious chemically resistant surface such as PVC aka 'vinyl' at least 2.5mm thick. The covering should be coved, by a 'supporting coving' to and up the walls up to a height of 15cm and be contiguous with the floor surface and sealed to the wall. All joints between sheets of floor covering must be welded to prevent possible seepage of spilled chemicals. Any residual crevices should be sealed with a suitable flexible sealant such as silicone. Where alternatives are required, such as tiles in furnace rooms or specialist flooring for liquid nitrogen handling areas it must be appropriate to the work being undertaken and selected with consideration of its chemical resistance and ease of cleaning.

1.2 Walls

Walls should be covered in an impervious water resistant finish such as a good quality vinyl or an oil based eggshell finish, depending on proximity to and nature of likely splashes. Where tiling is to be used around sinks etc it should have a suitable grouting of minimum absorbency. In areas where splashes are likely, consideration should be given to the use of sheet materials such as Perspex, Makrolon, Trespa TopLab^{VERTICAL} or stainless steel etc, as appropriate.

1.3 Worktops / Benchtops

Worktops and benchtops should be constructed of non-absorbent chemically resistant materials. '**Trespa**' is the preferred bench top material in the University. Trespa TopLab^{LAB} has good all round chemical resistance; the alternative product Trespa TopLab^{BASE} has a lower chemical resistance but may be appropriate for many areas, depending on the work envisaged.

Whilst cast epoxy, porcelain or stainless steel can also be used, but both have limitations. Stainless steel is available in a range of grades with differing chemical resistances and the standard '316' grade may not be suitable for all uses.

Benching may require additional reinforcing to support heavy equipment.

1.4 Cupboards and Shelving

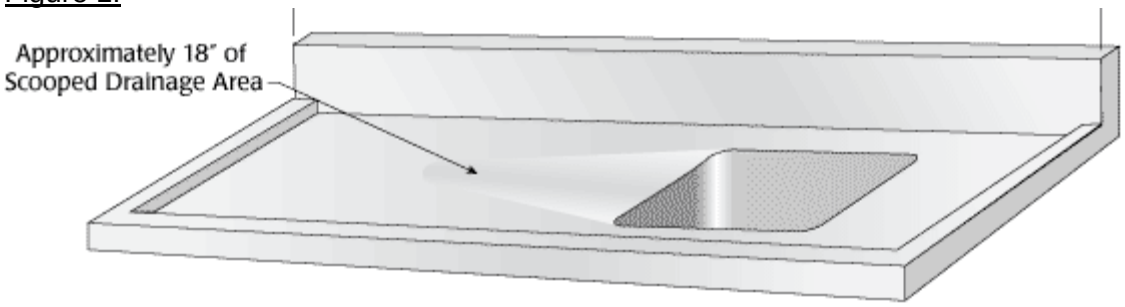
All cupboards and shelving must be suitable for their intended use and as a minimum be covered in an impervious easily cleaned surface. Cupboards intended for the storage of chemicals should be chemically resisting. Where flammable, volatile, fuming or malodorous chemicals are stored in cupboards in laboratories they should be appropriately ventilated by forced ventilation to a safe place outside the building. Cupboards for storing liquid and / or fuming acids should ideally be fully acid resistant. However, fully acid resistant cupboards are very specialised and this 'requirement' may need to be balanced against regular upkeep and replacement of less resistant cupboards than the ideal. Acid resistant drip trays and secondary containment of fuming acids will improve safety and can prolong the lifespan of less than ideal cupboards. Under bench cupboards should be mounted on upstands and be robust enough to withstand the laboratory environment. Domestic grade cupboards will not be appropriate. Wall cupboards above benches should not restrict free access to the bench, nor be mounted so high as to restrict safe access to their highest shelf. Where glass fronted cupboards are used, the glass panels must be a 'safety glass'.

Shelving and its supports must be physically strong enough to support any reasonably foreseeable load that they might have to withstand, both in their inherent structural strength and their wall fixing. Shelving should be easy to access, by an average person, without creating undue risk. Where shelving runs above an island bench with access from both sides, a centre divider/barrier should be built in to prevent items being 'pushed off the back' of a shelf.

1.5 Laboratory Sinks

Laboratory sinks for chemical work should be high quality stainless steel or heavy duty porcelain (aka the 'Belfast Sink') depending on the chemicals used. In many laboratories work with chemicals requires no more than a good quality stainless steels sink. Whilst stainless steel sinks 'inset into Trespa' may have a value in laboratories handling small quantities of low hazard chemicals, the type of sink in figure 1 below would provide better splash and spill protection. Bespoke sinks can have higher splash guards built in to the end(s) as well as the back.

Figure 1:



Again, remember, stainless steel is available in a range of grades with differing chemical resistances and the standard '316' grade may not be suitable for all uses.

Figure 2:

Heavy duty, chemically resisting, porcelain laboratory sinks (aka a 'Belfast Sink') may be slung under Trespa worktops and sealed in place:

Hands-free, elbow operated taps are a good way to avoid contaminating laboratory taps.

1.6 Hand Wash Sinks

Hand wash sinks must be provided close to the entrance / exit of laboratories handling chemicals. This is usually achieved by fitting an appropriate sink just inside the main door. There should be both hot and cold water, preferably supplied by a mixer tap and must have hands-free operation via elbow-operated taps.

1.7 Drains

All drains in laboratories should be complaint with British Standards and of a suitable chemical resisting construction in case of contamination. Vulcathene is the material of choice for all drains in laboratories handling chemicals. Consideration should be given to minimising the number of drains beyond the daily-use sink drains because seldom used drainage points can dry out, allowing foul air to enter the laboratory. Traditionally laboratories were often fitted with bench top taps and small drainage pots aka 'drip-cups', which dry out and have caused recurring problems.

1.8 Laboratory Seating

Laboratory seating should conform to the relevant British Standard including the requirement for 'five' legs / feet to provide stability. All surfaces should be easily cleanable and impervious. Generally vinyl coverings of the seat and back rest will suffice, and no woven fabric should be allowed on the contact surfaces. Tall laboratory chairs for bench work benefit from footrests, and must not be fitted with standard free-wheeling castors, which can cause serious falls. However, castors may be appropriate on standard height chairs used in write-up areas.

Four-legged wooden stools should be avoided and new facilities should not be equipped with them without robust justification. In addition to the ability for wood to absorb chemicals they can be subject to structural failure when the wood ages.
The provision of 'kneeholes' on benches should be adequate to accommodate seating and should not be considered as a convenient location for additional equipment or to store consumables unless the requirement for a kneehole is redundant.
Where a seat cover or structure is damaged, it should be immediately repaired, recovered or replaced.

1.9 Space

A minimum laboratory floor space of $5m^2$ per person should be allowed with at least a 2m linear length of benching per person (in addition to write up space). There should ideally be a 2m separation between the benches, with an absolute minimum of 1.5m.

1.10 Lighting

Lighting should be adequate for the task and DSE compliant. A light level of 300 lux will usually suffice, 500 lux is acceptable but levels above 500 lux are not recommended, unless required for a specific purpose.

1.11 Write-up Areas

Write-up areas should ideally be located outside the laboratory. However where this is impractical and where the level of risk posed by the laboratory work is assessed as 'low', then consideration can be given to suitably segregated write–up areas within the laboratory. Access and egress from write up areas should not involve passing directly through areas assessed as 'high' risk. In either case the almost inevitable provision of Display Screen Equipment (DSE) will require the area to be suitable for its use. Write-up areas outside the laboratory may be carpeted but areas within laboratories must have the same flooring as the laboratory itself. Chemicals should not be stored or used in write-up areas.

1.12 Signage

Laboratory signage at the entrance should be suitable and sufficient to identify the location of the significant hazards present in the area. Where Personal Protective Equipment (PPE) is required in the area this should be indicated at the entrance to the area/room. The signs may need to be able to be changed according to use. In such circumstances they can be kept in a holder so they may be replaced / turned around to indicate the hazards of the work being undertaken or other restrictions at that time. Storage cupboards or fridges should be labelled with wording and symbols (e.g. yellow/black warning triangle with words beneath, although the GHS system may now require certain red and white diamond signs and wording to be used) to indicate if they are used to store hazardous materials such as substances which are toxic, highly flammable, biohazardous, radioactive, corrosive, and/or oxidising.

1.13 Security

Unauthorised access to the laboratory must be prevented. This is ideally done by installing a door that is either accessed by means of a Mifare card (i.e magnetically locked) or by using a key. If neither is a prohibition sign stating 'no unauthorised access' displayed. Lockable cupboards should be used to store regulated poisons (see Safety Office website). A number of other classes of chemicals may also require secure storage e.g. explosives and drugs.

2. Storage

2.1 General Storage

Storage in Laboratories should be limited to that which is required for day-to-day operations and adequate storage areas should be provided for this purpose. It is not appropriate to store excess materials in bench 'knee holes' designed for seating. Should there be a need to discourage storage in a particular location, such as on top of high cupboards, then a barrier should be installed, usually at 45^{o}. Combustible materials must be removed daily. Empty cardboard or polystyrene boxes or packaging should not be accumulated in laboratories as these increase the fire risk in laboratories.

2.2 Chemical Storage

Provision should be made to store general chemicals, either in cupboards or open shelving which is considered appropriate after risk assessment, physically secure and easily/safely accessible to all users i.e. not too high or too far to reach across benches or equipment.

2.2.1 Very Toxic Chemicals

The storage of Regulated Poisons as well as other very toxic chemicals must prevent public access and may require a separate lockable cupboard, depending on the overall level of security in the area.

2.2.2 Corrosive Chemicals

The provision of storage for acids should include consideration of both the liquid and any fume arising from fuming acids such as concentrated nitric acid (which is also an oxidiser). NB: Glacial Acetic Acid is a fuming acid and a flammable liquid, therefore it MUST NOT be stored with any oxidisers, especially fuming oxidising acids such as nitric acid.

2.2.3 Flammable Solvents

Flammable solvents must be stored in appropriate cabinets. Where more than 50 litres of flammable solvent is stored in a room or where the potential for a solvent fuelled fire involves elevated risk to members of the public or irreplaceable infrastructure / objects this should include the provision of fire resisting flammable liquid storage cabinets to BS14470-1. See University Guidance: HSD051C; Storage of Hazardous Chemicals.

2.2.4 Waste Chemicals

There should be suitable, sufficient, safe and appropriate segregated storage for waste chemicals in the laboratory. All classes of chemicals likely to be used should be catered for. However, a system must be established to manage the disposal of chemical waste to prevent it building up to potentially dangerous levels.

2.3 Gas Cylinder Storage

Gas cylinders must be stored in accordance with University guidance. Ideally this would not be directly in the laboratory. Where they need to be located in laboratories the area should include the provision of suitable and sufficient means of keeping gas cylinders physically secure and upright. If there is an elevated risk as the result of a gas having a high hazard rating, e.g. very toxic, pyrophoric, extremely flammable, highly corrosive, then, subject to risk assessment there may be a need for fire resisting gas storage cabinets to BS14470-2.

2.4 Fridges and Freezers

Where Fridges or freezers are installed in laboratories they should be of a 'spark-free' type, having no internal sources of ignition. They should be clearly labelled as 'not for storing food or drink'.

2.5 Personal Protective Equipment (PPE)

There should be suitable and sufficient storage for all Personal Protective Equipment as appropriate to the laboratory. As a minimum this would include clean storage for safety glasses, goggles and face shields, as appropriate. A sufficient number of coat hooks should be provided near the entrance door for laboratory coats. Open storage for lab coats and other flammable materials must never be located in fire exit routes, unless placed in fire resistant cabinets. 'Clean Laboratories' and other specialised areas will have additional requirements for gowning areas and the storage of PPE.

3. Ventilation / Extraction

3.1 General ventilation

All laboratories should have a minimal level of forced mechanical air ventilation / extraction of 6 to 8 air changes per hour. The extraction should run continuously, although an exchange rate of 3 to 4 air changes per hour at night may be acceptable when the laboratory is unoccupied. However, rates below 6 air changes per hour are not usually efficient at producing uniform extraction across a laboratory. The use of externally vented fume cupboards or other externally vented extraction may provide a significant contribution to this requirement. The addition of 'make-up' air into the laboratory must be factored into the laboratory design. Where laboratory ventilation is part of the risk control measures in case of a gas leak or other similar incident, it must be tested by a competent person at least once every 14 months in order to comply with the Control of Substances Hazardous to Health Regulations – therefore easy access for testing must be provided.

Specialist uses, which can include the use or storage of liquid nitrogen may require higher rates of air extraction tailored to the particular risk. For example nitrogen gas arising from liquid nitrogen generally requires low level extraction, whilst helium gas would require high level extraction. In both cases a significant release may also require an elevated level of emergency extraction. Emergency extraction would normally be automatically triggered by sensors/monitors and in addition have a manual activation point.
Air exchange rates are based on the input of 'fresh air' and should not take account of the 'recirculated' air from air conditioning units' or similar.

3.2 Fume and Gases

Fume cupboards are partial containment devices for the control of fume and gases when handling chemicals (for dusts see below). Fume cupboards should be installed wherever significant quantities of flammable solvents are used, to prevent or control flammable atmospheres arising and where significant quantities of volatile toxic chemicals are in use to prevent personal exposures.

Whilst fume cupboards are not perfect, they do generally provide adequate control of fumes and gases in most Laboratory applications.

It is highly recommended that before installing a fume cupboard advice is sort and where possible 'an example' of the proposed cupboard is examined to establish its suitability for the task in hand - a recommendation from another user is always a good idea.

It is highly recommended that fume cupboards are of the type that are externally vented to a safe place outside the laboratory, preferably to a height of at the very least 3m above the roof of the building and at least 5m from any opening back into the building. Where recycling fume cupboards are the only practicable control measure they must be sited appropriately and subject to a rigorous management system.

Fume cupboards must be installed in accordance with British Standard BS EN 14175 (Part 1 to 7 as appropriate).

3.3 Dust and Fine particles

Where dust or fine particles arising from the work are a potential hazard, consideration should be given to installing a HEPA filtered cabinet in the laboratory. These can be particularly useful for handling or weighing powders of carcinogens, mutagens or reproductive toxins as well as a range on nanomaterials. Most applications of HEPA filtered 'dust' cabinets in laboratories will involve recirculating the air back into the laboratory and should therefore be subject to a rigorous management system.

4. Services

4.1 Water

The provision of water for the laboratory should include an adequate supply of fresh mains potable water for eye was stations and safety showers where a need for these is identified by risk assessment. Whist emergency drench showers are no longer standard equipment in all laboratories they should be considered as part of the risk assessment when designing a laboratory space. Where emergency drench showers are installed appropriate floor drainage must be provided and appropriate system put in place for weekly testing of showers for prevention of risks from Legionella build up.

4.2 Electricity

At the very least there should be enough switchable socket outlets to allow for each item of equipment to be plugged in separately. In addition there should be a reasonable number of 'spare' switchable sockets at regular intervals around the laboratory **to avoid the need to use extension leads with multi-sockets** (HSD174P on S.O. website). The sockets should be mounted above bench level at the rear of the worktop, but still allow ease of access to sockets around large items of equipment to enable isolation of the equipment. The same considerations apply to data points in labs. Pendant fittings may also be possible, but can introduce their own hazards. Mounting sockets on the cupboard framework below the front of worktops is best avoided, as it results in trailing leads up across the bench and the sockets can be exposed to liquid spills. Metal framework for benches used with live electrical apparatus must be earthed and cross-bonded.

The electrical supply should be provided with a residual current device (RCD) located and easily accessible within the laboratory, with its safe operation regularly tested.
Socket outlets located in 'wet' environments or in positions where they may get splashed should be to at least IP54 rating. However, having all power points within a laboratory fitted with these hinged sockets with spring loaded covers, may be undesirable and can introduce other hazards e.g. plug-in transformers would require extension leads.

Consideration should be given to a central isolation point close to the door (which if necessary could exclude certain sockets such as those supplying critical equipment e.g. fridges, freezers). This isolation point could be a mushroom-headed emergency isolation button; protecting this isolator with a suitable 'shroud' reduces the chance of inadvertent operation. These isolators can be key-operated switches, which are useful for controlling access to equipment requiring specialist training in order to be operated safely e.g. high speed (ultra) centrifuges in laboratories or pillar drills in workshops.

When installing an electrical supply to a laboratory or extending an existing supply, care should be taken to ensure electrical phases are not mixed on a bench run. This is to avoid the possibility of two adjacent items being connected to different 'phases' which would increase the consequences of an electric shock if it involved more than one phase.

5. Emergency Provisions

5.1 Eyewash

Eyewash bottles within the laboratory may be acceptable for many laboratory activities provided only relatively small quantities of corrosive or other hazardous materials are being handled. However, it is often desirable that at least one eyewash (plumbed-in to a fresh water supply) is located somewhere in the laboratory so that an extended period of irrigation of fifteen minutes or more would be possible.

5.2 First Aid

Dependent upon Departmental procedures, first aid equipment should be provided in a safe, easily accessible location.

5.3 Spill Kits

Dependent upon Departmental procedures, spill kits appropriate to the intended work should be provided. The exact requirement would be identified by risk assessment of the work to be carried out in the area.

5.4 Fire Extinguishing Equipment

Provision of extinguishers will be determined by the fire risk assessment but provision of fire points at strategic locations in corridors rather than widespread distribution of extinguishers across each laboratory is now best practice. An exception might be the provision of a specialist fire extinguisher for a specific hazard, e.g. a metal powder fire extinguisher close to a unique hazard.

UNIVERSITY OF CAMBRIDGE

Safety Office
Greenwich House
Madingley Road
Cambridge
CB3 0TX

Tel: 01223 333301
Fax: 01223 330256
safety@admin.cam.ac.uk
www.safety.admin.cam.ac.uk/

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