School Science Architecture Special Report Part Three: The Chemicals Store

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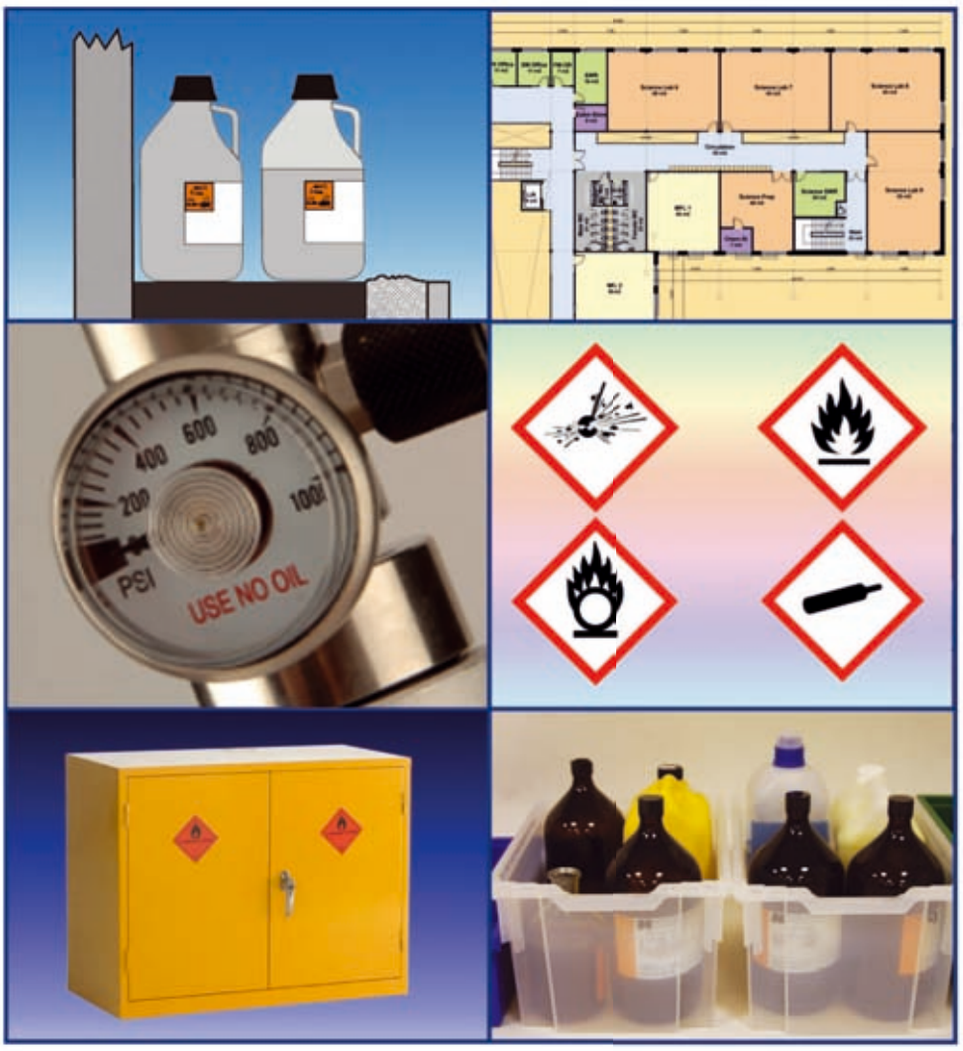

The Chemicals Store

Design of storage accommodation for chemicals in School Science Departments

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Design of storage accommodation for chemicals in School Science Departments

Published by Gratnells Ltd and Timstar Ltd

Written by Andy Piggott, Independent Science Education Consultant specialising in lab design and science health and safety.

Gratnells are manufacturers of tray storage systems, for equipment and chemicals.
Timstar are suppliers of laboratory and educational products and services, including chemicals.

Both Gratnells and Timstar have wide experience of chemicals and the associated problems with their storage in schools, especially where school specifications and design have not matched the national guidance for chemical stores. Gratnells and Timstar have therefore joined forces to present the following Special Report as a guide for architects, technicians, teachers and others involved with the design of new school buildings or the refurbishment of existing buildings.

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Gratnells Ltd, 8 Howard Way, Harlow, Essex CM20 2SU
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Timstar Laboratory Supplies Ltd, Timstar House, Marshfield Bank, Crewe, Cheshire CW2 8UY
T: 01270 250459 **F:** 01270 250601 **E:** sales@timstar.co.uk **W:** www.timstar.co.uk

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About the Author
Andy Piggott is an Independent Science Consultant, specialising in lab design and science health and safety. He is also Lead Tutor, Lab Design, future science accommodation for teaching and learning, National Science Learning Centre (*www.sciencelearningcentres.org.uk*) and previously Project Officer for the Laboratory Design for Teaching and Learning project (*www.ase.org.uk/resources/lab-design*).

Andy Piggott
APEC Educational Consultancy
71 Field Way
Chalfont St Peter
Gerrards Cross
Buckinghamshire
SL9 9SQ
Tel: 01753 885222
Email: andy.piggott@btinternet.com
www.andy-piggott.co.uk

GHS01 (Explosive)

GHS02 (Flammable)

GHS03 (Oxidising)

GHS04 (Gas under pressure)

GHS05 (Corrosive)

GHS06 (Acutely toxic)

GHS07 (Moderate hazard)

GHS08 (Health hazards)

GHS09 (Hazardous to the aquatic environment)

Reproduced with permission from CLEAPSS leaflet GL 101: An introduction to GHS / CLP chemical hazard labelling (01/13). Note: The text under each symbol has been adapted by CLEAPSS (www.cleapss.org.uk). It is intended to help users understand the nature of the hazard. It is not intended to replace the official hazard statements.

Adopting the new GHS-CLP hazard warning labelling system, Timstar have updated all its safety sheets to complement this and they are easily accessible from the Timstar website (*www.timstar.co.uk*).

Introduction

A school science department requires a Chemicals Store; that is, a secure room, equipped to hold the stock of hazardous chemicals.

The Home Office has recently issued guidance: *SYC, Secure Your Chemicals, Education*, written in collaboration with the HSE, CLEAPSS, and SSERC. This emphasises management responsibilities regarding the purchase, storage, use and disposal of hazardous chemicals. Indeed, it goes so far as to instruct that missing 'chemicals of security concern', or 'suspicious behaviour relating to such chemicals' must be reported to the local police and, if appropriate, to an Anti-Terrorist Hotline.

While schools hold only small amounts of hazardous chemicals (compared to research or industry), they do hold a wide variety of chemicals, thus enabling them to present stimulating demonstrations, experiments and projects for pupils. For schools teaching post-16, the range of chemicals will be wider still. Procedures for storing, using, and disposing of chemicals are all bound up with the siting and design of the Chemicals Store.

This guide assumes that dispensing of chemicals is accomplished in the Prep Room, in an area adjacent to the chemicals store. There is no dispensing within the store as the store is for the storage of chemicals only.

It should be possible to store all chemicals in the Chemicals Store; including flammables, oxidising agents, corrosives and toxics. There is no need for separate cupboards; when amounts are small, they are all kept on shelves within the Chemicals Store, which is kept secure. Science departments who use tray sets of small bottles of stock solutions might consider keeping these in the chemical store as well; the store would have to be big enough to contain the necessary racking.

However, there are two sets of 'chemicals' that need to be stored securely, away from the Chemicals Store and away from each other. These are radioactive sources (*see Appendix 1*) and gas cylinders (see *Appendix 2*).

'A separate, secure storeroom for hazardous chemicals is essential. It should open into the Prep Room and be separately ventilated.'

Site of the Chemicals Store

This should be a room opening directly into the main central Prep Room (or the chemistry Prep Room if separate), close by the dispensing area and Prep Room fume cupboard.

Figure A shows a typical layout within a science suite, taken from the DfE's Baseline Design Type 1, EFA, 2012.

Figure B shows the layout of a main central Prep Room, taken from *BB80, Fig 3/2, Science accommodation in Secondary Schools, DfES, 2004*. Note that this chemicals store has a floor area ≥10m^2 and is intended to serve seven laboratories.

There should be easy access to the central Prep Room, and hence to the chemicals store, for deliveries of hazardous materials (e.g. chemicals and gas cylinders). This access should be separate from pupil circulation areas where at all possible; it should at least be possible to make it secure during deliveries.

■ *Figure A: Typical layout within a science suite*

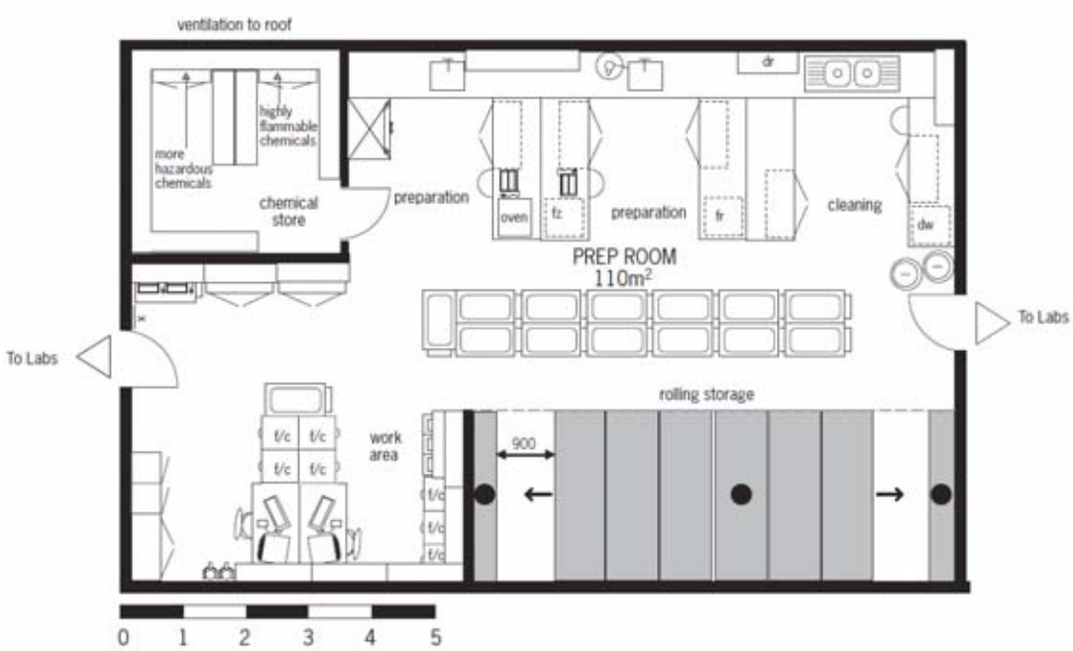


Figure B. Layout of a main central Prep Room

'All stores should be easily accessible from the Prep Room(s) and the laboratories.'

Solar gain

If possible, the store should have an outside wall as this makes ventilation easier and helps with cooling if the wall is not exposed to the sun (i.e. a North facing wall, certainly not a South facing one).

Equally, the store should not be sited under a flat roof, which would invite further solar gain.

Design of the room itself

Floor area

This should be > 6m^2 for a small secondary school teaching 11-16, > 10m^2 for a school of around 1000 pupils, larger still for schools teaching post-16 students and/or with more pupils.

Construction of walls / floors / ceiling

Fire resistance should be a minimum of 30 minutes, with the building materials being concrete, brick, concrete blocks, or similar. Stud-work partitioning is not sufficient.

False ceilings often have voids above the ceiling that are common with adjacent rooms, especially in older buildings. The walls must be fully fire-stopped (above the ceiling) to prevent the spread of fumes, smoke and flames.

'The Prep Room itself should have secure locks (with turn-buckles on the inside) to enhance security of chemicals (and ensure security of radioactive sources and gas cylinders).'

Voids under the floor are also a problem; ducts that carry services and are common right across many rooms and/or corridors. The floor of the chemicals store must be carefully sealed from such voids in order to prevent leaks of liquids, fumes or smoke travelling throughout the building.

Door

The door should be > 30 minute fire resistant and open outwards into the central Prep Room: Type D8, *Technical Annex to Area Data Sheets, DfE, 2013*. There should be a vision panel to enable monitoring of anyone working in the store.

For security the lock should be unique and have a known number of keys, allocated to a strictly limited number of authorised staff. For safety, the lock should enable emergency egress without a key (e.g. with a turn-buckle on the inside)

The Prep Room itself should also have secure locks (with turn-buckles on the inside) to enhance security of chemicals (and ensure security of radioactive sources and gas cylinders).

'Three principles can be applied to help provide safe storage of laboratory chemicals:
• Segregation
• Separation
• Ventilation'
– NERC guidance on safe storage of laboratory chemicals

Floor and Containment

The surface of the floor should be sealed at the edges, impermeable to water, chemically resistant and non-slip.

To contain spills, the floor should slope slightly to the back or centre of the store so that spills pool inside the store. Drains should not be installed, as this would allow spills of hazardous chemicals to enter the drainage system.

The main concern for industry and research laboratories is 'containment' of hazardous chemicals following breakage or spillage.

Schools, however, do not store large quantities of chemicals, and sudden destruction of all containers in the store is very unlikely. A more likely scenario would be a 'Winchester' (2.5 litre) dropping on another and breaking both. This would give a spill of 5 litres and a spill depth of just 1mm in a store of floor area $6m^2$!

A sill across the doorway to create a bund capable of taking all the containers spilled at once is therefore NOT needed; indeed it would create a trip hazard potentially far more dangerous than a spill.

Fittings and Furniture

Shelves

Shelves, for bottles and packets of chemicals, should be fixed to the walls with a structure tailor-made from wood or Spur brackets (metal brackets with paint or epoxy coating to reduce corrosion). The shelves themselves should be made of corrosion resistant material – wood being the best; securely fastened to the wood structure / Spur brackets.

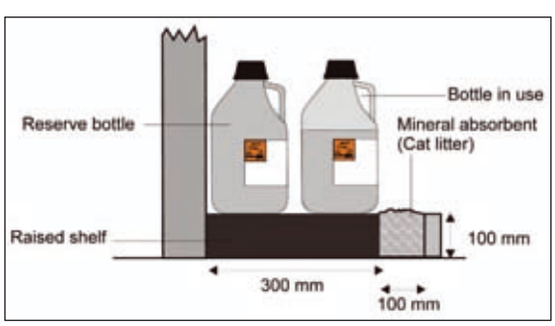
Lips to the shelf edges are inadvisable. Shelf depths should be kept small, ~ 150mm, to ensure that packets and bottles are not stacked more than two deep.

Bulk chemicals (school-standard 'bulk')

Bulk containers, such as Winchesters, should be stored on the floor to prevent spills affecting people handling them.

This can be done by using deep plastic trays, which provide for flexible arrangements, or a more permanent plinth (or raised shelf) with a channel around it filled with inert, absorbent material.

Chemical containers in plastic trays



Plinth (raised shelf) with channel

■ *Gratnells Treble Chemical Storage Set*

Trays

Where trays containing bottles of stock solutions are in use, and the store is big enough, there should be racks for these trays inside the store. Racks are generally made of metal and should be well painted or epoxy coated.

The racks should be of dimensions that suit the trays in use in the science department.

Flammables cupboard(s)

There is a limit of 50 litres of highly flammable liquids stored inside; a sufficient limit for school science departments.

These flammables should be stored in a metal cabinet, sited inside the Chemicals Store, away from the door so as not to impede exit in case of emergency. The cabinet should have 30 minutes fire integrity and be able to contain spills.

■ *Flammables cupboards from Timstar*

Timstar provide these cupboards in a variety of dimensions to suit the space requirement in the chemical storage room. They are manufactured in sheet steel with welded seams.

Electrical equipment

The light switch should be outside the room. Good ventilation and the small amounts of flammables in storage mean that spark-proofing of lights is not needed.

There should be no other electrical equipment in the store; no power sockets, no switchboards – nothing.

'There should be no other electrical equipment in the store; no power sockets, no switchboards – nothing.'

Temperature

The temperature inside the Chemicals Store should be kept within a usual range 10°C - 25°C, although a maximum of 30°C is unlikely to cause problems.

Heat from surrounding rooms should keep the minimum temperature up, while maximum temperatures are kept down by ventilation systems and by reducing solar gain.

There should be no heating pipes or heating devices within the store itself.

Ventilation

Ventilation rate

The ventilation rate for storage should be > 2 ach (air changes per hour); see BB101, Ventilation in School Buildings.

However, if it is planned that someone works in the store for any length of time (i.e. more than just going in to fetch or return material) then boost ventilation is required, to achieve a working rate of > 5 ach.

The default position is to specify mechanical ventilation. Such ventilation should be quiet in operation to avoid acoustic stress on persons working or living nearby; < 65dB at 300mm from the motor, or < 40dB ambient noise levels in the Prep Room or labs adjoining the store.

‘Clean vents and check the rate of air extraction regularly (at least once per year and possibly more frequently).’
– CLEAPSS

‘Fan(s) should be outside the building in order that negative pressure is maintained within the ducting.’

Extraction

Extract points should be placed at both low and high levels, as the majority of fumes involved are heavier than air.

Operation should either be 24/7, or regular operation controlled by an automatic timer; with options for boost as required. Operation 24/7 is likely to require less powerful fans, which will be quieter in operation and less expensive to install. Auto-timed fans are also liable to people ‘fiddling’ with the timer and reducing the ventilation to lower than 2 ach.

Systems that rely solely on manual switches operated to a schedule are not sufficient because it is difficult to ensure the continuity of ventilation over weekends and holidays.

Make-up air

Provision of make-up air is essential to the ventilation design. Pathways for the make-up air and the balance between it and the extraction rate are important.

Modern building-design features such as double-glazing and tightly fitting fire doors can restrict the provision of make-up air. Where the atmosphere is totally ‘managed’, with windows that cannot be opened, design for provision of make-up air is critical.

The temperature of make-up air is also important; high temperatures could add to problems of over-heating.

Ducting and fan(s)

Ducting should roughly follow the guidance for fume cupboards (see BB88, Fume Cupboards in Schools). That is, the ducting route should be as direct as possible, with horizontal runs kept to a minimum, with ‘no adverse falls where condensate might collect’.

Fan(s) should be outside the building in order that negative pressure is maintained within the ducting. Failure of ducting under positive pressure would spray contents back into the store or building.

Discharge

Fume discharge should also parallel BB88 guidance, with fumes discharged vertically at > 1m above the highest point of the building.

Prevailing winds, natural downdraughts, and eddies caused by interaction with neighbouring buildings, should also be taken into account in order to prevent fumes re-entering the science building or entering other buildings nearby.

The discharge point should also be planned in relation to other discharge points and sited away from air inlets on the same or adjacent buildings.

Not required!

It is important that the following are NOT involved in the design, construction, fitting out or use of the Chemicals Store in schools.

- Drain(s) in the floor
- Holes in the walls due to (former) pipes, poor construction work, etc
- Voids common to neighbouring rooms (e.g. above false ceilings or through service ducts)
- Heating pipes, gas pipes, water pipes
- Electrical sockets, switchboards, apparatus
- Toxics (Poisons) cupboard
- Corrosives cupboard
- Sill across the doorway
- Window(s)
- Outdoors chemical storage

Appendix 1

Radioactive sources - storage

See: *Managing Ionising Radiations and Radioactive Substances in Schools and Colleges, Guide L93, CLEAPSS, 2013.* Schools in Scotland have similar advice from SSERC.

■ *Radioactive cupboard from Timstar. Dimension: 380mm x 380mm x 380mm.*

Radioactive sources should be stored separately from gas cylinders, flammables and corrosives; that is, not in the Chemicals Store, nor near the gas cylinders.

Sources are stored in a small, secure, metal cabinet. This cabinet should be bolted to a wall or the floor in a secure area, more than 2m (ranges to more than 3m in Scotland) away from anywhere where a person works for long periods. The school's RPO (*Radiation Protection Officer*) or RPA (*Radiation Protection Adviser*) should approve the cabinet and its positioning.

Ideally, the cabinet should be sited in a separate, secure store that is used for science apparatus, stationery, or similar. If the central Prep Room is large enough, the 2m (or 3m) limit may be satisfied in a remote corner. The secure store or Prep Room should only be accessible by science staff.

Appendix 2

Gas cylinders – storage

Science departments should only keep one cylinder of each type of gas. This is therefore a 'ready-use' cylinder and is kept inside the department.

There should be no need for a science department to keep more than one of each type of gas and therefore require an outside cylinder store. (The Design and Technology department may, however, require such outside storage).

Gas cylinders should be kept separately from radioactive sources, flammables and corrosives. Therefore, they are not to be placed in the Chemicals Store, nor near the radioactives' cabinet.

The store place should be cool (not next to a radiator) and out of direct sunlight. Cylinders should either be chained to special-purpose trolleys or directly to the wall.

Overnight storage should always be in the same place, known to premises personnel so that they can inform the Fire Brigade in the event of a fire.

■ *Gas cylinder trolley with securing chain*
Photo courtesy AJ Products (UK) Ltd: www.ajproducts.co.uk

■ *Gas cylinders with wall fixing brackets and securing straps*
Photo courtesy UniMac: www.unimac.co.uk

Further advice for those concerned with school building/refits

Architects working on designs for schools can access further advice from these sources:

For schools in England, Wales, and Northern Ireland:
CLEAPSS – *www.cleapss.org.uk* (the school should be a member of CLEAPSS)

For schools in Scotland:
SSERC – *www.sserc.org.uk* (the school should be a member of SSERC)

References:

SYC - *Secure Your Chemicals*, *Education*, Home Office, 2012

Designing and Planning Laboratories, Guide G14, CLEAPSS, 2009

Managing Ionising Radiations and Radioactive Substances in Schools and Colleges, Guide L93, CLEAPSS, 2013

Area Data Sheets and Technical Annex, Building and Design Team, Education Funding Agency, DfE, 2012/3 (in preparation)

Baseline Design, Type 1, Building and Design Team, Education Funding Agency, DfE, 2012

Science Accommodation in Secondary Schools, Building Bulletin 80, DfE, 2004

Fume cupboards in Schools, Building Bulletin 88, DfE, 1998

Ventilation of School Buildings, Building Bulletin 101, DfE, 2006

Notes

Gratnells has been supplying integrated science storage system to schools worldwide for over thirty years. Our frames hold different depths of strong, sturdy trays, and our tray inserts ensure safe handling of laboratory materials and equipment. We also have a range of trolleys which enables safe transportation from the Prep Room to the Science Lab.

If you would like to know more about how Gratnells can help you design the perfect School Science Lab and/or Prep Room, using our FREE GratCAD sofware, which contains 2D and 3D modelling for AutoCAD*, Autodesk 3ds Max* and most other ACIS*-based modelling programs, then call us on **01279 401550**. We also offer consultancy and assistance in implementing School Science Lab and Prep Room storage areas.

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Timstar Laboratory Supplies Ltd, Timstar House, Marshfield Bank, Crewe, Cheshire CW2 8UY
T: 01270 250459 **F:** 01270 250601 **E:** sales@timstar.co.uk **W:** www.timstar.co.uk

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