Chemical storage in Science

Summary

Chemicals for science experiments are usually located in a chemical store, in prep room(s) and in student laboratories. Bulk chemicals which are classified as Dangerous Goods (DGs) should be kept in a chemical store, segregated by DG Class with, as a minimum, Flammable Liquids (Class 3) and Corrosives (Class 8) stored in dedicated cabinets. A chemical store should be constructed from durable materials, arranged in an ergonomic manner and ventilated to prevent accumulation of toxic or flammable vapours. Stored chemicals should have the full GHS labelling if in their original containers. The minimum quantity of flammable liquids should be kept in a chemical store. Extraction fan(s) and lighting should be spark-proof, if flammable liquids are present. Generally, chemicals that are not DGs should not be stored in a chemical store. Prep rooms should hold the minimum quantities of DGs; they may conveniently store the numerous containers of aqueous solutions and non-DG solids for class use. Student laboratories should hold only those chemicals required for immediately forthcoming experiments, in minimum quantities, arranged ergonomically for ease of access and minimum chance of spillage. Chemicals in prep rooms and in laboratories are considered “in use”, so should be labelled according to GHS, if decanted or transferred from an original container. A register must be kept of all Hazardous Chemicals in the chemical store and in any other storage locations, and the register must be updated regularly.

Contents

Introduction

This document provides advice regarding the safe storage of chemicals in a chemical store, in prep rooms and in student laboratories in schools. In every jurisdiction, chemical storage in a chemical store is regulated by Dangerous Goods (DG) legislation, and chemicals "in use" in prep rooms and laboratories are regulated by the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

The concept of "Dangerous Goods" was developed to allow safe transport of chemicals within and between countries. The dangers considered are principally those related to transport, and effects of spillage or other release from chemical containers. The definitions and provisions for Dangerous Goods are almost the same in every country. A "Dangerous Good" is defined as a chemical belonging to a long and internationally standardized list, e.g. Australian Dangerous Goods Code, 2024, Edition 7.9. Due to the focus on dangers during transport, many chemicals which pose health hazards or environmental hazards are not considered to be Dangerous Goods. Storage of chemicals is regarded as an intermediate stage of transport, since chemicals will commonly be stockpiled in warehouses during their travels. This is why the storage of chemicals in a chemical store is regulated by Dangerous Goods legislation.

The GHS was developed for a different purpose: the protection of people from harm when using chemicals. The GHS establishes criteria for different types of physical hazards, health hazards and environmental hazards, as well as labelling requirements and safety data sheets, so that people can be aware of hazards. A chemical or mixture of chemicals that satisfies one or more of the hazard criteria of the GHS is defined as a "Hazardous Chemical". All Dangerous Goods are Hazardous Chemicals, but many other chemicals or chemical mixtures which are not Dangerous Goods are defined in the GHS as Hazardous Chemicals.

Dangerous Goods are classified into nine Classes and a number of Subclasses (see Appendix 1), with legislated requirements for adequate packaging, segregation of Classes and separation distances between reactive Classes. Large quantities of Dangerous Goods may pose serious dangers. Above certain quantities, known as "placarding quantities", special signage must be erected to warn of their presence. Above even greater quantities, known as "manifest quantities", the relevant safe work authority and emergency services must be notified. Science departments usually hold only small amounts of chemicals, below "placarding quantities" and are considered to represent "minor storage".

Hazardous Chemicals are assessed for a wider range of properties than Dangerous Goods The GHS provides criteria for different degrees of acute toxicity, skin corrosion/irritation, serious eye damage/irritation, respiratory or skin sensitisation, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity (single exposure and repeated exposure), aspiration hazard, hazardous to the aquatic environment and hazardous to the ozone layer (https://unece.org/transport/dangerous-goods/ghs-rev11-2025). The classification of a chemical according to the GHS rules may result in one or more hazard statements for the chemical which, in turn, results in pictogram(s) and a signal word. Whereas the list of Dangerous Goods is nearly static, the hazards posed by hazardous chemicals are regularly reviewed and updated as new data become available.

Labelling according to GHS is required for all chemical containers everywhere. Original containers of chemicals will be labelled by the supplier with full GHS details, including signal

word, pictogram(s), hazard statement(s) and precautionary statements. When a chemical is transferred or decanted from an original container into a small jar or bottle for use in a prep room or in a laboratory, it is usually not possible to include all the details of the original label, since the surface of the container is too small. Legislation allows abbreviated information to be placed on the container, provided it is written in English, includes the name of the chemical and either pictogram(s) or hazard statement(s).

A list of the Hazardous Chemicals held in each storage area of a school, known variously as a "hazardous chemicals register" (in Australia) or an "inventory of hazardous substances" (in New Zealand) or a "hazardous products inventory" (in Canada), is required by law, and must be updated regularly. Exact requirements vary with jurisdiction, but usually include the name of the chemical, its quantity, Dangerous Goods Class and SDS. This information is crucial for emergency services in the event of a fire or other incident.

Chemical store

Every school science department needs a safe location, a chemical store, where bulk quantities of Dangerous Goods can be held safely, to supply day-to-day chemicals needed for experiments conducted in student laboratories (Figure 1).

Minimum quantities of Dangerous Goods should be held in a chemical store. This is especially critical for Flammable Liquids (Class 3), since ignition of flammable liquids has caused the greatest number of personal injuries and building fires in schools. After flammable liquids, Corrosive Substances (Class 8), especially mineral acids and ammonia solution, pose the greatest hazards for eye, lung and skin damage. Solids which release flammable gases on contact with water (Class 4.3) should be stored in a dry location, preferably in a cabinet or ventilated box. Oxidizing substances (Class 5) should be kept away from combustible materials, but the small quantities stored in schools should not pose a significant hazard in the event of a fire. Radioactive material (Class 7) in a school has very low activity and can be stored at any secure location. The most numerous Dangerous Goods in schools are Toxic Substances (Class 6.1); these generally pose few storage issues. Chemicals that are not Dangerous Goods do not need to be kept in a chemical store.

Location

The chemical store should be near the preparation room, ideally in a concrete "bunker". It should have no windows or skylight, and no flammable materials should be used in its construction. The chemical store should be sufficiently large to accommodate all the required chemicals, with segregation between the Dangerous Goods classes. New school buildings should be designed with a dedicated chemical store.

Door

The door MUST allow easy exit from the store and MUST open outwards. On the outside, the door must be lockable, but the lock must never be able to prevent opening from the inside. The door should be fire-rated, so that a fire could be contained readily within the store without spreading to other parts of the building. The door must be locked at all times when school staff are not using the chemical store. Only authorised staff should have access to a chemical store.

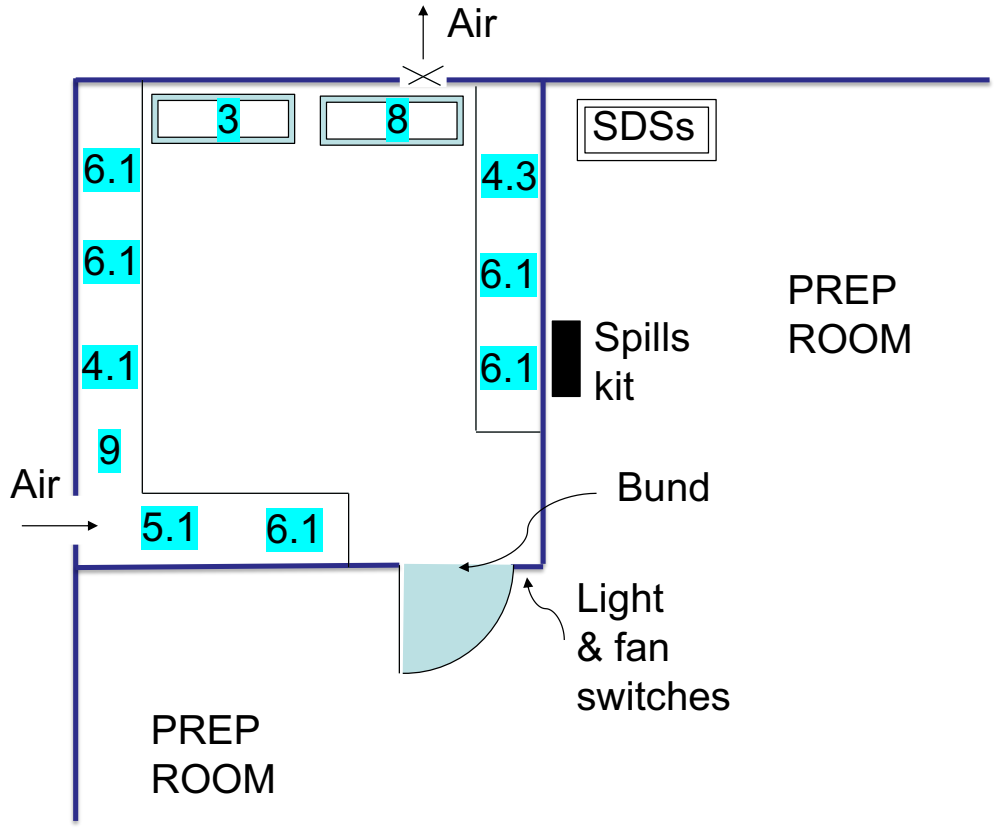

***Figure 1**: Example of a chemical store.*
Numbers in blue refer to Dangerous Goods Classes or Subclasses.

Bund

A bund is a containment around an area where hazardous liquids are handled, processed or stored. A bund around the floor of a chemical store is helpful in case of spillage of chemicals, to prevent liquid running beneath the door into an adjoining room (especially for flammable or corrosive liquids). The bund should be ramped on either side of the door, to avoid a trip hazard. It is usually possible to install a bund around an existing chemical store; a new chemical store should be designed with a bund.

Lighting

Ensure adequate lighting, so that you can easily see to work. Since there should be no windows or skylight in a chemical store, lighting must be provided artificially. All lighting MUST be spark-proof if any flammable liquids are stored, in case of spillage or breakage of bottles. Light switches can be located outside the store (and therefore need not be spark-proof).

Shelving

Shelving should be non-flammable and not readily subject to corrosion by acidic vapours. Steel shelving usually corrodes rapidly, and wooden shelving can burn in a fire. Plastics, such as PVC, produce highly toxic fumes containing chlorinated aromatic compounds in a fire.

Wood does not swell in contact with organic liquids, so is preferable to plastics or laminates. The best materials are bricks/mortar (for supports), compressed fibre cement sheet (for shelves) and tiles (for surfaces); such materials are expensive, but durable.

Ventilation

Ensure good ventilation for a chemical store. Sometimes, this is possible by natural means, e.g. gaps left in brickwork that is sheltered outside from the rain. Usually, a fan is required. Typically, national standards require the fan to have a capacity of 0.3 m^3/min for each m^2 of floor space, or 5 m^3/min, whichever is greater. The fan MUST be spark-proof if any flammable liquids are stored, in case of spillage of liquid or breakage of bottles. In the event of a spill/breakage, vapour will be drawn to the fan. A spark from the motor of a non-spark-proof fan may ignite the vapour, which will burn back, igniting the spilt liquid on the floor, creating a fireball. A spark-proof fan is expensive but has long-lasting bearings and a motor that can run continuously, making it more economical (as well as safer) than domestic fans. Consider where the air flow will come from. There should be no hole(s) in the walls or door of a chemical store that communicate with the prep room or any other room. Air should be drawn into the chemical store from outside the building and enter the store at a location remote from the extraction fan, so that fresh air sweeps through the chemical store.
There should be no significant odour in a chemical store:

> ***If you can smell chemicals in a chemical store, ventilation is inadequate and/or lids are leaking vapour!***

Electrical equipment

No electrical equipment, including spark-proof fridges (which are only spark-proof on the inside!) should be kept in a chemical store. No power outlets should be present in a chemical store, since they might encourage use of electrical equipment or cause electric shock to emergency workers if a foam fire extinguisher is used on a flammable liquid fire.

Layout

Cabinets for Flammable Liquids (Class 3) and Corrosives (Class 8) should be located furthest from the door, so that it is possible to escape in case of spillage or fire. A small cabinet or box for solids which release flammable gases on contact with water (Class 4.2) should be located away from the flammable liquids cabinet and remote from the door. Oxidising substances should be located away from both Class 3 and Class 4 chemicals. Toxic chemicals (Class 6.1) may be placed wherever convenient.

Shelves should be marked to indicate the Class of chemicals that they hold and it is a good idea to mark shelves to indicate the places where particular chemicals (or types of chemicals) are stored, so that they can always be returned there; a storage diagram is also helpful. Secondary containment, such as trays or ceramic dishes, may be useful for toxic or corrosive chemicals, in case of leakage.

Ergonomics

Store liquids below solids, since this minimises the chance of containers of liquids being dropped from a height and smashing on the floor. Large containers (>1 L or 1 kg) should be

kept within 1 m of the floor. It is unwise to keep any containers above chest height (~1.5 m), since it becomes difficult to grasp above this height, increasing the chance of dropping containers. Consider carefully how the store will be used, and arrange storage of heavy items between knee and shoulder height, preferably around waist height. Consider access and heights of trollies used to carry chemicals.

Segregation

Some Classes of chemicals react violently with others if mixed together. For instance, Oxidants (Class 5) may explode if mixed with Flammable Liquids (Class 3) or Flammable solids (Class 4). Within a Class, chemicals are regarded as "compatible", meaning that they do not react with each other. Different Classes of chemicals are usually "incompatible", meaning that some members of one Class may react with some members of the other. Even if chemical Classes are compatible, it is good to separate them, so that a spill or fire affecting one does not affect the other. Information about incompatible chemicals is given in SDSs, in compatibility tables, and in software such as RiskAssess.

Chemicals must be segregated according to Dangerous Goods Class. Within each Class, it is acceptable - and even a good idea - to store chemicals alphabetically. However, alphabetical storage of all chemicals is not permitted by law, since adjoining chemicals may be incompatible. Store flammable liquids (Class 3) in a Flammable Liquids cabinet. Store corrosive chemicals (Class 8) in a Corrosives cabinet. Special storage is required for flammable solids that release flammable gases in contact with water (Class 4.3), such as sodium metal; usually, only small quantities are kept in a school and a ventilated box (to stop spilled water) in a dry location is sufficient (away from water/pipes). Cabinets for storage of Class 4.3 chemicals are available but are usually far larger than required for the small quantities held in schools. Subclasses 4.1, 4.2 and 4.3 should be segregated, not stored together, or stored with flammable liquids. Only small quantities of oxidizing substances (Class 5.1) are kept in schools; these should be segregated and kept away from flammable materials. Flammable solids (Class 4.1) should be segregated, away from oxidizing substances (Class 5). Most chemicals in a store will be toxic chemicals (Class 6) and can be stored, as convenient, after the other Classes have been positioned.

A separation distance of 3 m is generally required between Classes of incompatible chemicals, with no exemption for minor quantities (less than the placarding quantity). This is difficult to achieve in most school chemical stores, due to their small size. Ease of egress in case of an emergency is more important than adhering to separation distances. The Flammable Liquids cabinet and the Corrosives cabinet should be as far from the door as possible, even if less than 3 m apart. Segregation in a chemical store can be enhanced by use of further cabinets, if the quantities of chemicals justify them, or by use of secondary containment such as plastic tubs and glass/ceramic dishes for small quantities of substances.

Incompatible chemicals should never be stored above each other, and liquids of any kind should not be stored above solids. Chemicals should not be stored on the floor, due to the possibility of liquid spills.

A Dangerous Good may have more than one dangerous property, the second one being known as a subsidiary risk, e.g. acetic acid (Class 8/3), hydrogen peroxide (Class 5.1/8), nitric acid (Class 8/5.1). Such chemicals are usually stored according to the first-listed Class, but the

subsidiary risk should be noted and, if possible, should also be taken into account in storage as far as possible.

The term "manufactured product" is used to refer to a chemical mixture which contains a large proportion of flammable liquids and at least 10% wt/wt solid material. Examples are paints, varnishes, lacquers, polishes and adhesives. Manufactured products should be stored with Class 3 flammable liquids in a Flammable Liquids cabinet. Provided they are in their original containers, they are not counted in Class 3 quantities for the purposes of placarding or notification to a safety authority.

Storage advice for Classes of Dangerous Goods

A dedicated storage cabinet for each Class or Subclass of Dangerous Goods is the ideal. In practice, science departments store small (or zero) quantities of chemicals in some Classes. It is common practice to store different Classes of Dangerous Goods in segregated areas of a chemical store, as far as practical from incompatible chemicals. This may not comply with legally mandated separation distances which are designed for industrial sites, but is generally considered low risk in a school situation. However, significant quantities of flammable liquids and corrosive substances are usually held in a school's chemical store. For these two classes, dedicated storage cabinets that meet the relevant national Standards are essential.

Class 3: Flammable Liquids cabinet
Store flammable liquids in a Flammable Liquids cabinet, with a bund at the bottom large enough to hold 25% of the maximum volume of liquid in the cabinet if the bottles were to break (e.g. in a fire). The cabinet should be approved by the national Standards Association.

Class 8: Corrosives cabinet
Corrosive liquids, such as hydrochloric acid and nitric acid, release acidic vapours which rapidly corrode the interior of steel Corrosives cabinets. It is best to purchase plastic cabinets, since they are much more durable. A Corrosives cabinet should have a bund at the bottom large enough to hold 25% the liquid in the cabinet if the bottles were to break (e.g. in a fire). If ammonia solution is stored in the same Corrosives cabinet as hydrochloric acid, an encrustation of ammonium chloride slowly forms inside the cabinet, by reaction of HCl and NH_3 vapours. It is best to store acidic and alkaline corrosives in separate cabinets, if space permits. Ensure that the lids of bottles containing volatile corrosive liquids are securely tightened.

Hydrochloric acid and ammonia are usually delivered in plastic containers. This makes breakage of the container less likely if the bottle is dropped, and a cracked plastic container will leak more slowly than a smashed glass container. Nitric and sulfuric acids are stored in glass containers, since the acids attack most plastics. These acids should best be purchased in glass containers with a layer of plastic on the outside. If dropped and broken, these containers will only leak acid slowly, making escape from the area by school staff easier (and cleanup less hazardous).

Other Classes:

Class 1: Explosives
Explosives are not normally stored in a school.

Class 2: Gases
Gases are stored under compression in cylinders (e.g. O_2) or as liquids in Dewars (e.g. N_2). Gas cylinders should be chained upright and a key to the main valve should be readily available, so that the cylinder can be turned off in case of emergency. Cryogenic liquids in Dewars require good ventilation to disperse the gases being continuously released and require special handling procedures. Only carbon dioxide is stored in solid form (dry ice) and is classified as Class 9. Do not travel in a lift with toxic gases, liquid nitrogen or dry ice!

Class 4: Flammable solids
Flammable solids (Class 4.1), such as sulfur, in the small quantities stored in schools, should be stored on shelves separately from other Classes, without special precautions.
Spontaneously flammable solids (Class 4.2), such as white phosphorus, are rarely stored in schools. They require special preservation, e.g., white phosphorus is stored under water.
Solids that release flammable gases with water (Class 4.3), such as sodium metal stored under oil, can be kept in a dedicated cabinet or a ventilated box. The small quantities stored in schools generally do not warrant a dedicated cabinet.

Class 5: Oxidizing substances
Oxidizing agents (Class 5.1), e.g. metal nitrates and metal salts of other oxidizing anions, are the most common chemicals in this Class. They should be segregated and kept away from flammable materials but, otherwise, require no special storage, due to the small quantities held and their thermal stability at room temperature.
Only tiny amounts of organic peroxides (Class 5.2), e.g., benzoyl peroxide, are generally stored. They are likely to degrade slowly at room temperature but can be cheaply replaced. A few chemicals are best kept at a temperature below room temperature. If the chemical is flammable or is a solution in a flammable solvent (e.g. organic peroxide dissolved in a ketone solvent), a spark-proof fridge MUST be used to prevent possible explosion of the air/vapour volume of the fridge. A spark-proof fridge should not be placed in a chemical store, but at some location away from people. Never put a flammable solvent in a domestic refrigerator!

Hydrogen peroxide solutions (Class 5.1) contain a stabilizer (e.g., hydroquinone) and degrade slowly over years at room temperature; they do not need to be kept in a fridge. They are also cheap to replace. Do not fully tighten the lid of a hydrogen peroxide bottle (so that oxygen gas can escape). A plastic bottle is the safest for storing hydrogen peroxide solution, since it can deform if there is a buildup of pressure.

Class 6: Toxic and infectious substances
Toxic substances (Class 6.1) are the most abundant Dangerous Goods in schools. They require no special precautions for storage.

Class 7: Radioactive substances
Radioactive sources (alpha, beta, gamma) are usually of very low intensity and can be safely stored in any secure location. They should not usually be kept in a chemical store, due to possible corrosion.

Class 9: Miscellaneous dangerous substances and articles
This Class includes miscellaneous items such as dry ice (solid CO_2) and aerosol sprays. Dry ice continuously releases CO_2 gas and should be stored in a location with good ventilation; it requires special precautions during handling.

Housekeeping

Chemicals should arrive in boxes with Dangerous Goods labelling on the outside. Containers inside the box should be fully labelled according to GHS. If this is not the case, reject the shipment and contact the supplier. Chemicals may be kept in their original boxes, but should not be kept for any significant period on the ground, as water spillage or rain could soak and weaken the cardboard packaging, making more likely the breakage of chemical containers within. Usually, containers will be unpacked from original boxes for easier storage within or near the chemical store. The containers should be placed in the correct storage location in the chemical store, according to their Dangerous Goods classification. GHS rules require no other labelling except that of the GHS, so the Dangerous Goods Class will not be shown on individual containers.

It is a good idea to write the date received with a marker pen on each new chemical bottle; this is especially important for substances (e.g. peroxides) which degrade on storage.

Do not store chemicals (e.g. dilute aqueous solutions) that are not classified as Dangerous Goods in the chemical store, unless there is sufficient room. Remember that these chemicals can be stored at any other location, provided it is secure. Never store chemicals in a food refrigerator!

Most of the smell of chemicals in a chemical store is due to leakage of vapour around lid seals. **Ensure that lids of volatile acids and volatile organic chemicals are tightened after use.** If you are not strong enough to tighten lids sufficiently, ask someone (stronger) to help you! Lids of chemicals should be checked regularly to see that none have cracked or are inadequately tightened. **Do not tighten fully the lids of substances that release gases during storage.** These substances include Class 4.3 chemicals (e.g., lithium, sodium, calcium, potassium, calcium carbide), hydrogen peroxide and organic peroxides, cryogenic liquids (e.g., liquid nitrogen) and solid carbon dioxide (dry ice).

Special attention should be given to chemicals which have extremely hazardous properties and need to be stored under special conditions, e.g., sodium metal under oil, white phosphorus under water. Containers of such substances should be checked every few months. No containers should protrude over the edge of a shelf.

The “lifetime” of a chemical is usually determined by the lid. Lids crack and crumble over time, due to heat, light and atmospheric ozone. Most chemicals are stable indefinitely, but evaporation, ingress of moisture and air, and contamination with fragments of degraded lid materials limit their effective lifetime.

Safety data sheets

By law, a safety data sheet (SDS) from the manufacturer/supplier should be “available” for every chemical in a chemical store. The SDS contains information about dealing with spills, chemical in the eyes or the on skin, and advice on first aid. The term “available’ is not defined in legislation; it would be determined by a court of law, on the basis of what could be reasonably expected. If a SDS for a chemical can be located within 1 minute, it is likely that a court would consider it “available”; if it took 10 minutes, probably a court would not. SDSs can be stored alphabetically as paper copies near the chemical store. Alternatively, they can be stored electronically but must be available very quickly. We recommend they are available

from at least two devices, for redundancy. For example, you could have all SDSs downloaded on a computer hard drive and also have them available from phones using a mobile network (e.g., in Cloud storage or in an online chemical register accessible via QR Code). We recommend you regularly test that SDSs are available in approximately 1 minute, including logging into systems if required. Activities involving chemicals should not take place if SDSs are not available.

Safety shower, eyewash station, spills kit and fire extinguisher

A safety shower and eyewash station should be located near the chemical store, in case of spillage, breakage or splashing of a chemical on skin or into the eye.

Keep a spills kit outside the chemical store. In the event of a spill, you should retreat from the spill, outside the store, decide what to do and - only if it is safe – return to the store to deal with the spill. The best absorbent to keep in a spills kit is bentonite clay, available cheaply as "kitty litter" (check carefully the contents, since not all "kitty litter" contains bentonite clay!). Bentonite can be spread on flammable liquid spills to prevent further spread, soak up the liquid and, if a dry layer is on top, the escape of vapour is greatly reduced. Bentonite clay can also be used on acid spills, since it does not react with concentrated acids.

In the event of a fire, it is best to close the fireproof door to restrict air to the fire and call emergency services. If safely possible, also turn off the extraction fan, since it moves air into the store. Do not attempt to use a fire extinguisher in a chemical store. Leave extinguishing a fire to equipped and trained emergency staff!

Prep room

Numerous operations involving chemicals are carried out in a prep room. Chemicals are taken from the chemical store and transferred or decanted into small containers for use by students in laboratories, and chemicals are used to prepare (mostly) aqueous solutions for use in laboratories. Chemicals and solutions are returned from laboratories to the prep room, along with a variety of chemical wastes, collected during classes in waste containers. This means that prep rooms hold large containers of chemicals in their original packaging, small containers of chemicals and solutions for laboratory use, and a variety of waste containers.

Prep rooms should be locked at all times when school staff are not present, to prevent unauthorized access by students or others.

Chemical storage

Chemicals from the chemical store in original packaging should already be labelled correctly according to GHS. Secondary containers of solid and liquid chemicals for use in laboratories must be labelled correctly, following the requirements for labelling of decanted or transferred hazardous chemicals in the Code of Practice for your jurisdiction. Containers of chemical wastes must also be labelled in a manner appropriate to their contents, in accordance with GHS.

Minimum quantities of chemicals in original containers should be kept in the prep room. As far as practical, containers of Dangerous Goods should be returned to the chemical store as

soon as the need for them has passed. Avoid storage of chemicals in strong sunlight or in hot locations in the prep room, since this may degrade the tops of bottles and encourage evaporation of volatile substances.

Small containers of decanted or transferred hazardous chemicals may be refilled and stored in the prep room, provided their contents are not classified as Dangerous Goods; otherwise, they should be kept in the appropriate location for the Class in the chemical store. Hazardous chemicals stored in a prep room should be recorded in the chemical register.

NEVER use food containers for storage of chemicals, since this increases the likelihood that someone will mistake a hazardous chemical for a harmless foodstuff. NEVER place a chemical in a refrigerator used for food.

Flammable liquids

Flammable liquids should be treated with respect at all times when being handled.
Many people have received horrific burns as a result of the ignition of flammable liquids.
No ignition sources near flammable liquids!
No conventional light fittings, fans, fridges, electric-element heaters, gas-fired heaters, power points, switches, or any other ignition sources . . . should be near flammable liquids, either stored or in use!

Chemical waste handling

Chemical wastes usually have the same hazardous properties as the original chemicals. Flammable liquid wastes should be stored in a flammable liquids cabinet while awaiting collection (or treatment). Chemical waste containers should have a GHS-compliant label and, it is recommended, a further label upon which can be written by hand the details of each waste added to the container.

Safety data sheets

Paper copies of SDSs may be conveniently stored in the prep room in alphabetical order, for inclusion of the relevant ones in kits sent to labs for each experiment. Alphabetical tags attached to SDSs may make it easier to find and return SDSs to the library. Since SDSs in laboratories may be damaged during use, it is advisable to keep electronic copies available for reprinting as required.

Laboratories

Minimum quantities of chemicals should be kept in student laboratories, usually only those chemicals which are required for the immediately forthcoming classes.

Students should only have access to chemicals in a laboratory during classes. At all times when school staff are not present in the laboratory, laboratory door(s) should be locked.

Ergonomics

Good ergonomics will help reduce spillage of chemicals, breakage of containers, and general injuries. Consider the number of students who will require access to a chemical at any time and arrange student groups and chemical containers so that crowding and collision of students with each other is minimised. Chemicals on benches should be placed well back from the edge of the bench, with good spacing between bottles or trays of bottles to reduce congestion.

Labelling

All chemicals in science laboratories should be labelled correctly according to GHS. Bottles in original containers should come from the manufacturer/supplier with full GHS labelling and require no further labelling. Small containers of decanted or transferred hazardous chemicals should be labelled according to legal requirements: chemical name and either pictogram(s) or hazard statements, as a minimum. Small containers with abbreviated GHS labelling can be organised on trays or in special holders, with more complete GHS labelling displayed on a sign supported vertically at the back of the tray/holder. Commonly, only pictograms are displayed on small containers; full hazard statements can be displayed on the sign, helping to make students more aware of potential hazards.

Chemical waste containers

Separate containers should be available for all chemical wastes which cannot be safely poured down the drain or thrown into the garbage. Typically, a waste container will be an empty chemical bottle (e.g. hydrochloric acid) which has been washed, its label removed, and a funnel placed in its mouth. Waste containers should be labelled according to GHS for their expected contents. Separate waste containers should be available, as required, for acid waste, alkaline waste, non-halogenated organic waste, fluorinated, chlorinated, brominated and iodinated organic wastes, for solutions containing each of the heavy metals (Cu, Ni, Co, Pb . . . .) and for solutions containing anions such as chromate, bromide and iodide. Waste containers for volatile substances (e.g. hydrocarbons, alcohols, ketones) should be kept in a fume cupboard or in a well-ventilated area, remote from ignition sources. Segregation of wastes permits recycling, saves money for the school, and helps to train students in environmental responsibility.

Safety data sheets

SDSs for all chemicals used in the lab should be available to students. The most common way to arrange this is to include paper copies of SDSs in the kit supplied to the lab for the student experiments. Paper copies can be conveniently stored in the prep room.

Help from RiskAssess!

RiskAssess can help with many aspects of chemical storage:

Identification of Dangerous Goods
First of all, to store a chemical correctly, you need to know if it is classified as a Dangerous Good. This is shown on the external packaging (usually cardboard box) when the chemical arrives at the school, but this information is lost when the box is unpacked. Dangerous Goods Class is not shown on the GHS label of individual bottles (according to GHS rules). However, you can quickly use the chemical search in RiskAssess to find summary information about the chemical, including its Dangerous Goods Class, if any. Chemicals that are not Dangerous Goods do not need to be kept in a chemical store.

Standard handling procedures
Chemicals that pose special issues for storage (e.g., hydrogen peroxide, sodium metal) are indicated in the Standard Handling Procedures section of the chemical search, with advice about best practices.

Understanding potential hazards
The summary information for a chemical in RiskAssess will alert you to particular hazards and offer advice to avoid injuries. This is valuable not just when using chemicals, but also when arranging their storage, so that incompatible chemicals are not put together.

Labelling of chemicals according to GHS
Chemicals in original containers should be labelled in full according to GHS and require no further labelling. However, as soon as the chemical is decanted or transferred to another container for student use, a GHS-compliant label must be affixed. Hundreds of containers need to be labelled correctly for student use in a typical school. RiskAssess provides a labelling module to create GHS-compliant labels for more than 3000 chemicals and solutions quickly (under 1 minute for a page of labels). With custom labels, it is possible to prepare labels for any chemical mixture that is not in the chemical database (e.g., non-aqueous solutions, special reagents) or for any commercial product (just copy information provided in its SDS).

Labelling of chemical wastes
Chemical wastes need to be labelled according to GHS, to ensure their safe storage. To help with this, RiskAssess provides large standard labels for 25 common chemical wastes. These labels are suitable for most wastes generated in school laboratories, but others can be easily created using custom labelling, if required.

Chemical inventory and chemical register with SDS management
By law, a register must be maintained of all hazardous chemicals stored in a school. This has usually been done with a variety of spreadsheets or using software designed for the broader chemical industry. The next release of RiskAssess will include a system designed for schools which includes a chemical inventory (in which you can record any chemical, track SDSs and see RiskAssess safety information), and a hazardous chemicals register which is automatically loaded from your inventory, showing only the hazardous chemicals. Emergency services or school staff can rapidly access the hazardous chemicals register via a QR Code (no login required). It is expected that this system will simplify the management of chemical storage in schools.

APPENDIX 1
Classification of Dangerous Goods according to Classes

Class 1 Explosive substances and articles
Class 2 Gases
- 2.1 Flammable gases
- 2.2 Non-flammable, non-toxic gases
- 2.3 Toxic gases

Class 3 Flammable liquids
Class 4 Flammable solids
- 4.1 Flammable solids, self-reactive substances, polymerizing substances and solid desensitized explosives
- 4.2 Substances liable to spontaneous combustion
- 4.3 Substances which, in contact with water, emit flammable gases

Class 5 Oxidizing substances and organic peroxides
- 5.1 Oxidizing substances
- 5.2 Organic peroxides

Class 6 Toxic and infectious substances
- 6.1 Toxic substances
- 6.2 Infectious substances

Class 7 Radioactive material
Class 8 Corrosive substances
Class 9 Miscellaneous dangerous substances and articles