Science ASSIST Information Sheet

Chemical Storage

Introduction

This information sheet is an updated review of the answers to the following questions, and replaces the previously published Q&As:

- What is the legal requirement for the temperature and the humidity for a chemical storeroom?
- Where can I find up-to-date regulations for chemical stores in schools?
- Where can I find up-to-date regulations for chemical stores setups/designs in schools?

In Brief

There is no one single reference that provides all the information required to address these issues. Some requirements are set by regulation, such as those in the various building codes and relevant Australian/ New Zealand Standards. These are of a general application and are not specific to, but include, school science areas.

Others apply to science chemical storage and laboratory areas, again without specific application to school science teaching areas. Other recommendations arise from consideration of good practice based on past experience, a knowledge of the nature of school science teaching and risk assessment processes. Any proposed design would then be a combination of regulated requirements and best practice considerations. The Science ASSIST team recommend greater national agreement and consistency in addressing these issues, hence the current Science ASSIST project.

At present, when it comes to the construction of new or upgraded science teaching areas, various educational jurisdictions around Australia have policies that have both similarities and differences in addressing the perceived requirements. We recognise that there are many facilities of earlier construction that would not meet current standards and which should be upgraded as a matter of priority.

Basic features of a school science chemical store room

In a secondary school setting, the storage of chemicals must be facilitated as follows:

- **A dedicated chemical storeroom** (sometimes referred to as a “chemical bunker”) is a dedicated storeroom just for chemicals, which is not to be a shared space with other functions such as computer workstations, desks, or office space. Chemicals should not be stored in an area which is also a workstation for staff such as school science technicians and teachers.
- **Access, egress and security:** A chemical storeroom will commonly have just one door. This must be locked to prevent unauthorised access. The door must open outwards, and must be able to be opened from inside without the use of a key. See also a previous question: *number of exit doors in labs and prep rooms*.[1]

- **Services and ignition sources:** If flammable liquids are stored, the chemical storeroom must be fitted with spark-proof lighting with the switch located outside the room. There should be no electrical fittings such power points located within the room, as these constitute ignition sources. There must be no ignition source within 3 metres, measured laterally, of stored flammable liquids. *(AS 1940:2017; section 4.9.7).*
- **Ventilation:** Chemical storerooms should be fitted with powered extractive ventilation. This can be achieved with an air inlet grille in or adjacent to the door, and the exhaust vent situated near floor level at the opposite end of the room. The system shall have a capacity of 0.3 cubic metres per minute for each square metre of floor space, or 5 cubic metres per minute, whichever is greater. *(AS/NZS 2243.10.2004; section 4.5.5).*[2] Suitable ventilation is effective in greatly reducing the incidences of chemical sensitivity and allergic responses suffered by school science technicians. See also the information sheet regarding ventilation: *Chemical Storage (ventilation).*
- **Suitable cupboards/shelving:** These must be compatible with the chemicals stored. Corrosion resistant laminate is commonly used. Particle board or similar is not recommended. *(AS/NZS 2243.10.2004; sections 3.4 and 4.5.2).*
- **Suitable size:** The chemical storeroom must be large enough for the planned purpose, and to include adequate storage facilities for both the quantity and range of the substances to be stored.
- **Segregation of incompatible chemicals:** The chemical storeroom must allow for the appropriate segregation and storage of incompatible chemical classes, so that in the event of an accidental spillage, the opportunity for incompatible chemicals to mix and react is eliminated. Though recognising the new GHS chemical classification system, existing practice is based on the Australian Dangerous Goods Code classes as given below:

This will usually require the segregation of the following chemical classes:

- Class 2: Flammable Gases
- Class 3: Flammable Liquids
- Class 4.1 Flammable Solids
- Class 4.2 Spontaneously Combustibles
- Class 4.3 Dangerous When Wet
- Class 5 Oxidising agents
- Class 8 Corrosives

Safety data sheets

The Safety Data Sheet for the chemical, plus the container label, should be consulted for optimal storage conditions of individual chemicals. The SDS will tell you if you need to store the chemical at a specific temperature.

The following sections of an SDS are relevant.

Section 7: Handling & Storage – Provides guidance on safe handling and storage including the chemical's unique properties and possible incompatibilities with other chemicals in the store.

Section 9: Physical and Chemical Properties – Describes the physical and chemical properties of the chemical e.g., melting point, boiling point, flash point, etc.

Section 10: Stability and Reactivity - Provides information on the stability of an individual chemical under ambient storage and handling conditions, plus conditions to avoid e.g., temperature, pressure or other stresses that may compromise its properties.

Safe Work Australia has developed the 'Managing risks of hazardous chemicals in the workplace code of practice'. You should check with your local work health and safety regulator to ascertain if this model Code of Practice has been approved in your jurisdiction. Safe Work Australia [3]

Your attention is drawn to Chapter 4 "Controlling Risks":

> *"Keeping hazardous chemicals stable*
>
> *Work Health and Safety Regulation 356*
>
> *A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that hazardous chemicals do not become unstable, decompose or change so as to create a hazard different to the hazard originally created by the hazardous chemical, or significantly increase the risk associated with any hazard in relation to the hazardous chemical.*
>
> *To keep hazardous chemicals stable, you should:*

- *follow manufacturer's instructions or instructions on the SDS;*
- *keep the hazardous chemicals within any control temperature range where necessary;*
- *keep the hazardous chemical and the packaging dry, unless the packages themselves are impervious to moisture."*

Temperature

The stability or deterioration of a chemical is influenced by the environment in which it is stored. Chemicals should be stored segregated from incompatible chemicals in a well-ventilated, cool and dry location. It is recommended to avoid exposure of chemicals to heat, direct sunlight and ignition sources.[4]

Many chemicals are affected by either high or low temperature, some react with or absorb moisture from the atmosphere, some degrade with light exposure, some produce uncontrolled decomposition with a change in pressure, others are air sensitive and require storage beneath a liquid or an inert atmosphere. Acetic acid, for example, has a freezing point of approximately 17°C and can freeze in an unheated room. Additionally, 2-methyl-2-propanol (tert-Butyl alcohol) freezes at about 24°C. As these chemicals freeze, a glass container will expand and can crack. If freezing occurs, thaw gently in a warm water bath. There is no standard range for any of these environmental conditions that apply to all chemicals.

An important environmental aspect of safe chemical storage is to ensure that chemicals are kept at an appropriate temperature all year round. For some chemicals, this may also include controlling temperature levels so that chemicals are stored within the range specified by the manufacturer.

AS 2243.10 states:

> *"Substances which are unstable at ambient temperature shall be kept in a controlled temperature environment set to maintain an appropriate temperature range."*[2]

If the temperature goes outside these limits the chemical may be affected so that it: becomes unusable, undergoes changes in its composition, reaches its autoignition range, or becomes otherwise hazardous. It is generally recommended to keep the temperature in a chemical storeroom as stable as possible.

There is no legal requirement to keep a chemical storeroom at a particular temperature. However, there is a legal obligation to store chemicals in a safe manner. AS/NZS 2243.1:2021 'Safety in laboratories – planning and operational aspects'[5] recommends that in a (working) laboratory, any heating or cooling

system provided should be designed to maintain a temperature of 22+/- 2°C, except where another temperature is required for the equipment or chemicals stored.

Determining a safe storage temperature

The appropriate chemical storeroom temperature range depends on the nature of the chemicals stored within. To determine an appropriate storage temperature range, a risk assessment should be conducted, beginning with the identification of the hazards of the stored chemicals. Particular consideration should be given to chemicals such as organic peroxides, volatile flammable substances and oxidising agents (NB: Science ASSIST does not recommend the use of organic peroxides in schools).

It is essential to consult the Safety Data Sheet (SDS) for a chemical and its container label for specific storage requirements including any specific temperature conditions. The relevant sections of the SDS include:

- Section 7: Handling & Storage,
- Section 9: Physical & Chemical Properties, and
- Section 10: Stability and Reactivity.

Chemicals that degrade or become unstable under certain conditions should be regularly monitored to ensure their quality and stability.[6]

To maintain the quality of chemicals and their containers, it is important to store them within a consistent, narrow temperature range and for many chemicals, to avoid high storage temperatures. Due to the wide variety of chemicals stored in schools, each with its own ideal storage conditions, it is difficult to choose a storage temperature range that works well for all the chemicals in the storeroom. Taking into consideration the large variation in climate conditions in Australia, and the nature of the chemicals stored in schools, Science ASSIST recommends:

- maintaining the chemical storeroom temperature below 30 °C and at a consistent cool temperature, with the average ambient temperature being within the range 10–24 °C;
- climate control systems be considered to maintain ambient temperatures where a chemical storeroom experiences:
    - temperatures which are **consistently** at or above 30 °C or,
    - temperatures which are consistently low, and which adversely affect the quality, physical characteristics and/or performance of a particular chemical or chemicals.

Problems with fluctuations to high temperatures

Some chemicals, if stored in hot conditions or at temperatures above their recommended temperature range, are at risk of becoming degraded, unstable, more volatile, potentially dangerous and unusable. Examples include:

- the rate of decomposition of hydrogen peroxide increases with temperature. Storage in a vented container is necessary to prevent the increased pressure in the container due to the build-up of oxygen;
- increased vaporisation of flammable liquids at higher temperatures, which may lead to the build of pressure in containers, may cause an inhalation hazard or may lead to the formation of a combustible atmosphere;
- the rate of peroxide formation increases with temperature in peroxidisable chemicals;

- the rate of absorption of CO_2 by hydroxides increases with temperature;
- organic peroxides can undergo self-accelerating decomposition if exposed to heat;
- the viscosity of liquids is also generally decreased with an increase in temperature;
- many oxidisers combust or decompose explosively on exposure to intense heat and contamination (with combustible material), which may lower the decomposition temperature

Problems with fluctuations to low temperatures

Some chemicals, if kept below their recommended temperature range, are at risk of freezing, becoming difficult to handle, or even unstable. If the chemical freezes, it may expand and possibly cause its container to split or crack. Examples include:

- glacial acetic acid, which freezes below 16 °C;
- *tert*-Butyl alcohol, which has a melting point around 25 °C, and may need to be warmed in cool weather before use;
- some liquids may become too viscous to work with;
- if peroxidisable liquids are stored below the melting point of their peroxide, the peroxide may freeze, thus increasing its sensitivity to heat and friction.

Providing temperature control for stored chemicals

In Australia, there is a wide variation in climate conditions between different geographical regions. If schools are located in regions that **consistently** experience low or high temperatures, then consideration should be given to providing heating or cooling to achieve a consistent ambient temperature range in the chemical store. Generally, but not always, chemical storerooms are located within the science building in schools and are not likely to be subject to the extremes of the outside temperature.

There are several ways to control the temperature levels for chemical storage.

- Provide extractive ventilation within the store by local exhaust or mechanical means. Ventilation minimises the build-up of any heat and therefore provides a safer working atmosphere by keeping any concentrations of hazardous vapours, fumes etc. within allowable limits.
- Consider the use of spark-proof refrigerators for certain chemicals.
- If logistically feasible, and room permits, relocate the chemical store to a cool, dry environment in another part of the school.
- The installation of a commercial, spark-free, temperature-control product designed for chemical stores.

Segregation in different jurisdictions

Chemical segregation is currently achieved in different jurisdictions and sites in two different ways, or by a combination of these. In some states, such as South Australia, segregation of incompatible chemical classes is by way of dedicated storage units for Flammables (Classes 3, 4.1, 4.3), Spontaneously Combustibles (Class 4.2), Oxidisers (Class 5), and Corrosives (Class 8), with the latter including further segregation of incompatibles such as acids and alkalis. In other states, such as Western Australia, segregation is commonly achieved through “vertical segregation”, with measures to ensure that incompatible classes are well separated, and that no chemical is stored above any incompatible substance. It is noted that, for the purposes of storage and segregation and because of the relatively small quantities involved, school science chemical storage areas will normally be classified as “minor storage”. The greater segregation distances that apply to large stored quantities would not apply to schools.

Standards in this document

Standards Australia. 2017. AS 1940:2017 *The storage and handling of flammable and combustible liquids*. Sydney, Australia.

Standards Australia. 2004. AS/NZS2243.10:2004 *Safety in Laboratories – Storage of chemicals*, Standards Australia; Sydney.

Standards Australia. 2021. AS/NZS 2243.1:2021 *Safety in laboratories Part 1: Planning and Operational Aspects.* Standards Australia: Sydney

References

[1] Science ASSIST website, (2023), '*Number of exit doors in labs and prep rooms',* retrieved from https://assist.asta.edu.au/question/2699/number-exit-doors-labs-and-prep-rooms

[2] This extract is from AS/NZS 2243.10:2004, '*Safety in Laboratories, 'Storage of chemicals','* Reproduced by ASTA with the permission of Standards Australia Limited under licence CLF1222asta. Copyright in AS/NZS 2243.10:2004 vests in Standards Australia [and Standards New Zealand]. Users must not copy or reuse this work without the permission of Standards Australia or the copyright owner.

[3] Safe Work Australia website, (2020, July), '*Managing risks of hazardous chemicals in the workplace – Code of Practice July 2020'*, retrieved from https://www.safeworkaustralia.gov.au/doc/model-code-practice-managing-risks-hazardous-chemicals-workplace

[4] Queensland Government, Department of Education website, (2022, March 29), '*Chemical management procedure*' version1.1, retrieved from https://ppr.qed.qld.gov.au/pp/chemical-management-procedure

[5] Standards Australia website, (2021) AS/NZS 2243.1:2021 *Safety in laboratories Part 1: Planning and Operational Aspects.* Standards Australia: Sydney. Reproduced by ASTA with the permission of Standards Australia Limited under licence CLF1222asta. Copyright in AS/NZS 2243.1:2021 vests in Standards Australia [and Standards New Zealand]. Users must not copy or reuse this work without the permission of Standards Australia or the copyright owner.

[6] Storemasta website, (2023, March 13), '*Dangerous goods management for laboratories',* retrieved from https://blog.storemasta.com.au/dangerous-goods-management-for-laboratories

Other resources

Worksafe Victoria website, (2022, November), '*Code of practice: The storage and handling of dangerous goods',* retrieved from https://www.worksafe.vic.gov.au/resources/code-practice-storage-and-handling-dangerous-goods

Victorian Government website, (2018, July 9), *'Chemical management procedure',* retrieved from https://www.education.vic.gov.au/hrweb/safetyhw/Pages/chemicalmgt.aspx

Queensland Government Department of Education website, (2022, March 29) '*Chemical management procedure',* retrieved from https://ppr.qed.qld.gov.au/pp/chemical-management-procedure

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E-quip4education website. (accessed 2023), Piggott, A. (2013), '*The Chemicals Store – Design of storage accommodation for chemicals in School Science Departments',* Gratnells Ltd and Timstar Ltd UK, https://www.e-quip4education.co.uk/PDF/Special-Report-3-The-Chemicals-Store-LowRes-for-Web.pdf

Flinn Scientific Inc. website, (2017), '*Safe storage and handling of lab chemicals',* retrieved from https://www.flinnsci.com/safe-storage-and-handling-of-lab-chemicals/sn033/

Chemstore UK website, (2015, January 19) 'Optimum Temperature Chemical Storage' retrieved from https://www.chemstore.co.uk/optimum-temperature-chemical-storage/

Australian National University website, (2018, March1), '*Chemical management handbook',* retrieved from https://policies.anu.edu.au/ppl/document/ANUP_000636