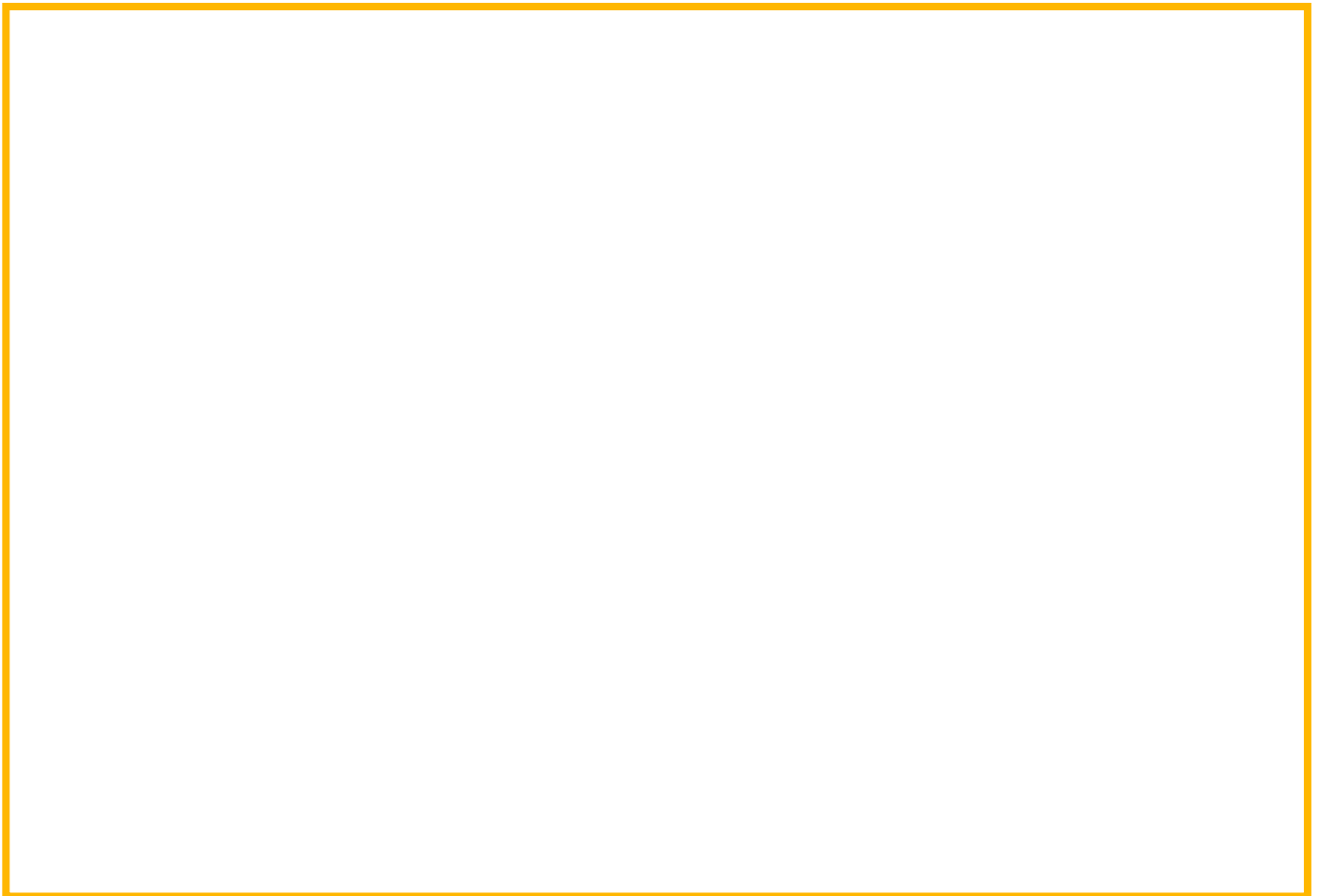


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DR AS 2243.2:2018, Safety in laboratories, Part 2: Chemical aspects



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Australian Standard

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DR AS 2243.2:2018, *Safety in laboratories, Part 2: Chemical aspects*

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Start date: 24 October 2018

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Upon successful conclusion of the Public Comment period it is proposed to publish this Standard as AS 2243.2:201X.

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Please provide supporting reasons and suggested wording for each comment. Where you consider that specific content is too simplistic, too complex or too detailed please provide an alternative.

If the proposed Standard is acceptable for Australia without change, an acknowledgement to this effect would be appreciated.

If you know of other persons or organizations that may wish to comment on this draft Australian Standard, please advise them of its availability. Copies of drafts and other publications from Standards Australia are available from SAI Global at www.saiglobal.com

Only comments submitted via the Standards Australia Standards Hub site before midnight on the closing date will be reviewed by the committee. The Hub automatically submits comments to the committee. Any other communication will not be considered by the committee.

At the expiry of the comment period, the committee responsible for the document is obliged to give serious consideration to all comments received. However, normally no acknowledgement of comment is sent.

Preface

This Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee CH-026, Safety in Laboratories, to supersede AS/NZS 2243.2:2006, *Safety in laboratories, Part 2: Chemical aspects*, and AS/NZS 2243.10:2004, *Safety in laboratories, Part 10: Storage of chemicals*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide information, recommendations and procedures involving the use and storage of chemicals to promote safe work practices in laboratories.

Major changes in this edition are as follows:

- (a) Incorporates chemical storage content from AS/NZS 2243.10, which has been withdrawn.
- (b) Addition of new clauses on nanotechnology
- (c) Addition of new Appendices on nanomaterials and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

The Standard is Part 2 of an 8-part series designed to promote safety in laboratory operations, and is aimed at specific aspects of chemical safety common to laboratories.

The other Parts in the series are as follows:

AS 2243.1, *Safety in laboratories, Part 1: Planning and operational aspects*

AS/NZS 2243.3, *Safety in laboratories, Part 3: Microbiological safety and containment*

AS/NZS 2243.4, *Safety in laboratories, Part 4: Ionizing radiations*

AS/NZS 2243.5, *Safety in laboratories, Part 5: Non-ionizing radiations — Electromagnetic, sound and ultrasound*

AS/NZS 2243.6, *Safety in laboratories, Part 6: Plant and equipment aspects*

AS/NZS 2243.8, *Safety in laboratories, Part 8: Fume cupboards*

AS/NZS 2243.9, *Safety in laboratories, Part 9: Recirculating fume cabinets*

It is recommended that Part 1 be used in conjunction with this Part, and that additional Parts be obtained where justified by the type of operations carried out in the particular laboratory.

The terms “normative” and “informative” have been used in this Standard to define the application of the appendix to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

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Introduction

AS 2243.1 deals in a general manner with planning and operational safety matters, and AS 2243.2 covers operational safety when using chemicals, including the method of storage and the amounts of chemicals that can be stored in laboratories. AS 1940 deals briefly with the design of stores for flammable and combustible liquids.

This Standard allows a high level of flexibility if a large range of chemicals need to be stored but is severely limiting in the specification of total quantities that can be stored. This Standard also sets out requirements for storage within a laboratory, which is not addressed in other Standards.

The relevant Standard for the particular Class of dangerous goods or type of chemical may be preferable if only non-flammable dangerous goods or only one or two Classes of dangerous goods or types of chemicals are stored, or they are in dominant quantities.

AS/NZS 3833 is intended mainly for the storage of large quantities of predetermined dangerous goods but excluding Packing Group I. It does not allow the storage flexibility often required for research and experimental laboratories. The required segregation distances are not normally available in laboratory stores. It might be more suitable for industrial applications where larger quantities of raw materials or finished products are held 'in quarantine' awaiting quality assurance testing.

Whichever Standard is chosen for the separate chemical storage area, it needs to be applied in full.

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Australian Standard[®]

Safety in laboratories

Part 2: Chemical aspects

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Section 1 Scope and general

1.1 Scope

This Standard sets out requirements and recommended procedures for safe work practices with chemicals in the laboratory. It includes procedures for handling flammable, toxic, corrosive, unstable and highly reactive chemicals, and compressed and liquefied gases.

This Standard applies to —

- (a) substances, mixtures or materials defined as hazardous chemicals, dangerous goods and hazardous substances, except for those that are explosive, infectious and radioactive;
- (b) combustible liquids; and
- (c) substances too dangerous to be transported.

NOTE National, state and territory legislation may impose requirements.

This Standard also applies to chemicals not classed as hazardous or dangerous if compatibility problems could arise during storage.

NOTE The term 'chemical' includes, but is not limited to, a pure element, a compound of a number of elements, or a mixture of two or more such compounds, and any solution, suspension, fume or aerosol thereof.

This Standard also sets out the requirements for the safe keeping and storage of chemicals and gases —

- (a) inside a laboratory;
- (b) in associated storerooms or spaces which are support areas to the laboratory.

The requirements of this Standard apply only to the keeping, in use or storage, of chemicals in packages.

1.2 Application

This Standard is intended to be used in conjunction with AS 2243.1, which provides requirements and recommendations on matters common to all types of laboratory work.

Where the size of packages of chemicals or the aggregate quantities to be stored exceed the limitations of this Standard, reference should be made to —

- (a) AS 1940, for storage of flammable and combustible liquids;
- (b) AS/NZS 1596, for LP Gas; or
- (c) other appropriate Australian, Australian/New Zealand or New Zealand Standards.

NOTE Refer to National, State and Territory regulations for specific information.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

NOTE Documents referenced for informative purposes and suggested further reading are listed in the Bibliography.

AS 1076, *Code of practice for selection, installation and maintenance of electrical apparatus and associated equipment for use in explosive atmospheres (other than mining applications)*

AS 1894, *The storage and handling of non-flammable cryogenic and refrigerated liquids*

AS 1940, *The storage and handling of flammable and combustible liquids*

AS 2714, *The storage and handling of organic peroxides*

AS 3961, *The storage and handling of liquefied natural gas*

AS 4260, *High efficiency particulate air (HEPA) filters — Classification, construction and performance*

AS 4326, *The storage and handling of oxidizing agents*

AS 4332, *The storage and handling of gases in cylinders*

AS/NZS 1336, *Eye and face protection — Guidelines*

AS/NZS 1337, *Personal eye protection (series)*

AS/NZS 1596, *The storage and handling of LP Gas*

AS/NZS 2022, *Anhydrous ammonia — Storage and handling*

AS 2243.1, *Safety in laboratories, Part 1: Planning and operational aspects*

AS/NZS 2243.6, *Safety in laboratories, Part 6: Plant and equipment aspects*

AS/NZS 2243.8, *Safety in laboratories, Part 8: Fume cupboards*

AS/NZS 2243.9, *Safety in laboratories, Part 9: Recirculating fume cabinets*

AS/NZS 2381.1, *Electrical equipment for explosive gas atmospheres — Selection, installation and maintenance, Part 1: General requirements*

AS/NZS 2927, *The storage and handling of liquefied chlorine gas*

AS/NZS 2982, *Laboratory design and construction*

AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 3833, *The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers*

AS/NZS 4681, *The storage and handling of Class 9 (miscellaneous) dangerous goods and articles*

National Transport Commission. Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG CODE)

Department of Jobs and Small Business, Work Health and Safety (Managing Risks of Hazardous Chemicals in the Workplace) Code of Practice 2015

1.4 Terms, definitions and abbreviations

For the purpose of this Standard, the definitions in AS 2243.1 and those below apply.

NOTE Some of the definitions listed below may not apply in New Zealand.

1.4.1

ADG Code

Australian code for the transportation of dangerous goods by road or rail

1.4.2

attached room

room attached to another room with one or more common walls, or a room within another room

1.4.3

auto-ignition temperature

lowest temperature at which a vapour will spontaneously catch fire in air

1.4.4

bund

embankment of earth, or a wall of brick, stone, concrete or other material which may form part or all of the perimeter of a room or compound, and which is sufficiently impervious to retain spillage and to enable recovery of any such spillages

1.4.5

capacity

maximum volume or space within a container or compound

Note 1 to entry: Note to this entry: The normal capacity of a container is less than its full capacity, to allow for ullage or vapour expansion

1.4.6

chemical storage cabinet

storage cabinet constructed in accordance with the requirements of [Clause 3.3](#)

1.4.7

class (of dangerous goods)

number assigned to dangerous goods which exhibit a common single or most significant risk, determined from the criteria given in the UN *Manual of Tests and Criteria* and listed in the ADG Code

1.4.8

combustible liquid

any liquid other than a flammable liquid that has a flash point, and has a fire point that is less than its boiling point

For the purpose of this Standard, combustible liquids are divided into two classes as follows:

- (a) *Class C1* — A combustible liquid that has a closed cup flash point of greater than 60°C and no greater than 93°C
- (b) *Class C2* — A combustible liquid that —
 - (i) has a flash point of greater than 93°C; or
 - (ii) has been excluded from being a flammable liquid by any of the criteria for sustaining combustion

Note 1 to entry: A water miscible solution with a water content of more than 90 % by mass, which has been excluded from being a flammable liquid and which does not have a fire point less than its boiling point is not a combustible liquid.

Note 2 to entry: The boiling point is that point at which it is no longer possible to achieve the rate of temperature rise required by ISO 2592 for the determination of fire point.

Note 3 to entry: ISO 2592, IP 36 and ASTM D92 are technically equivalent test methods for determination of fire point and fire point by Cleveland open cup tester.

[SOURCE: AS 1940:2017, 1.2.9]

1.4.9

combustible materials

materials deemed to be combustible when tested in accordance with AS 1530.1

1.4.10

cryogenic liquid

liquid having a normal boiling point below -90°C at atmospheric pressure (101.3 kPa)

1.4.11

dangerous goods

substances, mixtures or materials that —

- satisfy the UN tests and criteria for determining whether they are dangerous goods;
- are listed in the ADG Code; or
- are determined to be dangerous goods by relevant legislation

Note 1 to entry: Note to entry: UN tests and criteria are specified in the UN *Manual of Tests and Criteria* and the UN *Recommendations on the Transport of Dangerous Goods — Model Regulations*.

1.4.12

flammable liquids

liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60°C , closed cup test, normally referred to as the flash point

Flammable liquids include —

- liquids stored or handled at temperatures at or above their flash point; and
- substances that are stored or handled at elevated temperatures in a liquid state and which give off a flammable vapour at a temperature at or below the maximum storage or handling temperature.

Flammable liquids do not include liquids meeting the above definition with a flash point of more than 35°C which do not sustain combustion if —

- they have passed a suitable combustibility test (refer to Sustained Combustibility Test prescribed in the UN *Manual of Tests and Criteria*, Part III, sub-section 32.5.2); or
- their fire point according to ISO 2592:2000 is greater than 100°C ; or
- they are water miscible solutions with a water content of more than 90 % by mass.

Note 1 to entry: The above definition is consistent with the definition of flammable liquids in ADG 7.4 except for the omission of open-cup testing for flash point. This has been omitted to conform to GHS classification which is based solely on closed cup testing. This omission is consistent with a provision in the UN Model regulations.

GHS does provide for exemption based on the UN Sustained Combustibility Test, but does not provide for —

- inclusion of heated liquids (as GHS has no consideration of temperature); and
- exclusions based on fire point or water miscibility.

Note 2 to entry: Liquids excluded as not sustaining combustion are included within the definition of combustible liquids in this Standard.

Note 3 to entry: Packing group provides further information on flammable liquid classification.

Note 4 to entry: Liquids with a flash point less than 60°C that are excluded by not sustaining combustion, may present a risk of fire and explosion if there is a hazardous area in the head space of a tank or package. An assessment of the risk needs to be undertaken based on AS/NZS 60079.10.1.

[SOURCE: AS 1940:2017, 1.4.28]

1.4.13

GHS

an acronym that stands for 'Globally Harmonized System'. GHS is the international system of classification and labelling of chemicals, published by the United Nations

1.4.14

hazardous area

An area (three-dimensional space) in which an explosive atmosphere, due to flammable gas or flammable vapour, is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

Note 1 to entry: Note to entry: The classification of hazardous areas in relation to flammable liquids is given in AS/NZS 60079.10.1.

(SOURCE: AS 1940:2017, 1.4.35)

1.4.15

hazardous chemical

(Australia) any substance, mixture or material that satisfies the criteria of one or more Globally Harmonized System of Classification and Labelling of Chemicals (GHS) hazard classes, including a classification in Schedule 6 of the Work Health and Safety Regulations

1.4.16

hazardous substance

(New Zealand) any substance that triggers any one of the threshold levels defined in the *Hazardous Substances (Minimum Degrees of Hazard) Regulations 2017*

1.4.17

HEPA

an acronym that stands for 'High Efficiency Particulate Air'

1.4.18

in use

applicable to chemicals that are kept in a laboratory for frequent use, e.g. on a daily or weekly basis; and to gas cylinders, kept inside or outside a laboratory, that are connected to a system for use

Note 1 to entry: Note to entry: This term is only relevant to a laboratory. Chemicals, including gases and cryogenic liquids, are not considered to be 'in use' when kept in a storeroom.

1.4.19

incompatible

<in relation to dangerous goods or other goods> goods that are —

- (a) likely to interact with the dangerous goods so as to increase the hazard when mixed or otherwise brought into contact with the liquids;
- (b) listed in the ADG Code as being incompatible; or
- (c) declared by the regulatory authority to be incompatible

<in relation to packaging or transfer equipment> a container or item of equipment that is constructed of a material likely to interact with the liquids such that it is weakened or damaged to the extent that risk increases

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1.4.20**ignition source**

source of energy sufficient to ignite a flammable or explosive atmosphere

Note 1 to entry: Note to entry: It may include naked flames, hot surfaces, exposed incandescent material, electrical arcs, hot particles, electrical discharge including from static electricity, chemical reactions, high intensity electromagnetic radiation including visible light or ultraviolet radiation, mechanical sparks, fixed and portable electrical equipment, portable tools or vehicles such as forklifts

1.4.21**laboratory**

any building or part of a building used, or intended to be used, for scientific or technical work, including research, quality control, testing, teaching or analysis. Such work may involve the use of chemicals and gases, pathogens and radiation, or processes including electrical or mechanical work. The laboratory includes such support areas as instrument and preparation areas, laboratory stores and any offices attached or adjacent to the laboratory

Note 1 to entry: AS/NZS 2982 contains definitions of various types of laboratories.

1.4.22**may**

indicates the existence of an option

1.4.23**nanomaterial / nanoparticle**

substance with a nominal diameter (such as geometric, aerodynamic, mobility, projected-area or otherwise) smaller than 100 nm

[SOURCE: ISO/TR 27628:2007:2007, 2.12 (adapted)]

1.4.24**nanotechnology**

application of scientific knowledge to manipulate and control matter predominantly in the nanoscale (length range approximately from 1 nm to 100 nm) to make use of size- and structure-dependent properties and phenomena distinct from those associated with individual atoms or molecules, or extrapolation from large sizes of the same material

Note 1 to entry: Note to entry: Manipulation and control includes material synthesis.

[SOURCE: SA TS 80004.1:2015, 2.1 and 2.3]

1.4.25**on-site protected place**

building where people are employed within the property boundary, including offices, warehouses, manufacturing or processing areas, amenities and other dangerous goods stores where quantities exceed minor storage

1.4.26**packing group (PG)**

one of three hazard groups to which dangerous goods (of Classes other than 1, 2, 6.2 and 7) are assigned in the ADG Code, in decreasing order of hazard, by the Roman numerals 'I' (high danger), 'II' (medium danger) and 'III' (low danger)

1.4.27**protected place**

place of domicile or assembly, dwelling, residential building, place of worship, public building, school or college, hospital, theatre, and any building or open area in which persons are accustomed to assemble whether it is within or outside the property boundary of the installation. Depending on the context, a protect place can be one or more of the following:

- (a) *Place of work* — factory, workshop, office, store, warehouse, shop, or building where persons are employed, that is outside the property boundary of the installation.
- (b) *Marine* — ship lying at permanent berthing facilities.
- (c) *Storage* — storage facility for dangerous goods outside the property boundary of the installation, except for those defined as minor storages in AS 1940 or the New Zealand equivalent.

1.4.28**public place**

any place other than private property, open to the public, which the public has a right to use and which includes a public road. Parking areas for commercial buildings are not considered to be public places

1.4.29**risk assessment**

overall process of estimating the magnitude of risk and deciding what actions will be taken

[SOURCE: AS/NZS 4801 — 2001, 3.7]

1.4.30**safety data sheet (SDS)**

document which provides information on the identification, hazards, precautions for use and safe handling of a specific chemical product

Note 1 to entry: Note to entry: Refer also to Safe Work Australia, *Model Code of Practice: Preparation of Safety Data Sheets for Hazardous Chemicals*.

1.4.31**sampling**

taking a sample for analysis or quality control

Note 1 to entry: Note to entry: This term has special significance and refers to the withdrawal of a small amount from a package.

1.4.32**segregation**

keeping incompatible goods apart from one another in one room, using a barrier or an intervening space

1.4.33**shall**

indicates that a statement is mandatory

1.4.34**should**

indicates a recommendation

1.4.35**signal word(s)**

word(s) conveying danger or warning message used on a label to indicate to a label reader the relative degree of severity of the hazard, and to alert the reader to a potential hazard, under the GHS

1.4.36**storage**

keeping of chemicals and gases in a laboratory or an associated store

1.4.37**toxic substance (chemical)**

substances liable either to cause death or serious injury, or to harm human health, if swallowed or inhaled, or following eye or skin contact

Such substances —

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- (a) are listed in the ADG Code or NZS 5433;
- (b) meet the classification criteria set out in the UN *Manual of Tests and Criteria* or NZS 5433; or
- (c) in New Zealand, meet the criteria of the Hazardous Substances (Health and Safety Reform Revocations) Regulations 2017

Section 2 Planning for chemical safety

The best basis for planning safety into a laboratory function or design is to consider in advance the consequences of every action. (Refer also AS 2243.1.)

When designing a laboratory in which chemicals are to be used, risk assessment and hazard and operability (HAZOP) studies (refer to, AS IEC 61882) should be carried out to provide information to be used when addressing the following aspects of specific relevance to chemical laboratories:

- (a) Exposure control.
- (b) Ventilation.
- (c) Storage requirements.
- (d) Movement of chemicals.
- (e) Waste treatment.
- (f) Emergency management.
- (g) Provision of safety equipment.

For detailed information on the design of laboratories and storage facilities, Standards such as AS/NZS 2982 series and AS 4332 should be consulted.

Subsequent reviews of the risk assessment and HAZOP study findings should be undertaken regularly for existing operations and whenever new chemicals are introduced.

Safety provisions should be incorporated when installing instruments which emit hazardous substances (see also AS 2243.1). Such safety provisions include the following:

- (i) A well-ventilated area of the laboratory should be provided for the installation of spectrophotometers which can emit ozone (see AS/NZS 2982).
- (ii) Shielding should be provided from gas chromatographic detectors which contain radioactive sources, e.g. helium ionization and electron capture detectors, and from the effluent from splitters or detectors.
- (iii) Ducting to the atmosphere should be provided for atomic absorption and emission spectrometers.

NOTE Further information on the selection, installation and maintenance of electrical apparatus in hazardous environments can be found in the relevant parts of AS 1076 and the AS/NZS 2381 series (see also AS/NZS 2982).

Section 3 Chemical safety management

3.1 General

In addition to the laboratory safety and emergency procedures specified in AS 2243.1, procedures shall be implemented to ensure the following:

- (a) Laboratory personnel are not exposed to concentrations of hazardous substances greater than the lowest practically achievable level and in any case less than the maximum exposure standard.

- (b) Procedures are established to review and record the health and safety of personnel working within the laboratory and to detect any effects of exposure to chemicals.
- (c) Risk assessments of all operations are carried out and reviewed periodically.
- (d) Risk assessments are updated when new chemicals or methods are introduced into the laboratory and safety procedures are modified if necessary.
- (e) An inventory of all hazardous chemicals used in the laboratory is maintained, together with the manufacturer's Safety Data Sheet (SDS), which provide information on safe storage and handling procedures, management of spills and waste disposal.
- (f) A procedure is provided for the collection, storage and disposal of chemical wastes from the laboratory.

3.2 Management system components

3.2.1 General

In addition to the requirements in AS 2243.1, the procedures in [Clauses 3.2.2 to 3.2.8](#) shall be implemented.

NOTE For any particular laboratory, there may be additional procedures necessary to cover specific functions of that laboratory.

3.2.2 Safety information

There is a wide range of safety information available in reference books, Safety Data Sheets (SDSs) and other sources. Care needs to be taken to ensure that information is from reliable and authoritative sources. The information shall relate to the way the chemical is used. SDSs are most relevant for the use of chemicals in isolation. Where chemicals are to be mixed, information other than the SDS will be required, e.g. specific reactivities.

NOTE 1 Legislation may require SDSs to be available.

NOTE 2 SDS provide information about the general hazards and use of a product. This information needs to be interpreted for use in the laboratory as products are mixed, reacted, form intermediates or end products and may be used at a scale that may impact risk control measures.

The outcome of the risk assessment conducted for the work shall be readily accessible, reviewed and considered before chemicals are used. See [Clause 3.3.1](#).

Safety information shall be readily accessible in the work area. This information could include the type of hazard, treatment required for spills, burns and other injuries, proper storage procedures, safe handling and correct labelling. Information should be accessible and understandable to personnel involved in activities using chemicals.

3.2.3 Security

Chemicals such as controlled substances, drugs, poisons shall be used and stored so that they do not present a risk to persons in the vicinity and are secure against theft or unauthorized tampering.

NOTE In Australia, this would also include high consequence dangerous goods.

3.2.4 Storage and handling of chemicals

National, state or territory legislation may apply to the storage of chemicals in the laboratory.

Provisions shall be made for safe movement of chemicals and samples, e.g. trolleys and sample racks.

NOTE 1 Refer to relevant national, state and territory legislation on the storage and handling of chemicals.

NOTE 2 Consideration should be given to the type and design of trolleys, e.g. the use of lockable wheels on trolleys.

3.2.5 Maintenance of laboratory services and cleaning of laboratories

Maintenance and cleaning staff shall be familiarized with the hazards associated with the area to be serviced or cleaned and relevant emergency procedures prior to working in that area, e.g. by a safety induction. Particular hazards, such as condensation products in fume cupboard ducts and the presence of flammable or toxic materials in the vicinity of the work area, shall be pointed out by the laboratory supervisor.

Maintenance and cleaning shall not be carried out without a risk assessment and authorization. Such operations shall not introduce or contribute to the hazards in the laboratory. Where possible, the dangerous materials shall be removed from the work area before maintenance or cleaning commences.

3.2.6 Health surveillance

Health surveillance appropriate for any hazardous substances in use shall be conducted and records maintained.

An assessment shall be conducted to determine if ongoing health surveillance is required.

3.2.7 Safety equipment

Safety equipment shall be provided in accordance with AS 2243.1.

The risk assessment process conducted for the laboratory, in conjunction with information from relevant SDSs and other Parts of the AS/NZS 2243 series shall determine what, if any, additional or more specialized personal protective equipment is to be used. The issue and use of personal protective equipment should not be a substitute for implementing a safe system of work.

Where personal protective equipment is issued, adequate training shall be provided to all users. The equipment shall be maintained in an effective working condition in accordance with the relevant Standard or the manufacturer's instructions. See also AS 2243.1.

3.2.8 Laboratory chemical wastes

3.2.8.1 General

Clauses 3.2.8.2 to 3.2.8.4 consider aspects of handling laboratory chemical wastes. For the disposal of other types of laboratory waste, refer to AS 2243.1.

3.2.8.2 Collection, handling and storage

All laboratory wastes shall be collected, labelled, stored and disposed in accordance with accepted safe procedures.

Waste chemicals shall only be handled using suitable containers that are prominently labelled as to the type of waste contained. Containers may need to be prepared by decontamination prior to use. Waste chemicals shall be checked for storage compatibility and, if necessary, separate storage containers shall be provided (e.g. chloroform and acetone are incompatible especially in the presence of a base). Waste can contain chemicals that degrade on storage and can become more hazardous, e.g. build up pressure or become explosive. Such wastes shall be identified and managed appropriately.

When transferring flammable liquid wastes from one vessel to another, earthing should be provided to eliminate static electricity discharges. Good ventilation should be provided in the transfer area and all sources of ignition should have been removed.

Chemical wastes should be divided into aqueous solutions, solutions containing heavy metals, water-insoluble waste, chlorinated solvents and peroxides. Further division into particular types of compounds, e.g. cyanides, explosive materials or asbestos, may be necessary. Mutually reactive wastes shall not be stored together. Materials for disposal that are likely to have formed peroxides shall be assessed and handled appropriately before they leave the laboratory.

Containers of chemical wastes shall be stored in a well-ventilated area convenient to transport. A storage area for large volumes of collected waste should provide fume protection, fire protection and bunding.

3.2.8.3 Labelling of laboratory chemical waste

Categories of waste from the laboratory shall be properly segregated for temporary accumulation and storage as well as for transportation and disposal. Accordingly, all waste shall be properly labelled before being moved from the laboratory into the disposal sequence.

Guidelines on the wording on labelling of waste may be available from the appropriate government agency. Where this is not specified, the following are recommended as minimum information to be included on the label:

- (a) Signal words or the dangerous goods class and subsidiary risk labels where applicable.
- (b) Substance name or correct shipping name for single component waste.
- (c) United Nations (UN) number, or chemical abstract service (CAS) number where applicable.
- (d) Where possible for compatible mixed component waste, list the major ingredients and formulation.
- (e) Where necessary, provide warnings if special procedures are required to control emergency situations or to prevent life threatening human exposures.

Where mixed waste products are packaged together, the above information should be based on the major component or the component which constitutes the main risk.

The label shall be firmly secured to the container and remain in place until the container is cleaned and free of the substance, or it reaches its final disposal point. Where possible, the label should be resistant to degradation and positioned away from container openings. The lettering of the label shall be durable and of a size and style which is legible.

NOTE [Appendix A](#) provides an example of a suitable label for waste containers.

3.2.8.4 Disposal

Waste minimization, especially recycling of solvents, should be practised where practical. This includes the return of unwanted chemicals and containers to the supplier or agent.

Waste containing heavy metals, should not be disposed into the environment.

The disposal of certain wastes will be subject to local regulations or national, state and territory regulations.

NOTE Relevant authorities should be consulted on the correct methods for placing this material into storage or for its disposal.

NOTE 1 Disposal may need to be carried out by a licensed waste collector.

NOTE 2 With the approval by the appropriate water authority a variety of water soluble wastes can be disposed via the sewer, provided that limits of volume, pH and biological and chemical content are properly observed.

3.3 Chemical safety practices

3.3.1 Principles of protection

3.3.1.1 General

Work shall be planned and carried out to eliminate or minimize production of fumes, mists and dusts in the work area. The aim is to minimize the potential for incidents, e.g. fire or explosion.

3.3.1.2 Hazard identification, risk assessment and control process

This process should be based on at least the following:

(a) Identification of the hazards associated with the chemicals and the proposed handling methods. Consideration of the chemical's effects on people and its physicochemical properties. Appropriate sources of safety information, such as SDSs, should be consulted.

(b) Assessment of the nature of the risks associated with the toxicological and physicochemical hazards. Risk will be associated with both —

(i) the potential for exposure that can cause adverse health effects; and

NOTE The routes by which the chemical can enter or interact with the body need to be considered.

(ii) the potential for dangerous occurrences, e.g. fire, due to physicochemical properties.

(c) Evaluation of the severity or degree of risk.

(d) Selection and application of control measures to either eliminate or minimize risks.

(e) Assessment of the level of training suitable for personnel who handle or may be exposed to the chemicals.

3.3.1.3 Control measures

No situation should be allowed to continue where exposure is expected to be greater than the exposure standard or where exposures are likely to cause adverse health effects, injuries or illness. At all times, operations should be conducted in such a way that exposure or the risk of an incident (e.g. fire or explosion) is as low as reasonably achievable.

There are numerous effective measures available to control the risks associated with the use of chemicals. The controls chosen shall be suitable for, and compatible with, the chemicals and handling methods used.

General safeguards include the following:

(a) Elimination or substitution of the hazard, e.g. use of a different process or use of a different chemical.

(b) Engineering controls such as isolation (e.g. handle the chemical within a closed system) or ventilation (e.g. use volatile chemicals within a fume cupboard or under local exhaust ventilation).

(c) Administrative controls such as minimizing the time spent using chemicals or documenting and implementing handling procedures (e.g. standard operating procedures and standard test methods).

(d) Personal protective equipment (PPE). The least effective control measure is the use of PPE. However, it should be noted that the use of safety glasses, laboratory coats and the like are generally used as a "universal" secondary control measure.

When applying these controls, appropriate protocols should be developed, documented, implemented and reviewed to ensure their effectiveness.

3.3.2 Environmental considerations

The following requirements shall be observed to minimize hazards in a laboratory:

- (a) Work shall be planned and executed to eliminate or minimize vapours, fume, dust or mist in the work area.
- (b) The appropriate sources of safety information shall be consulted before commencing work involving the use of or production of toxic volatile substances.

NOTE The sense of smell should not be used as a substitute for safe working procedures or as a method of monitoring chemical vapours.

- (c) The use of chemicals in an area with restricted or low ventilation shall be avoided or conducted with appropriate monitoring as it can result in an oxygen-depleted or hazardous atmosphere.
- (d) Self-contained breathing apparatus shall only be used by personnel trained in its use.

NOTE Cartridge and canister respirators are limited in performance as their effectiveness depends on time and the type and concentration of substances to which they are exposed. Cartridge and canister-type respirators provide no protection in oxygen-deficient atmospheres (see AS/NZS 1715 and AS/NZS 1716).

Where a process requires the continued (day-to-day) use of respirators, the process shall be modified to minimize, or possibly eliminate the respiratory hazard.

- (e) As the discharge of materials to ducts and drains can cause corrosion and a build-up of potentially dangerous products in the piping system, such discharges shall be minimized. If permissible contamination limits are likely to be infringed, preventive measures such as dilution of contaminants or rendering the toxic substances harmless, shall be taken.

3.3.3 Housekeeping

The following provisions shall form the basis of good housekeeping practices in the laboratory:

- (a) Do not handle, store or consume food or drink for personal consumption in the laboratory.

NOTE Refrigerators, freezers, ovens and microwave ovens used in the laboratory should be labelled to prohibit their use for food or drink for personal consumption.

- (b) Do not store food and drink for personal consumption in a refrigerator, freezer or cupboard used to store laboratory materials.

- (c) Only use suitable storage containers for chemicals.

NOTE Some containers have limited shelf-life.

- (d) Keep benches, shelves and cupboards clean and tidy.
- (e) Clean up after each stage of an operation, e.g. return all reagents, equipment and glassware not in use to their proper place in a clean condition.
- (f) Clean up spilled material immediately, using a procedure suitable for the particular substance. See [Clause 3.4](#).
- (g) Clearly and permanently label all chemical containers to reflect the contents.
- (h) Do not return "used" chemicals to reagent containers.
- (i) Do not store in the laboratory work area quantities of chemicals greater than those required for the efficient operation of the laboratory.

- (j) Do not allow wastes to accumulate so that they become a hazard. Collect chemical wastes and remove them from the work area. Store them in a safe area in accordance with [Clause 3.2.8](#).
- (k) Dispose of broken glassware by using a container reserved and labelled for the purpose.

3.4 Spill management

3.4.1 General

Every endeavour shall be made to prevent leaks or spills, and to control them if they occur (e.g. through use of secondary containment). Where a spill occurs, clean up shall be initiated immediately.

The response for a spill in the laboratory will depend upon the hazard (toxicity, corrosivity, flammability) of the material and the volume. Possible consequences of the spill such as environmental pollution and cross-contamination shall be included in the assessment of the hazard from the spill. A low hazard, low volatility material may be cleaned up with a paper towel. A spill of a large volume of high hazard material or high volatility material can require clean-up personnel to wear protective clothing and respiratory protection.

3.4.2 Planning

Planning for the control of a spill within the laboratory involves teaching staff the correct response to accidents, the provision of written instructions and suitable equipment for clean-up, and having available those sources of information that will help a trained clean-up group to select the correct approach for the particular circumstances. Review of the outcome of the spill assessment needs to occur and take account of relevant information in SDSs, legislation and other reference materials. At every occurrence of a leak or spill, the emergency plan shall be implemented and consideration shall be given to notifying the emergency services.

Clean-up materials and equipment should be kept at an appropriate, accessible location (e.g. a safety station) and should include the following:

- (a) "Do not enter" signs or barricade tape.
- (b) Relevant hazard signs.
- (c) Suitable types and quantities of absorbent materials or spill kits.

NOTE [Appendix B](#) provides information on the use of absorbent materials and spill kits.

- (d) Personal protective clothing appropriate to the hazards.
- (e) Appropriate containers for used absorbent materials and contaminated PPE.

3.4.3 Spills inside fume cupboards

Droplet-size spills or those up to 500 mL may be treated easily by wiping or absorbing with an appropriate absorbent. If a larger spill, leakage or breakage occurs, more extensive treatment may be needed.

Spills inside a fume cupboard are generally not as hazardous as those outside cupboards as they are generally contained and fumes, dusts or mists are swept away by the cupboard air stream. The suggested clean-up procedure is as follows:

- (a) Ensure that the fume cupboard remains operating.
- (b) Place absorbent or neutralizing materials over the spill. Proprietary absorbent or neutralizing materials may be used.

NOTE [Appendix B](#) lists general absorbent or neutralizing materials.

- (c) Decontaminate any contaminated materials or equipment adjacent to the spill and fume cupboard surfaces.
- (d) Remove protective gloves in the fume cupboard. Remove clothing, if contaminated, and wash hands and arms.
- (e) Dispose of any waste or used absorbent materials.

3.4.4 Spills outside fume cupboards

Spills outside fume cupboards can be complex events. They can be within laboratories where a limited number of persons work or they can be in corridors used by a considerable number of persons. For this reason, all work shall be planned to minimize the chance of a spill. Chemicals being moved in or between laboratories or service areas shall be contained.

Spills can involve amounts of material ranging from 1 mL or less to many litres. The amount spilled, the physical characteristics of the material and how the spill occurred are important factors in determining the area of involvement.

When liquid is spilled, it is generally dispersed as the following three spill fractions:

- (a) The bulk of the liquid that remains in an irregular puddle.
- (b) The portion that separates as splashes and rivulets.
- (c) The portion that becomes airborne (e.g. volatilizes or generates airborne dusts).

NOTE Where airborne dust is produced, larger particles settle rapidly whereas the smaller particles can remain suspended in air for a considerable time and can be transported from the spill site by a ventilation system. In the event of a spill of liquid in the laboratory, the potential for airborne material needs to be considered.

Spills in confined areas, especially cold-rooms and basement laboratories, require special consideration.

The response to an accidental spill of chemicals in the laboratory will depend upon the hazards of the material, including the physicochemical properties, and the volume of the spill. The SDS for the chemical should be consulted for spill procedures because the procedures vary with the class of chemical. Commercial spill kits are available for both small and large spills of many chemicals. However, very large spills can require attendance by the fire brigade.

3.5 Fire, emergency and rescue procedures

See AS 2243.1 for requirements and recommendations concerning fire, emergency and rescue procedures for laboratories.

Firefighting equipment and services suitable for the types of fires likely to be encountered should be readily available in all laboratory areas.

NOTE The HAZCHEM Code provides the correct firefighting medium for all substances listed under the ADG Code and is set out in that document. In New Zealand, refer to NZCIC HSNO Approved Code of Practice, *Signage for Premises Storing Hazardous Substances and Dangerous Goods*.

Section 4 Safe use of chemical substances

4.1 General

Laboratories are unique in that they have a diverse range of chemicals, often in smaller quantities than in industrial environments. The methods and systems used within the laboratory can be complex. Hazardous situations can arise in day-to-day operations if personnel are not appropriately trained and aware of the hazards.

This Section provides guidance on the range of common chemical hazards that can be encountered in laboratory operations and the precautions to be adopted to address the hazards.

NOTE [Appendix K](#) lists the ADG categories versus the GHS categories.

4.2 Chemical hazards

Chemicals can be hazardous due to their physical properties, chemical nature or interaction with living organisms.

The storage conditions of the chemical substance can also present a hazard if storage containers used are incompatible with the substance (e.g. storage of peroxides in metal containers) or if the substance is stored under poor environmental conditions (e.g. hot conditions, or those which can lead to the deterioration of the storage container).

Consideration should be given to substituting a less hazardous material for use where possible.

Chemical safety is subject to national, state and territory legislation. Some specific chemicals, due to their public health impact are legislated under drugs, poisons and controlled substances legislation and related legislation for agricultural and veterinary chemicals.

NOTE 1 For an explanation of dangerous goods classes, the ADG Code should be consulted.

NOTE 2 In New Zealand, consult NZS 5433 and hazardous substances regulations.

4.3 Gases

4.3.1 General

All compressed and liquefied gases should be regarded as hazardous, the hazards arising from one or more of the following factors:

- (a) *Compressed state* — Rapid expansion takes place suddenly and with considerable force on release of the gases from their container, e.g. liquefied petroleum gas (LP Gas).
- (b) *Low temperature* — Many gases, when released rapidly, become cold as a result of adiabatic expansion. Also, gases stored as cryogenic fluids are at exceptionally low temperatures upon release (see AS 1894 for further information).
- (c) *Reactivity* — Gases (e.g. chlorine, oxygen, ammonia) which are normally highly reactive with certain substances tend to be much more so when released from the compressed state, by virtue of their high concentration.
- (d) *Flammability* — Many compressed gases are flammable and should be treated as such. Their high concentration and pressure increases the potential hazard.
- (e) *Toxicity* — The toxic properties of gases, such as ammonia and chlorine increase with increasing concentration in air.
- (f) *Oxygen depletion* — Gas released may displace air, and this can cause asphyxiation, even though the gas may not be very toxic. Examples of these gases are carbon dioxide, helium and nitrogen.
- (g) *Density effects* — Heavier than air gases such as LP Gas and carbon dioxide can travel large distances without dilution (or dissipation).

Depending on their nature, gases used in laboratories are usually contained in one of three ways (each presenting its own specific hazards), as follows:

- (i) High pressure cylinders at approximately 13.7 MPa or at 30.0 MPa. Examples of such gases are oxygen, nitrogen, hydrogen, methane.

- (ii) Liquefied or dissolved gases in cylinders under pressure. Examples are LP Gas, propane, ethylene, acetylene, chlorine, ammonia, sulfur dioxide.
- (iii) Refrigerated liquid gases in vacuum jacketed containers at pressures between 100 kPa (approximately one atmosphere) and 20 mPa. Examples are refrigerated argon, helium, liquid air, carbon dioxide, oxygen, nitrogen, hydrogen, neon.

Cylinders shall be handled and stored in accordance with AS 4332 and AS 2243.6. Reference should also be made to AS/NZS 2982.

4.3.2 Handling of gases, compressed or liquefied (other than cryogenic liquids)

In addition to the mechanical aspects covered in AS 4332 and AS 2243.6, the following chemical precautions shall be taken when handling compressed or liquefied gases other than cryogenic liquids:

- (a) Materials that a gas comes in contact with prior to its use shall be chemically compatible with that gas. Cylinders or gas lines used for flammable gas shall be earthed.
- (b) When leak-testing an oxygen system only leak detection solutions that are compatible with oxygen shall be used.
- (c) If the gas is corrosive or toxic, adequate precautions shall be taken before it is used, and emergency equipment shall be readily available, e.g. respirator, breathing apparatus, resuscitator and antidote. Training shall be provided.
- (d) The venting of gases or lines shall be carried out with care. For Class 2.1 flammable gases in cylinders, the cylinder shall be held vertically in a well-ventilated area. LP Gas shall not be released where a potential ignition hazard exists or where a hydrocarbon cloud can be formed in low-lying areas (see AS/NZS 1596).
- (e) When decanting liquefied gases, protective clothing, insulated gloves, and eye and face protection shall be worn. Sampling personnel shall use methanol to remove ice which can build up on valves and connections during sampling.

In addition, the following precautions are recommended:

- (i) Acetylene should not be allowed to come in contact with copper or any alloy containing more than 65 % copper.
- (ii) "Empty" cylinders should be left containing a slight positive pressure in order to avoid possible contamination with moisture or air. The cylinders should be marked "empty" and removed from the work area to appropriately segregated storage.

For fluorine, information on the hazards involved in the handling of fluorine should be obtained from the supplier and any requirements or recommendations it contains should be observed.

For ammonia, AS/NZS 2022 should be consulted for handling instructions.

For chlorine, AS/NZS 2927 should be consulted for handling instructions.

The concentrations of toxic or flammable gas in the atmosphere of the area of use should be monitored. A manual system (gas detection tubes with hand-pump) may be used, however the use of an automatic alarm system with remote sensors is preferred. Hydrocarbon gas detection should be provided in all areas where light hydrocarbon gases and liquids are stored. Ceiling detectors should be calibrated for light volatile hydrocarbons (methane and ethane) while at floor level the detectors should be calibrated for heavier hydrocarbons, e.g. propane, butane.

4.3.3 Handling of cryogenic fluids

Information on the hazards of cryogenic fluids, and of emergency procedures to be followed when using them, can be found in AS 1894, which deals with the safe handling of these materials. For laboratory

situations, the precautions, safe practices and emergency measures set out in [Appendix C](#) shall be taken into account.

4.4 Flammable chemicals

4.4.1 General

Flammable chemicals are assigned to the following dangerous goods classes:

- (a) *Class 2.1* — flammable gases.
- (b) *Class 3* — flammable liquids.
- (c) *Class 4.1* — flammable solids.
- (d) *Class 4.2* — spontaneously combustible substances or pyrophoric compounds.
- (e) *Class 4.3* — substances that emit flammable gases when in contact with water.

NOTE 1 In Australia, see AS 1940.

NOTE 2 In New Zealand, consult the hazardous substances regulations.

The following general considerations apply to the use and storage of flammable chemicals:

- (i) Flammable chemicals should be stored in a well-ventilated, cool area and they should not be used in proximity to sources of ignition such as flames, hot surfaces, sparks from electrical switches, or static electricity.
- (ii) Flammable gases and the vapour from other flammable chemicals, even at ambient temperature, can be carried by draught through a laboratory area and can bring it into contact with a source of ignition. The vapour can therefore ignite and burn back, setting fire to surroundings or igniting the parent chemical. Flammable chemicals therefore should only be used in well-ventilated areas or in a fume cupboard.
- (iii) Containers of flammable chemicals should not be left open in the laboratory or storage area. Container lids should be replaced immediately.
- (iv) Expert advice on safe handling procedures should be sought before working with chemicals which undergo spontaneous ignition, e.g. yellow phosphorus, Raney nickel catalyst.
- (v) Continuous or large-scale work with flammable organic solvents should have adequate ventilation appropriate to the needs of the particular operation. Forced-ventilation is highly desirable in such situations, as is the use of flameproof electrical installations.

4.4.2 Precautions for highly flammable liquids

The following precautions, as well as those listed in [Clause 4.4.1](#), are essential for work with any substance that has a flash point below 23°C. The following precautions shall apply to the use of volumes in excess of 4L, not only in the immediate work space, but to the whole working bench:

- (a) Naked flames or other ignition sources shall not be permitted in the work area.
- (b) Highly flammable liquids shall be heated only by use of a heating mantle with a sealed thermostat, a water bath, an oil bath, steam or infrared radiation sources.
- (c) Electrical equipment used in the area shall be in accordance with with the relevant parts of AS 1076 and AS/NZS 2381.1.
- (d) Special precautions shall be taken for liquids that have a low auto-ignition temperature. For example, carbon disulfide can be ignited by steam pipes or even low-energy electronic devices.

- (e) Work shall be carried out in a fume cupboard or in a purpose built facility.
- (f) Reflux and distillation apparatus shall not be left unattended unless monitored by automatic cut-off safety equipment.
- (g) The quantities of flammable liquid in the work area shall not exceed those required for the daily working operations. Surplus materials shall be returned to the appropriate storage area.
- (h) Highly flammable liquids shall not be poured into drains or sinks unless they are specifically designed and built for that purpose. Refer to the relevant statutory authorities for legal obligations relating to methods of disposal.

NOTE A list of highly flammable liquids of Class 3 is given in [Appendix D](#).

4.4.3 Special sources of danger

Electrical wiring shall conform to the requirements of AS/NZS 3000.

The following are specific sources of danger that may need to be considered:

- (a) *Evaporation of solvents* — Evaporation of highly flammable liquids in enclosed areas can form an explosive mixture. As little as 2 % vapour in air, e.g. 2.5 mL of diethyl ether in 30 L of air, is sufficient to give a mixture of composition equal to the lower explosive limit.
- (b) *Ignition sources* — Ignition of flammable vapour can occur from contact of the vapour with hot surfaces, electrical sparks or electronic devices. Equipment and procedures requiring assessment for their potential to act as ignition sources include —
 - (i) electric ovens;
 - (ii) microwave ovens;
 - (iii) rotary evaporation equipment;
 - (iv) refrigerators; and
 - (v) the use of various catalysts, such as finely divided platinum, palladium on charcoal or rhodium sponge.

NOTE In particular, the following precautions apply:

- (a) Extreme care should be exercised in the use of electric and microwave ovens when evaporating residual solvent from deposits of crystals.
- (b) The bulk of the solvent should never be evaporated using a heating source which can ignite the solvent. The use of a rotary evaporator or steam bath is recommended.
- (c) If the use of an oven is required, it should be of a ventilated-type, the area should be assessed in accordance with AS/NZS 2430.3.
- (d) Apparatus that is to be oven-dried should be rinsed with purified water and not with an organic solvent.
- (e) A ventilated oven should be used for the regeneration of absorbents (e.g. silica gel or molecular sieves) that have been in contact with organic solvents or vapours.
- (c) *Refrigerators* — A refrigerator may be used to store flammable chemicals provided it has been designed and manufactured to eliminate ignition sources. It may be possible for a domestic refrigerator to be modified by a competent person to eliminate ignition sources.

NOTE 1 Refrigerators unsuitable for solvent storage should bear a prominent label inscribed with the words “Not suitable for flammable solvents”.

NOTE 2 For a normal domestic refrigerator, removal of ignition sources entails removal of the wiring for the internal light, removal of the switching part of the thermostat from inside the compartment and possibly modification of any automatic defrosting procedure and internal fans, depending on the results of a competent person's checks for their potential as ignition sources.

NOTE 3 Solvents stored in suitable refrigerators should be properly labelled and sealed. A complete check of the condition of the refrigerator contents should be carried out at least monthly.

- (d) *Cool rooms* — Cool rooms are not intrinsically safe and advice should be sought prior to the storage or use of flammable solvents in walk-in cool rooms or freezers.
- (e) *Static electricity* — The relative movement of two contacting surfaces or fluids can cause charge separation and give rise to static electricity. The following are common causes of static electricity:
- (i) Pumping of hydrocarbons.
 - (ii) Belts passing over pulleys.
 - (iii) Unearthed compressed gas lines.
 - (iv) Agitation of insulated solids.
 - (v) Mixing of immiscible liquids so that one settles through the other.
 - (vi) Leaks of steam, vapour and condensable gases.
 - (vii) Plastic sheets or surfaces parted from metallic or non-metallic objects.

Attention should be given to the static charge which can be acquired by personnel movement and which can be stored on the body and clothing. The use of wholly synthetic-fibre laboratory clothing should be avoided. The major danger arises from the electrical earthing of these charges in a flammable atmosphere, when the energy released acts as a source of ignition. A secondary danger is that persons who have acquired static charge are at risk of dropping objects and materials that they are holding when their charge is electrically earthed. The working area should be rendered safe by providing sufficient low-resistance paths to earth for every component and for personnel, e.g. copper bars on walls, braided copper or brass straps from a container to a wall or earthing mats. For further information on static electricity, see AS/NZS 1020.

4.4.4 Precautions for Class 4 substances (dangerous solids)

Class 4.2 and Class 4.3 substances, e.g. metal hydrides and metal alkyls, shall only be used by a competent person or under the supervision of a competent person. Protective clothing and eyewear shall be worn. Metal powders, such as magnesium, aluminium, zinc and iron powders, shall not be placed in contact with oxidizing agents such as nitrates, chlorates, perchlorates or peroxides, with which they form explosive mixtures. For Class 4.3 substances, which are dangerous when wet, dry-powder fire extinguishers shall be provided. Carbon dioxide extinguishers shall not be used. Addition of water should be avoided.

NOTE [Appendix E](#) provides information on the hazardous properties associated with highly reactive chemicals and recommended safety precautions.

4.5 Toxic chemicals

4.5.1 General

Sometimes work in the chemical laboratory involves the use of substances which are —

- (a) quick-acting poisons;
- (b) slow-acting poisons;

- (c) cumulative poisons;
- (d) dermatitic;
- (e) allergenic;
- (f) carcinogenic;
- (g) mutagenic; or
- (h) teratogenic.

These substances are a potential hazard to health if not handled correctly as they can gain entry into the body by the following routes:

- (i) Absorption through the skin, eyes or wounds.
- (ii) Ingestion.
- (iii) Inhalation.

With some substances, the effects of toxicity may not become evident in the short term; however, through continued exposure to the substance, a cumulative effect may produce long-term symptoms, e.g. peripheral nerve damage caused by exposure to mercury compounds. Some compounds only require a limited exposure to become lethal to the operator.

NOTE 1: Some chemicals, e.g. arsenic, inorganic cyanides and scheduled poisons, are regulated by National, State or Territory legislation. Special storage and handling may be required.

Workplace monitoring and health surveillance for some toxic chemicals is covered by national, state or territory legislation, e.g. lead, carcinogens. Additional cases for monitoring and surveillance shall be identified by risk assessment. Some chemicals present or increase the risk for people of reproductive age and for developing foetuses. There may be a need to limit exposure to these chemicals. The chemicals shall be identified from sources of safety information and separately controlled.

NOTE [Appendix F](#) provides information on the properties of some hazardous chemicals.

4.5.2 Toxic dusts

The danger of poisoning by inhalation or absorption through the skin is obvious when the substance is a liquid or gas. With solids however, danger can also arise from breathing toxic dust or from ingesting substances lodged under fingernails or on the skin. Gloves and other appropriate protective equipment shall always be worn when handling toxic dusts; however, more complete protection is obtained by using a glove box or other enclosed systems.

4.6 Corrosive substances

Corrosive substances can damage or destroy materials or living tissue by direct chemical action. Corrosive substances are listed as Class 8 dangerous goods under the ADG Code and NZS 5433. Even though the primary hazard of these substances is their corrosive nature, special attention should be given to the subsidiary risk which can be present, e.g. flammable, oxidizing or toxic. For example, some corrosive substances can compromise storage compatibility, affect waste disposal and affect medical treatment procedures.

NOTE 1 Specific information on the safe storage and handling of corrosive substances can be obtained from AS 3780.

NOTE 2 [Appendix G](#) provides information on the hazardous properties of some corrosive substances.

4.7 Unstable chemicals

Chemicals that are prone to degrade over time or react violently (either spontaneously or due to environmental contact) can often produce an explosion or fire. Chemical instability is usually indicated by a note or warning placed on the container by the supplier and on the SDS for the chemical.

NOTE [Appendix H](#) provides information on the hazardous properties of some unstable chemicals.

Data on compound instability can be found in the literature (e.g. Lewis 2004 and Bretherick, Urben and Pitt 1999, see Bibliography). Additional authorization, safety, storage and security procedures may need to be instituted for the use of unstable chemicals.

Unstable chemicals left over from chemical work should be deactivated. Consideration should be given to handling unstable chemicals with remote control devices.

4.8 Highly reactive chemicals

Many chemicals, even some common reagents, have a dangerously high level of reactivity.

NOTE [Appendices F](#) and [J](#) provide information on the hazardous properties of some highly reactive chemicals and perchloric acid.

Contamination of reactive chemicals can produce an exothermic reaction which can evolve dangerous amounts of heat. The heat evolved from the mixing of chemicals can cause splashing and spraying of the mixture which can cause burns, poisoning, fire or explosion. It is therefore essential to take extreme care in handling and storing reactive chemicals. Substances that react violently together shall not be stored in close proximity to each other. Information on appropriate storage conditions should be sought from manufacturers or relevant state authorities. When transferring highly reactive chemicals to secondary storage containers, ensure the compatibility of the chemical with the container and provide appropriate labelling.

NOTE The chemical should be compatible with the previous contents of the container. Preferably the chemical should be transferred to a clean, dry, new container.

Full eye protection, e.g. goggles or a face shield, shall be worn when any highly reactive materials are being used. Safety carriers shall be used to transport containers of reactive liquids.

In stores and service rooms, appropriate safety equipment shall be available when dispensing or handling highly reactive chemicals or when cleaning up after spills. Floor drainage, separation bunds (see [Definition 1.4.4](#)) and ventilation of stores and service rooms are important (see AS/NZS 2982).

4.9 Nanotechnology

4.9.1 General

All nanomaterials and nanotechnology processes shall be considered potentially hazardous unless evidence is obtained to the contrary. While the bulk form of a material may be non-hazardous, the nano form of the same material may have altered physical properties or toxicological profile, which could lead to it being hazardous. A general description of nanomaterials is found in [Appendix J](#).

4.9.2 Hazard identification

The health, safety and environmental hazards associated with each nanomaterial or nanotechnology process shall be identified and documented. Aspects to consider include:

- The type of nanomaterial being manufactured, supplied or used, and its quantity
- The proposed use of the nanomaterial and process method
- The types of plant and equipment being used with nanomaterials

- (d) The physical characteristics of the nanomaterial, e.g. size, shape, surface area, solubility, charge
- (e) Whether the bulk form of the nanomaterial is designated as a hazardous chemical, e.g. carcinogenic, mutagenic, corrosive, flammable, toxic, a skin sensitizer or respiratory irritant
- (f) Secondary or subsidiary risks of the nanomaterial, e.g. fire, explosion, toxicity of intermediaries or catalysts
- (g) If the nanomaterial is used alone or in combination with other potentially hazardous materials
- (h) Whether there is potential for exposure to the nanomaterial that would allow it to enter the body through one or more of the following routes: inhalation; ingestion; skin or mucous membrane contact; and injection
- (i) Whether there are existing workplace exposure limits for the bulk form of the nanomaterial
- (j) Tasks where dusts or aerosols may or do occur, such as:
 - (i) Transferring from packaging, weighing, pouring, mixing, stirring;
 - (ii) Abrading, polishing or cutting a composite material containing nanomaterials.
- (k) How the nanomaterial will be stored and any signage required
- (l) How the nanomaterial will be contained and/or made safe by filtration, neutralization, dissolution or other chemical or physical means
- (m) How safe disposal will be carried out
- (n) Packaging, transport, clean-up and waste disposal requirements.

4.9.3 Safety data sheet (SDS)

The SDS for the nanomaterial shall be read. Where the SDS is only available for the bulk form of the material, further information on the nano form shall be sought.

NOTE Research on the health and environmental hazards associated with nanomaterials is ongoing. Users should seek updates on the hazardous properties of nanomaterials being used on a regular basis.

4.9.4 Risk assessment and control

The risks associated with each of the identified hazards of nanomaterials and nanotechnology processes shall be assessed and controlled.

4.9.5 Register

A register shall be maintained where nanomaterials are used, stored or manufactured. The register shall include the following details:

- (a) Description of nanomaterial being used, stored or manufactured.
- (b) Description of process.
- (c) Location of the process.
- (d) Safety Data Sheet developed or obtained from a manufacturer/importer.
- (e) Whether a risk assessment has been conducted and documented.
- (f) Whether labelling has been implemented.

4.9.6 Work area

Where the level of hazard is not known, or a high hazard is determined, consideration shall be given to undertaking the work in a laboratory or other facility dedicated to the use of that material.

- (a) Depending on the nature and quantity of the nanomaterial being manufactured (e.g. carbon nanotube) it may be appropriate to have a specifically designed work area that includes negative pressure work areas, clean rooms and airlock facilities.
- (b) The floor of the work area shall be permanent and washable.
- (c) The floor shall be fitted with tack-regenerating mat or sticky mats. Sticky mats shall be placed at both inside and immediately outside the access points to the work area.
- (d) Dedicated hand basins or an alternative means of decontaminating hands shall be provided inside each laboratory near the exit.
- (e) Storage for PPE shall be provided. Hooks for storage facilities for laboratory gowns that prevent cross-contamination shall be provided within the laboratory near the exit.

4.9.7 Fume cupboards and ventilation

Processes that generate dusts or aerosols shall be avoided where practicable. Where this is not practicable, appropriate ventilation, exhaust and filtration systems shall be used to control atmospheric and environmental contamination.

Work shall be performed in a fume cupboard, where this is practicable. Where deemed appropriate, the fume cupboard shall be fitted with a HEPA filter. Fume cupboards shall be maintained in accordance with AS/NZS 2243 Parts 8 and 9. HEPA filters used in the exhaust system shall be in accordance with AS 4260.

Where it is not practicable to conduct the work in a fume cupboard, an alternative method of preventing exposure to workers or the environment shall be identified and implemented appropriately.

NOTE 1 This may include enclosing plant, or that part of plant producing the dust or aerosol and exhausting the air through a HEPA filter to a point external to the building.

NOTE 2 The possibility of using a Class II biological safety cabinet may also be considered.

4.9.8 Information, instruction, training and supervision

Information, instruction, supervision and training shall be provided to workers conducting activities involving nanomaterials and nanotechnology processes, including cleaning and maintenance personnel. This shall include:

- (a) The hazardous properties of nanomaterials, and where it is available, on the specific hazards of a particular nanomaterial
- (b) Minimization of the hazard and methods of protecting against damage
- (c) The steps to be used in handling or manufacturing the nanomaterials, including storage and transport
- (d) Clean-up methods and disposal procedures to make nanomaterial safe
- (e) Recognition, assessment and possible treatment of any affect from over-exposure.

4.9.9 Labelling

Products containing engineered or manufactured nanomaterials, or chemicals that contain manufactured nanomaterial, shall be clearly labelled in accordance with regulatory requirements for labelling of hazardous chemicals.

Additionally, as a precautionary approach, one of the following label statements shall be used for products containing nanomaterials where the hazards arising from the nanomaterial are not fully characterized:

- (a) Contains engineered/manufactured nanomaterials. Caution: Hazards unknown.
- (b) Contains engineered/manufactured nanomaterials. Caution: Hazards not fully characterized.

4.9.10 Signage

The laboratory or area where nanomaterials are being used or manufactured and/or nanotechnology processes are being conducted shall be signposted to warn of the hazard

Cupboards that contain nanomaterial shall be sign-posted

Signs shall also be displayed to indicate any PPE to be used in the laboratory and to state any access restrictions.

4.9.11 Personal protective equipment (PPE)

4.9.11.1 General

PPE appropriate to the hazard and the task shall be worn. PPE shall be maintained appropriately

Areas where workers and others are required to use PPE shall be clearly identified by signs or other means

All PPE shall be removed prior to exiting the laboratory.

4.9.11.2 Gloves

Impervious gloves shall be selected and worn at all times when handling or using nanomaterial. The practise of double gloving shall be used, unless contraindicated by a risk assessment.

NOTE Nitrile gloves may be suitable.

4.9.11.3 Footwear

Enclosed shoes shall be worn at all times and disposable overshoes shall also be worn when working with nanomaterials.

Respiratory protection – a minimum of P2 level face protection shall be worn at all times when handling or using nanomaterials that are in a dry state or powder form. This may be in the form of a P2 face mask, half or full face respirator. This practice shall be used, unless contraindicated.

NOTE Refer to AS/NZS 1715 for guidance on selecting a respirator for specific air contaminants, and AS/NZS 1716 provides information on the filter class (P1, P2 or P3).

4.9.11.4 Eye protection

Eye protection shall be used at all times when handling, using or manufacturing nanomaterials. The decision as to whether to use safety goggles or safety glasses should be based on the activity, the nature of the nanomaterial (i.e. liquid or dry state) other controls used and the hazards of the nanomaterials and other chemicals involved. Further information regarding the selection and use of eye protection can be found in AS 1337.

4.9.11.5 Body protection

When working with, using or manufacturing nanomaterials, full body and hooded impervious coveralls shall be used unless contraindicated by a risk assessment. Coveralls shall meet or exceed Category III, Type 5-B or 6-B.

4.9.12 Safety equipment and hygiene

Eyewash facilities shall be provided in accordance with AS/NZS 2982

PPE shall be removed before leaving the laboratory

Hands shall be decontaminated before leaving the laboratory. Provision for hand decontamination, e.g. a hand basin, shall be suitably located near the exit. The hand decontamination methodology (e.g. detergent and hand washing) shall be effective for removal of the nanomaterial being used in the laboratory.

4.9.13 Storage, packaging and transport

Storage, packaging and transport may be the subject of national, state and territory legislation and national codes of practice. In addition, the following requirements apply:

- (a) All nanomaterials shall be placed in plastic bags, and then double-bagged or placed in a second sealed container, and labelled
- (b) All nanomaterial shall be stored in break-proof containers and shall be sealed securely
- (c) All containers in which nanomaterial is stored shall be clearly labelled in accordance with regulatory requirements for labelling of hazardous chemicals.

4.9.14 Cleaning and maintenance

Dedicated spill kits shall be readily available for use

Wet cleaning methods, such as the following, shall be used where possible:

- (a) Mist the area with water containing mild detergent.
- (b) Wipe with disposable wipes until clear then double bag wipes for disposa.

The following requirements and recommendations apply:

- (i) Larger areas such as floors should be cleaned using a wet vacuum with HEPA filtration or wet mopping technique with a disposable mop head
- (ii) An alternative to wet cleaning is the use of a tested and certified HEPA vacuum method developed for use with dry materials or residues from dried spills
- (iii) Plant and equipment using nanomaterials and conducting nanotechnology processes shall be checked after routine and unscheduled cleaning and maintenance, and significant modification that may impact on safety or emissions
- (iv) An emergency response plan shall be established to deal with the accidental release or spill. This plan should be commensurate with the size of the spill or accidental release of nanomaterials. The plan shall be readily accessible and available to all who may need it in case of emergency.

4.9.15 Waste disposal

Disposal of hazardous waste may be the subject of national, state and territory legislation. This may involve the use of a licensed waste disposal company. In addition, the following requirements apply:

- (a) All nanomaterial waste including contaminated PPE, laboratory wipes etc. shall be segregated from other wastes
- (b) Nanomaterial waste shall be placed in plastic bags, and then double-bagged or placed in a second sealed container
- (c) All nanomaterial waste shall be labelled and include the characteristics of the nano material (e.g. carbon nano tube)

NOTE Binding the nanomaterial into a stable inert polymer matrix may also be appropriate prior to disposal.

Section 5 Basic principles of storage

5.1 Scope

This Section describes the basic principles for storing chemicals and gas cylinders to ensure the safety of persons, property and the environment.

The storage requirements do not apply if the chemicals are —

- (a) currently being processed or used in experimental operations such as reaction, blending, or mixing; or
- (b) kept in the laboratory prior to use within the next 12 h or following use within the previous 12 h and their quantity or inherent hazard do not create any significant danger to persons or the environment. Where separation distances are specified, these shall be measured horizontally unless stated otherwise in the accompanying text.

5.2 Documentation

Documentation for all processes, including design criteria and the risk assessment, shall be kept for future reference for a period not less than that required in relevant legislation.

5.3 Knowledge of chemicals and gases

Information on the properties of the chemicals and gases to be stored shall be available to, and be understood by, personnel using and handling chemicals. As a minimum, this shall include the provision of SDS for all hazardous chemicals with which they may come in contact.

5.4 Choice of risk control measures

In addition to the requirements of this Standard, any storage of chemicals outside the laboratory shall conform to the requirements of AS 2243.1 and either —

- (a) conform to the requirements of the Standards applicable to the storage of each class or mixed classes of dangerous goods stored; or
- (b) be subject to a risk assessment and have control measures applied that provide a level of safety equal or higher than that achieved by Items (a) or (b).

NOTE National, state or territory regulations may also apply.

The basic principles, storage procedures and features for laboratory storage set out in this Standard shall be applied to all laboratory storage. The choice of control measures applies to storage areas outside the laboratory.

5.5 Storage procedures

When keeping chemicals in storage the following precautions shall be observed:

- (a) The quantities of hazardous chemicals shall be kept to a minimum, commensurate with their usage and shelf life. Some chemicals degrade in storage and can become more hazardous. Such chemicals shall be identified and managed appropriately.
- (b) Containers that have held hazardous chemicals shall be treated as full, unless the receptacle or package has been rendered free from hazardous chemicals.
- (c) All packages in storage shall be labelled to allow unmistakable identification of the contents. All labels shall be in accordance with relevant regulations.
- (d) Storage of chemicals, including wastes, shall be based on the properties and mutual reactivities of the chemicals. Incompatible chemicals shall be kept segregated from one another, e.g. by fire isolation in a chemical storage cabinet or segregation in space. A separate spill catchment shall be provided for each incompatible liquid.
- (e) Opening of packages, transferring of contents, dispensing of chemicals or sampling shall not be conducted in or on top of a cabinet or a cupboard for storing hazardous chemicals unless it is specifically designed for this purpose and appropriate procedures and equipment are used.
- (f) Where aluminium cylinders, including fire extinguishers, are used, they shall be protected from incompatible dangerous goods used in the area.

NOTE Mercury or alkaline liquids can very quickly produce a hole in an aluminium cylinder.

- (g) Provision shall be made for the receiving and despatch of materials, and the inspection of packages for damage.
- (h) Packages shall be inspected regularly to ensure their integrity. Leaking or damaged packages shall be removed to a safe area for repacking or disposal. Labels shall be reattached or replaced, as necessary, to clearly identify the contents of the package.
- (i) A direct-fired heater in which flame is exposed or the products of combustion are discharged into the room, or a gas or electric radiant heater, shall not be used for heating any room where flammable substances or temperature sensitive chemicals are stored.

NOTE If required, a heating device of the type specified in [Clause 8.4.6](#) may be provided.

- (j) Where flammable vapours or combustible dusts may be present as part of normal or abnormal operations, the areas shall be classified in accordance with AS/NZS 60079.10 and AS/NZS 60079.10.2. The relevant requirements concerning avoidance of ignition sources shall be complied with in situations other than those where the ignition source is controlled and is necessary for experimental purposes, such as the use of a bunsen burner. Electrical equipment shall be in accordance with AS/NZS 3000 if installed, or other applicable Standards if portable.
- (k) Procedures shall be established to deal with clean up and safe disposal of spillages. Supplies and materials needed to control the spillages shall be readily accessible.
- (l) Substances which are unstable at ambient temperature shall be kept in a controlled temperature environment set to maintain an appropriate temperature range. Reliable alternative safety measures shall be provided for situations when utilities, such as power, fail. Substances that can present additional hazards on heating shall be clearly identified.

- (m) Sunlight can affect some plastic containers or the chemical contents. Containers or chemicals that can be affected shall not be stored in a laboratory where they can be exposed to direct sunlight if there is potential for the sunlight to create a safety hazard. If the stability of the chemical can be affected without creating a safety hazard, procedures shall be in place to ensure the chemical is assessed prior to use.

In addition to the above, the following precautions should be observed:

- (i) The type and size of individual packages should be chosen to minimize the quantities and handling risk. Breakable or non-spillproof packages should be avoided. 'User-friendly' small packages for laboratory use may be filled from larger containers kept elsewhere.
- (ii) Where incompatible chemicals are in the same work area, precautions should be taken to prevent their accidental mixing.
- (iii) Volatile toxic substances should be stored in a continuously mechanically-ventilated cupboard, away from sources of heat or ignition.

5.6 Segregation

5.6.1 Information on chemicals and gases

It is not practicable to provide comprehensive advice on detailed methods to be adopted when keeping incompatible materials apart. The guidelines given in this Clause may achieve a measure of safe storage.

Before the method of segregation can be determined, information should be obtained on the chemicals and gases that may be stored. The required information includes the following:

- (a) Knowledge of dangerous goods and hazardous substances classifications.
- (b) Properties of chemicals from SDS.
- (c) Reactivity with water for ingress of water or firefighting considerations.
- (d) Physical properties of chemicals, such as boiling point, stability, flash point.

NOTE Where local knowledge and published information on their properties indicate that it is prudent, certain chemicals may need to be further segregated from those with which they may react by keeping the packages separated.

5.6.2 Classification for segregation

When considering the need for segregation of chemicals, the following categories of chemicals may be used:

- (a) *Unstable chemicals* — unstable at or below ambient temperature requiring storage in a cold store; unstable at or above ambient temperature and requiring some shade.

NOTE In almost all cases chemicals and dangerous goods should be stored away from direct sunlight.

- (b) *Flammable and combustible liquids* — such as Class 3 dangerous goods
- (c) *Flammable solids* — such as Class 4.1 dangerous goods
- (d) *Spontaneously combustible or pyrophoric chemicals* — such as Class 4.2 dangerous goods
- (e) *Chemicals that react with water* — such as Class 4.3 dangerous goods
- (f) *Organic peroxides* — such as Class 5.2 dangerous goods
- (g) *Other oxidizing chemicals* — such as Class 5.1 dangerous goods

- (h) *Toxic and carcinogenic materials* — such as chemicals suspected to be carcinogenic, mutagenic or teratogenic, and Class 6.1 dangerous goods
- (i) *Corrosive chemicals* — such as Class 8 dangerous goods.

Note 1 Incompatibilities may exist within the broad classifications given in this Clause. Further information should be sought to ensure suitable segregation of incompatible substances.

Note 2 The ADG Code provides information on a number of chemicals which are classified as dangerous goods

Section 6 Required features for a laboratory, storeroom or space, chemical storage cabinets, laboratory cupboards, racks and shelves

6.1 Scope

This Section sets out requirements for features for laboratories where chemicals including gases are used, for a dedicated room or space where chemicals are stored, and for a room or space where chemicals may be transferred from a package.

6.2 Laboratory

The laboratory shall meet the requirements of AS/NZS 2982.

6.3 Chemical storage cabinets

6.3.1 General

Chemical storage cabinets for the storage of dangerous goods are intended —

- (a) to protect the contents against damage;
- (b) to provide segregation between incompatible substances;
- (c) to contain spillages; and
- (d) in the case of fire, to allow at least 10 min for escape of persons or use of firefighting equipment.

6.3.2 Cabinet storage capacity

Cabinets shall not exceed 250 L capacity.

6.3.3 Mixed Class DG storage in a cabinet

Storage of mixed class dangerous goods within one cabinet shall comply with AS/NZS 3833. Refer to segregation requirements in [Table 2](#).

6.3.4 Design

Cabinets shall be in accordance with AS 1940. Cabinets containing Class 5.1 and Class 5.2 hazardous chemicals shall be in accordance with AS 4326 and AS 2714, respectively.

A chemically resistant lining should be considered for the entire interior of the cabinet as spill trays may not be sufficient to prevent contact of spilled material with parts of the interior of the cabinet.

NOTE Bare metal, rust or corrosion may catalyse decomposition of the spilled material.

6.3.5 Ventilation

Cabinet ventilation should not normally be required unless determined as an essential risk control measure.

Ventilation for Classes 5.1 and 5.2 hazardous chemicals shall be in accordance with AS 4326 and AS 2714, respectively.

6.3.6 Cabinet location

Cabinets shall not be located —

- (a) one above the other;
- (b) where they can jeopardize emergency escape;

NOTE A minimum of 3 m is recommended between any cabinet and escape doors.

- (c) under stairs or in corridors.

No more than three 250 L cabinets shall be kept in a 250 m² laboratory area. Cabinets shall be separated by at least 3 m.

6.4 Laboratory cupboards

Laboratory cupboards used for the storage of hazardous chemicals shall be compatible with the chemicals held or shall be suitably protected from the chemicals.

NOTE The use of particle or similar boards is not recommended as they may fail when subjected to moisture.

Laboratory cupboards shall be provided with spill trays. Where necessary, ventilation of the cupboard shall be provided in accordance with the relevant requirements in [Clause 6.3.4](#).

NOTE Labelling of cupboards to indicate their contents is recommended.

No more than 250 kg of mixed hazardous chemicals shall be stored in cupboards.

6.5 Display of hazard identification information

The entrance to a room and the doors of a chemical storage cabinet shall display signage regarding dangerous goods which are stored or handled within. National, state or territory regulations may apply.

NOTE The information required may include class labels, packing groups and emergency contact details.

6.6 Storeroom or space

A dedicated room or space where chemicals are stored shall meet the appropriate requirements of Section 8.

6.7 Room for opening packages

A room or space meant for transfer of contents of a package (see Section 10) shall meet the requirements of Section 8.

6.8 Shelves and racks

Shelves and racks shall incorporate the features described in Clause 7.5.2.

PUBLIC COMMENTING DRAFT

Section 7 Storage of chemicals and gas cylinders within a laboratory

7.1 Scope

This Section specifies the manner in which chemicals and gas cylinders are to be kept when in use within a laboratory.

7.2 Size of chemical package

The size of individual packages for hazardous chemicals kept on laboratory shelving or benches for use in the laboratory shall not exceed the limits set out in [Table 2](#).

Any individual container brought into the laboratory for decanting or dispensing shall not be greater than 25 L for liquids or 25 kg for solids unless manual handling facilities are provided (see [Clause 5.6](#)).

Individual containers used for the collection of chemical wastes shall not exceed 25 L. Waste containers should not be larger than necessary for the scope of the laboratory's operations. Waste containers should be removed from the laboratory frequently to prevent any hazards from accumulated waste.

7.3 Quantities of chemicals in storage within a laboratory

7.3.1 General

The quantities of chemicals should be restricted to the minimum levels consistent with the operations of the laboratory. Following use, chemicals should be returned to storage.

7.3.2 Maximum quantities of hazardous chemicals in storage within a laboratory

The quantities of hazardous chemicals stored in a laboratory shall not exceed those specified in [Table 2](#). For particular groups of chemicals or items, due to their hazardous nature or regulatory requirements, additional storage requirements may be necessary. Goods too dangerous to be transported according to the ADG Code, e.g. some forms of nitrocellulose and some products containing nitrocellulose, shall be individually assessed and the quantities and storage conditions determined accordingly.

Consideration shall also be given to additional storage requirements for the following:

- (a) Scheduled drugs, poisons and controlled substances.
- (b) Scheduled carcinogens.
- (c) Illicit drug precursors.
- (d) Chemicals of security concern.

NOTE Refer to government agencies for further information.

- (e) Hydrofluoric acid.
- (f) Nitric acid etchant blends, e.g. nital.
- (g) Perchloric acid and its etchant mixtures.

7.3.3 Maximum quantities of hazardous chemicals in chemical storage cabinets within a laboratory

7.3.3.1 Cabinet storage capacity

The capacity of any chemical storage cabinet used in a laboratory to store chemicals of Classes 4.1, 4.2, 4.3, 5.1 or 5.2 shall not exceed 50 L. For other chemicals, the capacity shall not exceed 250 L.

7.3.3.2 Separation

Within a radius of 10 m, measured from any one cabinet, the cabinet storage capacity aggregated for all cabinets in that radius shall not exceed 250 L or 250 kg, including no more than 10 L or 10 kg each of dangerous goods of Classes 4.1, 4.2, 4.3, 5.1 or 5.2 that are classified as PG I. The radius shall be measured horizontally through intervening walls, unless those walls are able to prevent the spreading of a fire of the magnitude that could be expected to result from the contents of the cabinet(s).

NOTE A fire rating for the walls is not specified. Concrete or masonry walls or walls of plasterboard on steel or hardwood studs reaching to ceiling height without windows or glass panels would normally suffice. Doors in such walls should be of similar fire-resistant nature and self-closing.

Table 2 — Maximum storage quantities

Laboratory (see Notes 1,2,3)	Mixed class chemical storage in a laboratory shall not exceed 250 kg with the following conditions: (a) No more than 25 kg or PG 1 (b) Class 3 Flammable liquids shall not exceed the following: (i) 50 L per 50 m ² of floor space, or 50 L in a room of up to 50 m ² of floor space for PG I or PG II (ii) 100 L per 50 m ² of floor space for PG III (iii) 200 L total for C1 and C2 combustible liquids (iv) The limit for any manufactured product is the same as for a liquid of the same Packing Group
Mixed class chemical storage	< 250 kg or 250 L with the following conditions: (a) No more than 25 kg of PG 1 (b) Class 3 Flammable liquids shall not exceed minor storage provisions for "laboratory" in AS 1940
Chemical storage cabinets	< 250 kg each for Classes 3, 4.1, 4.3, 5, 6.1 and 8 Maximum 3 cabinets at 3 m apart in a 250 m ² area
Internal fire rated store	2000 kg mixed dangerous goods Segregation based on AS 3933
External store	Segregation based on AS 3933

Where more than one type of dangerous goods are kept in a cabinet, such goods shall be compatible (AS/NZS 3833 — 2007, Clause 5.10.1)

If the compatibility of the goods being kept cannot be fully ascertained from the available technical information, each class shall be kept in a separate cabinet, except that Class 3 and 4.1 and combustible liquids may be store in the same cabinet. (AS/NZS 3833 — 2007, Clause 5.10.1).

NOTE 1 This Table is intended to cater for the day-to-day working stock in the laboratory. If these quantities are to be exceeded, it will be necessary to install a cabinet or major store facility according to the scale needed.

NOTE 2 Laboratories that are constructed, operated and equipped in the form of a flammable liquid storage room, and are used for the analysis of flammable liquids being processed, are exempt from this Table.

NOTE 3 Materials being analysed, used, mixed, blended or reacted upon on laboratory benches or in fume cupboards are exempt from the limitations of this Table.

NOTE 4 Where more than one type of dangerous goods are kept in a cabinet, such goods shall be compatible (AS 3833 part 5.10.1).

NOTE 5 If the compatibility of the goods being kept cannot be fully ascertained from the available technical information, each class shall be kept in a separate cabinet, except that Class 3 and 4.1 and combustible liquids may be store in the same cabinet. (AS 3833 part 5.10.1).

7.4 Method of keeping chemicals

7.4.1 Enclosed storage

All chemicals should be stored in chemical storage cabinets or laboratory cupboards (see [Clauses 6.3](#) and [6.4](#)).

7.4.2 Open storage

Chemicals kept on shelves or racks shall be subject to the following restrictions:

- For shelves over benches, chemicals shall not be stored on shelves higher than 1.5 m from the floor.
- Shelving and its fixtures shall be compatible with the goods stored, or shall be suitably protected from the goods.

NOTE The use of particle or similar boards is not recommended as they may fail when subjected to moisture or chemicals.

- The maximum holding capacity of the shelving systems shall not be exceeded.

NOTE To assist housekeeping, chemical packages should not be kept on the floor.

- Shelves used for chemical storage shall be restrained against lateral movement.

Liquids of any kind should not be stored above solids to reduce the risk of contamination. Liquids should be stored as low as possible to reduce the risk of breakage and spillage.

7.4.3 Burettes

Where dilute reagents are in use for gravity feed burettes, the glass containers may be stored on a higher shelf consistent with the operation. In such cases provision should be made for spill control.

7.5 Restriction on opening packages

Adequate ventilation, consistent with the properties of the substance, the quantity being handled, the method of transfer and the hazardous zoning applicable shall be available in the location selected for the opening of packages. Spill control shall be provided. Spill control may be achieved through the use of bench design, the use of a tray made from materials resistant to the chemicals being handled, the use of spill control kits or a combination of these.

NOTE Consideration should be given to the human exposure hazard associated with opening packages of hazardous substances.

7.6 Segregation in storage

7.6.1 Incompatible chemicals

7.6.1.1 General

Incompatible chemicals shall not be stored together unless segregated.

7.6.1.2 Horizontal and vertical storage on open shelving

If segregating by leaving an intervening space, the intervening space may be left empty or used for keeping compatible goods, if it is sufficient to prevent the mixing of incompatible chemicals should two containers break at the same time; or the spill catchments for areas in which incompatible goods are kept are separated.

Any goods kept in such intervening spaces shall be compatible with the chemicals being segregated and shall be either —

- (a) non-combustible; or
- (b) if combustible, only be used after a risk assessment, including an assessment of additional fire load, has been carried out and any necessary additional fire protection has been provided.

7.6.1.3 Chemical storage cabinets

If incompatible chemicals are stored in a chemical storage cabinet, measures shall be taken to prevent contact between the chemicals or mixing of spills and any necessary additional fire protection shall be provided.

NOTE The requirements in [Clause 7.6.2](#) to 7.6.11 are specified to simplify segregation procedures and include measures taken after consideration of firefighting procedures for certain Classes.

7.6.2 Class 3 dangerous goods (flammable liquids) and combustible liquids

A chemical storage cabinet or cupboard used to store these liquids shall not be used for the storing of dangerous goods of any other Class.

7.6.3 Class 4.1 dangerous goods (flammable solids)

A chemical storage cabinet or cupboard used to store Class 4.1 dangerous goods shall not be used for storing dangerous goods of any other Class.

7.6.4 Class 4.2 dangerous goods (substances liable to spontaneous combustion)

If Class 4.2 dangerous goods are kept in a cabinet or cupboard, the cabinet or cupboard shall be dedicated to the storage of that particular class of goods only.

NOTE Incompatible chemicals include flammable liquids and oxidizing agents.

7.6.5 Class 4.3 dangerous goods (substances that, in contact with water, emit flammable gases)

If Class 4.3 dangerous goods are kept in a cabinet or cupboard, the cabinet or cupboard shall be dedicated to the storage of that particular class of goods only.

NOTE For Class 4.3 dangerous goods, incompatible chemicals include flammable liquids, oxidizing agents and water.

7.6.6 Class 5.1 dangerous goods (oxidizing substances)

Class 5.1 dangerous goods shall be kept in a chemical storage cabinet, suitable refrigerated storage or a laboratory cupboard dedicated to their storage.

NOTE Incompatibilities exist between chemicals in Class 5.1, refer to SDS or suppliers for further information.

7.6.7 Class 5.2 dangerous goods (organic peroxides)

Class 5.2 dangerous goods shall be kept in a chemical storage cabinet, suitable refrigerated storage or a laboratory cupboard dedicated to their storage.

7.6.8 Class 6.1 dangerous goods (toxic substances)

Toxic substances may be subject to special storage requirements under national, state and territory regulations. Packages containing inorganic cyanides shall not be stored with acids or in any other way that will allow reactions with incompatible chemicals.

7.6.9 Class 8 dangerous goods (corrosive substances)

Class 8 dangerous goods shall be stored in a manner that will prevent reactions between —

- (a) acids and alkalis;
- (b) acids and hypochlorites;
- (c) acids and cyanides;
- (d) acids and Class 4.3 dangerous goods;
- (e) oxidizing acids and combustible materials; and
- (f) incompatible acids.

7.6.10 Class 9 dangerous goods (miscellaneous dangerous goods and articles)

The segregation of Class 9 dangerous goods shall be in accordance with AS/NZS 4681.

7.7 Compressed gases and cryogenic liquids

7.7.1 Compressed gas cylinders

A laboratory compartment shall not be used for storing gas cylinders. Cylinders may be kept connected for use inside a laboratory only if an outdoor location is not practical. The inadvertent release of gas from cylinders kept connected for use in laboratories shall be considered with respect to any potential hazard such as asphyxiation, oxygen-enrichment or other hazardous effects of the gases.

LP Gas cylinders shall be used or stored in accordance with AS/NZS 1596.

7.7.2 Class 2.3 toxic gases

Cylinders of toxic gas shall not be kept in any laboratory, unless in use. When such cylinders are in use in a laboratory, the presence of the gas shall be clearly signposted at each entrance to the room.

NOTE Toxic gases should preferably be kept outside the laboratory. Reference should be made to local regulations.

7.7.3 Cryogenic liquids

7.7.3.1 Flammable or toxic cryogenic liquids

Where flammable or toxic cryogenic liquids need to be used in a laboratory, the capacity of the container shall not exceed 5 L, and the container shall be kept in a specially ventilated extraction enclosure exhausting to atmosphere.

Cryogenic liquids that are flammable or toxic shall not be stored in a laboratory.

7.7.3.2 Other cryogenic liquids

The capacity of a container for keeping other cryogenic liquids shall not exceed 250 L in accordance with AS 1894.

Cryogenic liquids shall not be stored in unventilated rooms, e.g. cold rooms, because of the risk of oxygen depletion and asphyxiation.

A risk assessment shall be undertaken to determine the requirements for ventilation, oxygen monitoring, fail-safe mechanisms and other controls.

Basement laboratories and basement storage areas are discouraged. Cryogenic liquids shall only be stored in such areas when a dual ventilation system consisting of a main system and a backup system is installed.

7.7.4 Size of gas cylinders

The size of gas cylinders shall be in accordance with local regulations or, where there are no local regulations applicable for the particular gas, the size shall be in accordance with the Standard for that gas.

Gas cylinders used in a laboratory shall be the minimum size consistent with the operations of the laboratory, with reference to the purpose of use, the hazards posed by the specific gas, the rate of consumption, ease of supply or replacement and the manual handling associated with the movement of the cylinder(s). In any case the volume of a cylinder meant for use by being brought into the laboratory, shall not exceed 70 L.

NOTE A "G" size cylinder is approximately 50 L internal volume.

Section 8 Storing chemicals in a separate store

8.1 Scope

This Section gives requirements for the storage of hazardous chemicals where the quantity of these chemicals does not exceed the limits set out in [Table 2](#) in a separate store.

8.2 Store location

8.2.1 General

The store may be —

- (a) attached to a laboratory;
- (b) attached to any other room; or
- (c) a freestanding building or structure.

8.2.2 Internal store

All internal stores should be located on the floor directly accessible from street level or a site roadway. For stores located on any other floor, a risk assessment shall be conducted and documented.

Maximum of 2000 kg of hazardous chemicals and dangerous goods shall be stored in an internal store.

8.2.3 Construction

Construction of stores shall be in accordance with AS/NZS 3833.

An external store shall be separated from on-site protected places, protected places and public places by at least —

- (a) 3 m for a storage capacity of hazardous chemicals not exceeding 1000 kg or 1000 L; or
- (b) 5 m for a storage capacity of hazardous chemicals between 1000 kg or 1000 L and 4500 kg or 4500 L.

Firewalls or vapour screens in accordance with AS 1940 may be used to achieve the required separation.

NOTE Designated open air rest and recreation areas should be regarded as on-site protected places.

8.3 Exclusions

Gas cylinders and cryogenic liquids shall not be held in this store.

NOTE See Section 9 for storage of gas cylinders and cryogenic liquids.

8.4 Store requirements

8.4.1 General

Laboratory stores shall be used for the storage of hazardous chemicals (except gases) for laboratory use when they are—

- (a) in quantities that exceed the quantities permitted to be kept on laboratory shelves or in chemical storage cabinets in the laboratory; or
- (b) chemicals that are not used frequently.

Other chemicals that are neither dangerous goods nor hazardous substances (e.g. starch or distilled water) may also be kept in the store.

Waste shall only be stored if it has been classified, packaged and labelled in accordance with AS 2243.1.

Other laboratory items such as glassware, apparatus or safety equipment should not be kept in the store.

A laboratory store shall meet the requirements of—

- (i) this Standard, where the quantity involved does not exceed the aggregate maximums specified in [Table 2](#);
- (ii) the Standard(s) relevant to the particular class(es) of dangerous goods; or
- (iii) AS/NZS 3833 for the storage of mixed classes of packaged dangerous goods.

The following background information for each option is provided:

- (A) This Standard allows a high level of flexibility in the range of hazardous chemicals that may be stored but it severely limits the total storage quantity. It is not applicable for quantities in excess of the allowances in [Table 2](#). This Standard is most appropriate for stores containing a large and possibly unpredictable range of hazardous chemicals, usually in relatively small quantities.
- (B) The relevant Standard for the Class of dangerous goods may be preferable if only non-flammable dangerous goods or only one or two Classes of dangerous goods are stored or if they are in dominant quantities.
- (C) AS/NZS 3833 is intended mainly for the storage of large quantities of pre-determined dangerous goods but excludes Packing Group I. It does not allow the storage flexibility often required for research and experimental laboratories. Further, the required internal segregation distances are not normally available in laboratory stores. AS/NZS 3833 may be suitable for industrial applications where large quantities of raw materials or finished products are held in “quarantine” awaiting quality assurance testing.

When option (a) is chosen, the laboratory store shall meet the requirements set out in Section 6 and this Section.

8.4.2 Store construction

8.4.2.1 General

For external and internal stores, the store construction shall comply with the requirements for flammable liquid stores in AS 1940 apart from the variations set out in this Clause. The store shall be designed to prevent ingress of direct sunlight.

8.4.2.2 Floor

The floor of a room or space shall contain the chemicals and be —

- (a) of non-combustible construction;
- (b) non-absorbent;
- (c) resistant to attack by the chemicals; and
- (d) provided with a spill catchment (see [Clause 8.4.7](#)).

8.4.3 Ventilation

The store ventilation shall be in accordance with the design principles specified in AS 1940 and shall have a capacity of not less than that specified in AS 1940. While AS 1940 permits the use of natural ventilation as the sole means of ventilation, mechanical ventilation should be considered to ensure sufficient airflow under all weather conditions. A higher rate of ventilation may be necessary if very volatile, toxic or corrosive substances are stored to ensure a safe working environment. Exposure standards may be used for guidance.

NOTE A two-stage ventilation system, where natural or low-capacity mechanical ventilation operates in normal operation and high capacity mechanical ventilation operates in the event of vapour release, may be considered. Activation may be by manual means or through a vapour detection system.

There shall be no recirculation of exhaust air except in a cooled store where a risk assessment has been conducted and appropriate risk control measures have been implemented.

Where stores are mechanically ventilated, the ventilation system shall be exclusive to the room.

If individual cabinets are ventilated, they shall be ventilated to external atmosphere in accordance with [Clause 6.3](#).

8.4.4 Cooled stores

The design of cooled rooms should take into account the effect of any recirculation of air and ensure any ignition sources associated with refrigeration equipment are isolated.

8.4.5 Heating

A direct-fired heater, in which the flame is exposed or the products of combustion are discharged inside the room, or a gas or electric radiant heater, shall not be used inside a store.

Heating shall only be provided by an indirect heating device, such as hot air or hot water based circulation systems. Any heating device shall be provided with controls that ensure that the room or space is not heated above the safe storage temperature of any chemical in the room or its packaging.

Stored chemicals shall be kept a safe distance from circulation system components and the entry points for hot air.

Ignition sources, such as an air-conditioning unit providing heated air, shall conform to the applicable hazardous zone requirements.

8.4.6 Ignition sources

Ignition sources shall not be permitted in hazardous areas. Any hazardous area assessment shall identify the criteria of the hazardous chemicals considered. The assessment should include the equipment group and temperature classification for the chemical being stored (see AS 2430.1, NZS 6101.1 and AS/NZS 2381.1). The temperature classification for a store shall be based on the lowest self-ignition temperature of any substance that may be stored. For example, if carbon disulfide, which has a self-ignition temperature of 100°C, is to be stored, the temperature classification will be T6.

NOTE The equipment group and temperature classification need special attention. For example, some solids (e.g. calcium carbide) may need an equipment group rating of IIc—acetylene.

8.4.7 Spillage containment

A room or space intended for storing or handling liquid chemicals shall be provided with a catchment for the retention of spills. It shall be sufficiently impervious to retain spillage and to enable recovery of any such spillage. Where incompatible chemicals are stored in the same area, the spill catchment system shall prevent these substances from coming into contact with one another in the event of a spill.

Individual trays or other receptacles, of a capacity equal to 100 % of the largest container stored, may be used under a shelf, rack, or single package as a catchment device in lieu of a catchment on the floor.

Hazardous chemicals with a significant spillage hazard shall be kept in chemical storage cabinets (see [Clause 8.5.1](#)). Cabinets shall have built-in spillage containment for at least 25 % of the storage capacity or the capacity of the largest container likely to be stored in the cabinet, whichever is the greater.

Additional containment for the store should be provided based on the worst reasonably likely spillage scenario.

Where a room has been provided with water or foam sprinklers, provision shall be made to contain, either inside or outside the room but within the premises, the volume of effluent arising from a sprinkler operation time of at least 20 min.

8.5 Method of storage

8.5.1 Chemical storage cabinets

Chemical storage cabinets shall be used within the store to prevent contact between incompatible substances and to reduce the rate of a fire spreading. Hazardous chemicals and combustible substances shall be stored in chemical storage cabinets except as allowed in [Table 2](#).

The maximum quantity of chemicals in any one chemical storage cabinet shall not exceed 250 L or 250 kg as specified in [Table 2](#). The quantity of particular classes of dangerous goods in one cabinet shall be further limited as specified in [Table 2](#). If a chemical storage cabinet contains any quantity of dangerous goods of PG I, the whole contents shall be regarded as PG I.

NOTE Smaller cabinets may be preferred for chemicals assigned to some packing groups.

Chemical storage cabinets shall be in accordance with [Clause 6.3](#) apart from cabinet separation requirements. Cabinets shall be separated from each other by not less than 250 mm airspace, which shall remain clear and accessible at all times.

8.5.2 Other storage

8.5.2.1 General

Chemicals stored outside chemical storage cabinets shall be stored on shelves, on racks or on pallets in accordance with 7.5.2 and this Clause.

8.5.2.2 Pallet storage

Pallets of chemicals may be stored on the floor or on racks. Pallets of chemicals shall not be placed on top of one another.

8.5.2.3 Shelving

The requirements of [Clause 7.4.2](#) shall be observed.

8.5.2.4 Access

Sufficient aisle space shall be provided for movement of personnel and mechanical handling units that may be used to handle the packages.

8.6 Management of movement of goods

The possibility of incompatible materials contacting one another, as a result of a container failure while being transported through or moved in the store, shall be evaluated. It shall be ensured that such materials can be conveyed in a manner which will not allow chemical interaction.

NOTE 1 As an example, the evaluation should consider how movement of packages of Class 5.2 goods through a Class 3 goods storage area can be avoided, when the packages are placed in or taken out of storage.

NOTE 2 Spillproof and unbreakable primary or secondary containers should be used to convey any substances other than those that do not pose a significant risk by virtue of their inherent properties or their small quantities. Larger glass bottles should be carried in a bottle carrier, rather than by hand.

8.7 Restriction on opening of packages

Packages shall be opened in accordance with the requirements set out in Section 7.

8.8 Segregation in storage

The requirements of [Clause 7.6](#) shall be observed.

8.9 Fire protection

The store should be provided with an automatic fire extinguishing system, or be equipped with an alarm which will sound at an attended place when the concentration of flammable or toxic vapour exceeds set limits, when there is smoke, or when heat is generated.

The selected method of fire protection shall be compatible with all hazardous chemicals stored. As a minimum, there shall be one portable fire extinguisher immediately outside the door to the store. Additional fire extinguishers may be required based on risk of the store's contents and design. The minimum size of fire extinguisher shall be equivalent to a 2A 60B(E) for powder-type extinguishers or a 2A 20B for foam extinguishers. Where dangerous goods of Packing Group I Classes 3, 4, 5 or 8 are kept, specialist advice may be required.

NOTE In New Zealand, the Hazardous Substances (Emergency Management) Regulation 2001 should be consulted.

8.10 Display of hazard identification information

At the entrance to the storage area, appropriate signage as required for the goods, determined from regulations, shall be displayed.

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8.11 Safety equipment

The following safety equipment shall be available and accessible to users of the laboratory chemical store and any associated loading bay or dock:

- (a) A permanently fixed, aerated eyewash facility capable of operation in a hands-free mode once activated.
- (b) At least one safety shower capable of operation in a hands-free mode once activated.
- (c) Adequate first aid facilities and supplies (see relevant National, State or Territory regulations).

Section 9 Storing gases and cryogenic liquids in a dedicated store

9.1 Scope of section

This Section gives requirements for the storage of gas cylinders and cryogenic liquid vessels in a room or area that is —

- (a) attached to a laboratory;
- (b) attached to another room or space;
- (c) in a freestanding building or structure; or
- (d) in the open.

9.2 General

Only gases or cryogenic liquids shall be kept in the room or space.

An “empty” gas cylinder shall be treated as a full container for the purposes of this Section, since empty containers retain a residual gas under pressure and should be secured as a full vessel.

NOTE Good practice requires that a small residual pressure should always be left in a cylinder to prevent internal contamination.

9.3 Requirements and location of store

9.3.1 General

The storage of liquefied petroleum gas, ammonia, chlorine, cryogenic liquids and liquefied natural gas in cylinders shall be in accordance with the requirements of AS/NZS 1596, AS/NZS 2022, AS/NZS 2927, AS 1894 or AS 3961 as appropriate, and requirements in those Standards shall be considered to have precedence over any requirements stated in this Section. When no separation is stated in the relevant Standard for cylinder storage, the separation distances specified in this Section shall apply.

The room or space shall meet the requirements of AS 4332 and [Clause 8.4.3](#). The separation distances of [Clause 9.7](#) shall apply.

The store floor shall be level, solid and well drained.

NOTE It is recommended that one side of the store be left open.

An open air location for storing gas cylinders need not be provided with a roof. If any gases that are sensitive or reactive to heat are to be stored, appropriate protection shall be provided.

9.3.2 Ventilation

Ventilation shall meet the requirements of AS 4332.

When lighter than air gases are stored in a room or space, ventilation shall also be provided at the highest point in the room.

NOTE A room in which flammable vapours or gases may accumulate may require ventilation, or be provided with vents which will relieve any explosion within the room without damage to the structure. AS 1375 and NFPA 68 give guidance on the design of explosion vents.

9.3.3 Electrical equipment

The area shall be classified in accordance with the AS 2430.1 or other appropriate Standards in the AS/NZS 2430 series and all electrical equipment installed in accordance with AS/NZS 3000. Portable electrical equipment taken into or for use in the store shall comply with relevant requirements for the hazardous zoning applicable to the store. See also [Clause 9.7.4](#).

9.4 Maximum quantities

The aggregate capacity of gas cylinders and cryogenic liquid vessels stored shall be in accordance with the limitations specified in the relevant standards.

NOTE Regulatory controls may also apply and if so take precedence.

9.5 Method of storage

The following precautions shall be observed when storing cylinders:

- (a) The location shall be such as will ensure that cylinders are not liable to physical damage, tampering, or excessive temperature rise. This requirement shall not be taken to preclude storage in the open, exposed to the sun (see [Clause 9.3.1](#)).
 - (b) Any shelter structure for stored cylinders shall be ventilated at the top and bottom. The cladding for walls and roof shall be non-combustible.
 - (c) Cylinders shall not be stored within 1 m of any opening in a building.
- NOTE Larger distances may be required for LP Gas and for toxic gases.
- (d) Cylinders shall be secured.
 - (e) Cylinders shall be stored with relief devices, e.g. safety valves or fusible plugs, always directly connected with the vapour space inside the cylinder.
 - (f) Valves and fittings on cylinders shall be protected from accidental damage and any pressure relief devices shall be directed away from other cylinders.

In addition to the above, the following precautions should be observed:

- (i) The cylinder storage area should be kept clear, and access should be restricted to authorized personnel only.
- (ii) Cylinders should not be stored in conditions likely to promote corrosion.
- (iii) Cylinders should be stored upright unless storage in another orientation is specified by the manufacturer.

9.6 Segregation in storage

Segregation of gas cylinders within the store shall be in accordance with the following:

- (a) Gases of Class 2.1 shall be segregated by at least 3 m from those of Class 2.2 having a Subsidiary Risk of 5.1.

NOTE This distance may be measured in a horizontal plane around an intervening, non-combustible, impervious vapour barrier provided that the height of the barrier extends at least 0.5 m above the highest cylinder in the store. The intervening distance may be used for the storage of Class 2.2 gases.

(b) Gases of Class 2.3 shall be segregated from gases of other classes by at least 3 m.

9.7 Separation from other occupancies

9.7.1 Separation distance

A room or area used for storing gas cylinders, whether full or “empty”, shall be separated from other areas or structures by distances not less than the minimum separation distances for gas cylinder stores listed in AS 4332.

9.7.2 Mixed storage of gases

For mixed storage of gases, the separation distances in AS 4332 shall apply.

9.7.3 Fire-resistant walls

Cylinders of gases of any type shall only be stored adjacent to the wall of an adjoining building if the requirements of AS 4332 are fulfilled.

9.7.4 Ignition sources

There shall be no ignition sources within the hazardous area around a flammable gas store, as determined using AS 2430.1. Ignition sources inside adjacent buildings shall be taken into account.

9.8 Display of hazard identification information

At the entrance to the storage area, appropriate signage for the stored goods, shall be displayed. Particular requirements may be specified in applicable regulations.

Section 10 Package opening and transfer

10.1 General

Where the opening of packages for the purpose of sampling or transfer of package contents is conducted in a store, a dedicated area, distinct from the area for storing packages should be provided. Packages should not be opened, or the contents accessed, in the actual storage cabinet, shelf or immediate storage area (especially while resting containers on top of other packages) to avoid the risks resulting from handling obstructions, close proximity to other packages, accidental escape of chemicals, escape of vapours or dust during transfers and possible reaction with other substances. Packages of incompatible chemicals shall not be opened at the same time.

Due to the wide variety of chemicals, quantities and methods of handling that can be involved, it is not possible to provide any specific design criteria for a handling area. Design considerations should be based on the most hazardous substance(s) permitted in the area.

Ventilation shall be provided for the dispensing area to remove vapours and dusts to levels that ensure a safe environment. Exposure standards may be used for guidance. Fume cupboards may be necessary for particularly hazardous chemicals. Fume cupboards shall be in accordance with AS/NZS 2243.8.

Any individual container brought into the laboratory for decanting or dispensing shall not be greater than 25 L for liquids or 25 kg for solids unless manual handling facilities are provided. See also [Clause 5.6](#).

10.2 Work procedures for package opening

Packages may be opened for transfer of contents, sampling and repackaging, and for the decanting of cryogenic liquids from one vessel into another.

At the end of transfer operations, the original package, either “empty” or with the residual contents, shall be removed from the area. After cleaning its exterior to remove any material adhering to the package, the original package shall be returned to storage or disposed.

The following procedures shall apply:

- (a) The area shall not be used as a store.
- (b) Goods in the area shall be of the same class of dangerous goods, and shall be compatible.
- (c) The packages in the area shall be restricted to those required for the process.
- (d) No part of a transfer operation shall be conducted without a person being present.

10.3 Transferring and repackaging

Where an empty container is to be filled with a chemical for storage and use at another time, it —

- (a) shall be suitable for the product, particularly in relation to its compatibility with the intended contents and the vapour pressure that can be generated; and
- (b) shall be properly identified and labelled to show, as a minimum requirement, the full name of the contents, class label and sub-risk label if applicable, and where required, the hazards of the contents.

NOTE 1 Labelling requirements may be specified by National, state and territory regulations.

NOTE 2 Electrical bonding may be required to prevent build-up of static electricity when flammable liquids are being transferred. See AS/NZS 1020.

10.4 Liquid transfer

Decanting or pouring should be avoided to reduce the risk of splashing, overfilling, vapour escape and, for flammable liquids, the risk of static electricity discharge. Hand-operated dispensing pumps should be used instead.

If decanting is unavoidable (e.g. with viscous liquids), self-closing, non-combustible (preferably metal) taps should be used. Liquid dangerous goods should not be poured except from small containers while using appropriate personal protection.

Pressurization should not be used as a method of transfer, unless—

- (a) all equipment involved has been designed for that purpose;
- (b) packages do not remain pressurized once disconnected; and
- (c) appropriate overpressure protection is provided for the whole system, including the packages.

10.5 Spillage containment

Spillages shall be prevented from contacting other chemicals (see Clause 8.4.8 on spillage containment). For containers holding liquids that are taken from cabinets for dispensing, spillage containment of a capacity equal to the largest container should be provided.

10.6 Fire protection

Where flammable or combustible material packages are opened, appropriate equipment, such as fire extinguishers, shall be provided.

Where appropriate, an automatic fire extinguishing system should be installed. The room should be provided with thermal alarms, smoke alarms or both, linked to the local fire authority's communications system or to an attended location within the premises.

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Appendix A (informative)

Label for laboratory chemical wastes

LABORATORY CHEMICAL WASTE	
Contact Person (and numbe)	
Substance name	
UN number or CAS number	
Dangerous Goods Class	
GHS Category	
Major ingredients/formulation	
Special control procedures	

PUBLIC COMMENTING DRAFT

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Appendix B (informative)

The use of absorbent materials and spill kits

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained, or else deleted.

B.1 Scope

This Appendix provides information on the clean-up of spills using different types of absorbent materials and spill kits.

B.2 Clean-up procedures

The following general procedures can be used:

- (a) *Acids* — For small spillages of acids, the area should be flushed with water but not to the extent that the spillage is spread unnecessarily. The spillage should be contained with earth or sand and neutralized carefully with soda ash or sodium bicarbonate.

WARNING — DO NOT USE RAGS OR SAWDUST TO CLEAN UP SPILLS OF OXIDIZING ACIDS.

- (b) *Alkalis* — For alkalis, spillage should be contained using sand or earth. Citric acid or other dilute acid may be used to neutralize the alkali before clean-up. Residual alkali should be washed with water ensuring no contact occurs between washings and any aluminium or zinc containers.
- (c) *Volatile liquids and organic solvents* — Spillages of organic solvents should be absorbed using diatomaceous earth, activated charcoal or a proprietary product suitable for the absorption of the liquid. Many organic solvents are volatile and, as such, respiratory protection may be needed. Spills of flammable solvents will require control of ignition sources.
- (d) *Toxic chemicals* — Spillages of toxic chemicals should be cleaned up with methods that recognize the hazards of the spilled material, in particular those set out in [Appendix F](#). All materials used for cleaning should be disposed in a safe manner, taking into account the hazards of the spilled material. Mercury can be removed using a proprietary mercury spill kit, mercury sponges, a specially-designed vacuum and suction apparatus or a combination of these.

NOTE Proprietary spill kits and sponges are available for most hazardous substances. There are few universal absorbents available so the absorbent needs to be compatible with, and suitable for, the spilled material.

Appendix C (normative)

Handling of cryogenic fluids

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained, or else deleted.

C.1 Scope

This Appendix sets out requirements for personal protective equipment, and the transport and bulk storage of cryogenic fluids, and general precautions for handling, working with, storing, transporting and transferring cryogenic fluids. Emergency measures and general first aid rules are also recommended.

C.2 General

The seven cryogenic fluids most widely used in research and industry are helium, hydrogen, nitrogen, fluorine, argon, oxygen and methane. In addition to the hazards identified in [Clause 4.3.1](#), cryogenic liquids have additional hazards relating to their large gas expansion ratio.

In addition to conforming to the applicable requirements in AS 1894, the following general precautions should be taken:

- (a) *Containers* — Liquefied gases at atmospheric pressure should always be contained in vacuum-jacketed vessels or, if they boil at very low temperatures, with a guard jacket of liquid nitrogen surrounding them. Containers should display an appropriate sign indicating the cold hazard.

NOTE The sign should include the symbol for warning of low temperature or freezing conditions identified in W010 in ISO 7010, supplemented with appropriate text.

- (b) *Transfer* — Transfer operations should only be undertaken by operators who have been trained by the suppliers of the liquefied gas. Where possible, a vacuum-jacketed siphon should be used, as gas poured from a container can develop a plug of solid in the outlet. If the boiling point of the gas is less than that of liquid air, care should be taken in transferring the liquid from stock to the apparatus, e.g. into Dewar-type vessels or cryostats, as an ice plug can form at the outlet.

It is sometimes convenient to transfer liquid oxygen or nitrogen from its container by pressurization. This can be carried out safely if the appropriate dry gas is used, and if the liquefied gas container is of the type that will withstand pressure.

- (c) *Spills* — If any spill of the following substances cannot be contained, the area should be evacuated and the emergency services contacted. Potential hazards associated with specific gases are as follows:
- (i) *Liquid nitrogen, argon or helium* — If liquid nitrogen, argon or helium is spilled, the surrounding atmosphere will not support life.
- (ii) *Liquid oxygen* — Spilled liquid oxygen will greatly increase the risk of fire. Some materials can spontaneously ignite in the presence of liquid oxygen.

- (iii) *Liquid hydrogen or methane* — If liquid hydrogen or methane is spilled, a flammable or explosive mixture with air will result.
- (d) *Dewars and flasks* — Empty containers for liquid oxygen and liquid nitrogen should be allowed to warm up to ambient temperature and then be purged with dry nitrogen. This will avoid danger from accumulation of hydrocarbon gases extracted from the atmosphere, and minimize the nuisance caused by water freezing in the container.
- (e) *Liquid nitrogen* — Traps attached to apparatus, open-to-air at atmospheric pressure should not be placed where they can be cooled by liquid nitrogen. Liquid nitrogen is sufficiently cold to condense oxygen from the atmosphere and quite large quantities of liquid oxygen can accumulate in an open vessel cooled by liquid nitrogen. The liquid oxygen will evaporate vigorously if the coolant is removed.
- (f) *Liquid oxygen* — Mixing liquid oxygen with flammable material produces a major potential hazard. Liquid oxygen should only be used under the supervision of designated members of staff. A Dewar flask used to contain liquid oxygen should never be used for any other purpose and should be oil free, clean and dry before oxygen is added. Mixtures of liquid oxygen and organic materials can create an explosion and a fire risk. Liquid oxygen spilt on asphalt can produce an explosive substance which is touch-sensitive.
- (g) *Solidified gas, e.g. dry ice* — Large quantities of dry ice should not be used in a confined space unless adequate forced ventilation is provided. Dry ice should never be handled with bare hands as a severe burn can result.
- (h) *Other gases* — Instructions for handling liquid hydrogen, helium, argon and methane should be sought from the supplier.

C.3 Ventilation

Although a number of the gases in the cryogenic range are not toxic, they are capable of causing asphyxiation by displacing the oxygen in the air. Even oxygen can have harmful effects if inhaled at high concentrations for lengthy periods. Prolonged inhalation of cold vapour or gas, whether respirable or not, can have detrimental effects on the lungs.

In poorly vented areas, the large ratio of expansion in volume from liquid to gas can rapidly change the composition of the atmosphere in the room where fluids are used or stored. Fluids should always be handled in well-ventilated areas to prevent excessive concentrations of gas. If there is any doubt about the composition of the air in a room that has been closed off, it should be ventilated well before entering, and the composition of the atmosphere of the room should be checked using an oxygen meter. Self-contained breathing apparatus should be accessible to those working in areas that can become oxygen depleted as determined by a risk assessment.

NOTE Fans in cold rooms are typically circulation rather than ventilation fans.

C.4 Personal protection requirements for cryogenic fluids

C.4.1 Protection of face

A full face-shield or goggles in accordance with AS/NZS 1336 and AS/NZS 1337 (series) shall be worn when transferring liquid from a bulk supply, or from one vessel to another, or when immersing objects, or at any other time when spraying or splashing may occur. During bulk transfer operations, under the control of a valve in the transfer line, a protective barrier between the vessel being filled and the operator will afford good protection. A protective screen shall be used when working with the cryogenic materials held in glass.

C.4.2 Protection of hands

Gloves shall be worn when carrying cryogenic fluids in small containers, including those with handles, or when handling anything that is, or may have been, in contact with cryogenic fluids. Even when using gloves, cold equipment can be held only for a short time. During handling and transfer operations, the hands shall be protected by clean, dry insulated leather or other suitable gloves. The gloves should be a loose fit so that they may be removed quickly should any liquid splash on or into them.

C.4.3 Protection of the body

Appropriate safety clothing, which minimizes the formation of traps capable of holding liquid in close proximity to the flesh, shall be worn when handling cryogenic materials. Safety footwear should always be worn. See AS/NZS 2210.1 for guidance on the selection and use of protective footwear.

The degree of body protection necessary will depend on the operation being carried out and the quantity of liquid involved. For example, when transferring liquid from bulk supply without the benefit of a protective barrier, overalls without pockets or turn-ups, and with a leg length sufficient to shield the top of the shoe, should be worn in addition to eye and hand protection. Trousers should be worn outside boots or shoes. When filling a small cold trap in the laboratory this degree of protection may be unnecessary; however, eye and hand protection should always be worn.

C.5 Handling guidelines

C.5.1 General

Handling precautions are as follows:

- (a) Cryogenic fluids should always be handled carefully. Liquid or low temperature gas from any cryogenic substance can produce an effect on the skin similar to a burn. This will vary in severity with temperature, heat capacity of the fluid, and exposure time. Delicate tissues such as those of the eyes, can be damaged by a very brief contact with the fluid, which may not affect the face or hands.
- (b) Exposed or insufficiently protected parts of the body should not be allowed to come into contact with uninsulated pipes or vessels as they can stick fast because of the freezing of available moisture. This can result in the flesh being torn on removal from the apparatus.
- (c) Suitable tongs should be used to withdraw objects immersed in liquid and gloves should be worn. The tongs and the objects should be handled carefully. The tongs should be pre-cooled in the vapour before use. In addition to the hazards of burns, or skin sticking to cold surfaces, objects that are soft and pliable at room temperatures become very hard and brittle at cryogenic temperatures and are very easily broken.
- (d) When charging a warm container, or when inserting a transfer tube or other objects into the cryogenic liquid, the operations should be carried out slowly to minimize thermal shock and the subsequent splashing and boiling of the fluid. Where practicable, the transfer tube should be allowed to cool in the evolved vapour before immersion in the cryogenic liquid.
- (e) Vessels with a carrying handle and splash guard should be used for transporting small quantities of fluid. Care will still be necessary if the inner vessel is of glass because it may fracture unexpectedly, allowing the contents to boil rapidly and discharge through the neck of the outer vessel.
- (f) Larger vessels should be transported on a stable trolley designed to hold them securely in position during transit, and to permit easy and safe loading and unloading. Some vessels are fitted with integral wheels.
- (g) Caution should be exercised when transporting cryogenic fluids through confined or unventilated spaces.

C.5.2 Air condensation and oxygen enrichment

Air coming into contact with a surface cooled below 82 K (-191°C) will condense. The composition of this oxygen-enriched condensate, which is approximately 50 % oxygen and 50 % nitrogen, will significantly enhance combustion of flammable materials and of materials which are normally regarded as being relatively non-flammable.

If condensation occurs at the surface of a cryogenic liquid, the liquid can become contaminated. This can occur with liquid nitrogen, the boiling point of which is 77.3 K (-195.7°C) or liquid neon which has a boiling point of 27.2 K (-245.8°C). If condensation is allowed to continue for any length of time, the oxygen content of the liquid nitrogen may become appreciable and the liquid will require the same precautions as liquid oxygen when being handled. The small neck area of most liquid nitrogen containers together with the barrier formed by the nitrogen gas issuing from the surface, usually prevents this occurring during storage.

Due to the possibility of oxygen enrichment, inert cryogenic liquids should not be stored for long periods in an open system, e.g. in a flask. An indication of oxygen enrichment is a blue tinge in the liquid. Any oxygen impurity in nitrogen or helium will concentrate in time due to the lower volatility of the oxygen.

Care should be taken when using liquid nitrogen as coolant for a cold trap. The system should be pumped down before charging the trap, otherwise liquid air can condense in the trap causing explosion when the system warms up.

A potential hazard can arise where the coolant becomes depleted and the condensed gas is warmed by the atmosphere. The volume of gas produced by the volatilization of the trapped substances is often far greater than the available volume within the trap; the gas will escape through any manometer, by blowing out the key of a tap or by bursting the vessel.

C.5.3 Working at reduced pressure

If the pressure on a cryogenic liquid is reduced below atmospheric, the following additional precautions should be taken:

- (a) Ensure that the system is vacuum-tight to prevent moist air being drawn in and forming ice plugs.
- (b) Provide a protective screen when working with glass Dewar flasks.
- (c) Carefully control initial pumping speed to avoid pressure oscillation and liquid entrainment.
- (d) Prevent violent boiling of superheated liquid by the use of boiling centres deposited inside the Dewar flask.
- (e) This precaution is especially necessary when working with nitrogen in a glass system. These boiling centres will need to be compatible with the liquid in use.
- (f) Where the backing pump is used to pump evolved gas into a valved recovery system, provide a pressure-relief valve on the exhaust side of the pump to protect against the situation where the pump can be turned on with the recovery valves shut.

C.5.4 Proprietary equipment

Proprietary equipment, such as cryostats and liquefiers, should always be operated and maintained in accordance with the manufacturer's instructions. Regular maintenance and inspections should be arranged.

C.6 Storage and transport

C.6.1 General

The following precautions should be taken:

- (a) Only containers thermally insulated to minimize loss by evaporation and specifically designed for holding cryogenic fluids should be used as they are made to withstand the rapid changes and extreme differences in temperature encountered.
- (b) The most common container is the double-walled evacuated metal or glass vessel known as a Dewar flask. Exterior glass surfaces should always be taped to prevent fragmentation of the glass should it break. Domestic vacuum flasks should not be used to store cryogenic fluids.
- (c) Dewar flasks should be handled with care as the glass may become scratched and, since the flasks are always under stress due to the internal vacuum, may break unexpectedly. With encased containers the sudden failure of the inner container will result in the liquid boiling rapidly and being ejected from the neck of the vessel.
- (d) Metal containers used for storing quantities greater than 10 L should have double walls and contain insulating material in the evacuated space.
- (e) Depending on the nature of the cryogenic fluid, containers should be either open to the atmosphere or protected by a vent or other safety device which permits vapour to escape. Where a special vented stopper or venting tube is used, as on some small portable containers, the vent should be checked at regular intervals to make sure it is not plugged with ice formed from water vapour condensed from the air.
- (f) If an ice plug forms, it can be cleared by reaming with a sharp edged tube or by inserting a brass or copper rod down the neck of the container; this source of heat should melt the plug. Care should be taken to avoid burns from the escaping vapour or sudden ejection of the plug, rod or tube. Gloves, safety glasses and a face shield should be used.
- (g) Only the stopper supplied with the container should be used. Containers not supplied with vented stoppers should be kept covered with a loose fitting cap to prevent air or moisture from entering and to provide pressure relief. Inadequate venting can result in excessive gas pressure which can damage or burst a container.
- (h) Small containers should not be stored in the open where they may come in contact with rain or moisture, unless suitable protection from the weather is provided. Even then, excessive moisture on moving parts such as valves, relief devices and couplings can cause malfunctions due to formation of external ice.
- (i) Specially constructed, insulated containers should be provided for cryogenic fluids with boiling points below that of liquid nitrogen to prevent rapid loss of fluids due to evaporation. There is also an increased risk of ice plugs forming in vents and discharge orifices.

C.6.2 Transport requirements

If cryogenic liquids are transferred between facilities using motorized transport, an enclosed vehicle shall not be used, unless permitted by the relevant national, state or territory regulations. Similarly, if Dewars are transported by lift between floors, the containers shall not be accompanied by passengers.

C.6.3 Bulk storage unit requirements

The following precautions shall be taken:

- (a) For both safety and economic reasons, pressurized bulk storage units shall be maintained in a locked compound.

NOTE Access should be restricted to a limited number of trained personnel who are familiar with the emergency shutdown procedure.

- (b) The operation of bulk pressurized storage units shall be in accordance with the supplier's instructions. Concise emergency, safety and transfer instructions shall be clearly displayed near the storage units. (see AS 1894).
- (c) Small containers shall be filled using a transfer tube from a small, e.g. 50 L, bulk container, only by operators who have received adequate training. Personal safety equipment shall be retained with the compound key and issued to those required to fill small containers.

NOTE 1 The small bulk container can be recharged as required from the bulk storage unit and should be located in the same locked compound.

NOTE 2 To safely achieve optimum filling time and percentage fill, consult the manufacturer's guidelines for liquid transfers. If the pressure on the supply tank is kept low, the percentage transferred to the smaller container as liquid will be maximized, as the flash losses are minimized.

NOTE 3 A protective barrier should be provided between the receiving vessel and the operator.

C.7 Transfer techniques

The following techniques can be used when transferring cryogenic substances to secondary containers:

- (a) *Pressurization* — The conventional method used to transfer cryogenic fluid from a storage container to another vessel. Gas pressure is used to force the fluid from storage container to receiver through a transfer tube with one end immersed in the storage container. The necessary pressure can be obtained in a number of ways; by heat leak into the storage container, by a heat source within the container, or by pressurization with a gas corresponding to the liquid product.
- (b) *Submersible pump* — Some cryogenics, e.g. liquid nitrogen, may be transferred by use of a small submersible pump which passes down the neck of the container. If the pump is electrically driven it can be stopped and started by level-operated controls in the apparatus being filled. Precautions should be taken to prevent condensate entering and freezing in the pump, especially when changing containers.

Submerged pumps should not be used for liquid oxygen transfers.

- (c) *Transfer tubes* — Only transfer tubes approved by the supplier of the cryogenic liquid should be used.

The heat added by the insertion of a transfer tube at ambient temperature can be utilized to generate sufficient pressure to transfer liquid from a small flask. The warm tube vaporizes liquid as it is placed into the flask. If a gas seal is made at the outlet of the neck tube, the vapour generated provides a source of pressurization which can be sufficient to transfer up to 20 L of liquid without the use of additional pressurizing gas. The quantity which can be transferred by this means will obviously depend on the thermal characteristics of the tube and liquid. Quite small containers can be safely and conveniently filled using this method which is preferable to pouring liquid from one vessel to another.

- (d) *Pouring* — when using this technique, a filling funnel should be used with the top of the funnel partly covered to reduce splashing.

C.8 Emergency measures and first aid

C.8.1 Cold contact burns

Tissue damage does not normally occur immediately cryogenic liquid touches warm flesh. Initially, the blood supply to the tissue acts as a heat source and creates a heat-insulating gas film at the liquid/flesh

interface. This time delay is usually sufficient for severe injury to be avoided even when a large volume of fluid is involved, provided that appropriate action is taken.

If cryogenic fluid is splashed on the body, the affected area should be immediately flushed with cold water, and any clothing that is saturated with the fluid should be removed. It is especially important to remove gloves or footwear quickly if liquid is splashed into them, as large volumes can be trapped, thereby enhancing the risk of tissue damage by prolonged contact.

The high heat capacity of water, its harmlessness and ready availability all combine to make it an important safety contribution to cryogenic operations. If practicable, water should be made readily available wherever cryogenic liquids are handled. All bulk storage installations should include a safety shower.

If, despite initial treatment, cold contact burns are inflicted, the over-riding first-aid considerations should be to get the casualty to hospital quickly. Professional medical attention should always be sought for cold contact burns because of the risk of complications.

C.8.2 First aid and general treatment

Irrespective of the severity of burns, general first aid rules are as follows:

- (a) DO NOT rub or massage the affected area.
- (b) DO NOT expose the affected area to a radiant heat source.
- (c) DO NOT allow the casualty to smoke, eat or drink until medical advice is obtained.

First aid and general treatment for cryogenic burns are virtually the same as those specified for frostbite in first aid and medical manuals (see also AS 1894 for requirements on operating instructions and warning signs).

If a person begins to exhibit signs of asphyxia while working with cryogenic liquids, they should be taken to a well-ventilated area immediately. If breathing has stopped, artificial respiration should be applied. If the oxygen level is depressed to below about 15 % (V/V) in air, or if the gas is toxic, the rescuer will need to wear a self-contained supplied-air respirator.

In sudden and acute asphyxia, such as that from inhalation of pure nitrogen, unconsciousness is immediate and the victim can die within a few minutes.

Where asphyxia develops slowly by gradual reduction of the oxygen content in the air, early outward signs are the inability to think clearly, disturbance of muscular coordination, rapid fatigue and easy arousal of emotions, particularly of ill-temper. If the oxygen reduction becomes severe, complete physical collapse can occur. The victim can be unaware that anything is wrong until beyond self-rescue or the summoning of aid.

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Appendix D (informative)

Examples of commonly used highly flammable chemicals

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained, or else deleted.

D.1 General

Data on the flammability of a chemical can be found in its SDS.

D.2 Organic

The following are examples of common organic solvents and reagents:

Acetaldehyde	Methanol
Acetone	Methyl ethyl ketone
Acetonitrile (methyl cyanide)	Pentane
Carbon disulfide (auto-ignition temperature 100°C)	Petroleum ether
Cyclohexane	2-Propanol
Diethyl ether (auto-ignition temperature 180°C) (see Note)	Tetrahydrofuran (see Note)
Ethanol	Toluene
Ethyl acetate	Vinyl acetate (see Note)
n-Hexane	Xylene
NOTE This chemical form peroxides.	

D.3 Inorganic and organometallic

Sodium and other alkali metals are readily ignited by heat or on contact with water.

Metals in a finely-divided form may be spontaneously combustible, e.g. Raney nickel, pyrophoric iron. Finely divided materials such as aluminium, magnesium and zinc are easily ignited.

Metal hydrides, such as aluminium hydride, and metal alkyls, such as trimethylaluminium, are spontaneously flammable compounds.

Yellow phosphorus ignites on contact with air.

Appendix E (informative)

Properties associated with commonly used highly reactive chemicals

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained or else deleted.

E.1 Scope

This Appendix lists some of the hazardous properties associated with highly reactive chemicals commonly used in the laboratory and includes recommendations on safety procedures to be adopted. For more complete information on safe handling and storage procedures, see the SDS for the appropriate chemical.

E.2 Acid salts

Acid salts, e.g. potassium hydrogen sulfate, made by only partially neutralizing an acid, retain the corrosive properties of the acid.

E.3 Sodamide

Sodamide (sodium amide) is a strongly alkaline substance which reacts violently with water forming ammonia and sodium hydroxide. If contaminated by air, the amide becomes discoloured and highly unstable.

E.4 Gaseous halogens

Bromine and chlorine are highly toxic gases which affect the respiratory tract (see also [Appendix F](#) and AS/NZS 2927). Bromine and chlorine can form explosive mixtures with hydrogen and volatile hydrocarbon vapours.

Fluorine is violently reactive towards a wide range of substances. Expert advice should be sought before working with fluorine gas.

Interhalogen compounds are as reactive as the halogens. Those containing fluorine, such as bromine trifluoride, are explosively reactive with concrete and organic chemicals.

E.5 Metals, metal hydrides, metal alkyls

E.5.1 Alkali metals, lithium, sodium, potassium

Sodium and potassium react explosively with water. They also react violently with carbon tetrachloride and other halogenated hydrocarbons. Because of their ready oxidation by air and their sensitivity to water vapour, they are stored under hydrocarbon oil, e.g. paraffin oil. Lithium is less violently reactive but should still be treated with caution and stored in the same manner.

Sodium is frequently used for organic chemical reactions and for drying some organic solvents. Solvent bottles containing sodium as a drying agent should be clearly labelled and sodium residues should be

destroyed before the empty bottles leave the laboratory. The use of highly effective molecular sieves or sodium-lead alloy (10 % sodium) is recommended as a safer alternative form of drying agent.

A small side-bench remote from any source of water should be reserved as a place for storing, cutting and pressing sodium. When using a sodium press, care should be taken to ensure that the plunger and die are perfectly clean and dry before use. After use, all sodium metal still adhering should be removed by soaking the parts in a bath of isopropanol.

Sodium metal residues should be destroyed with isopropanol followed by 95 % (V/V) ethanol (industrial methylated spirits is suitable) and the resultant solution discarded. Lithium can be destroyed by dissolving in an aqueous solution of alcohol.

Considerable caution should be exercised in destroying large amounts of sodium or potassium. Crusted material is especially dangerous because of the presence of peroxides, particularly in the case of potassium.

E.5.2 Powdered metals, including magnesium, aluminium, zinc, iron

Magnesium powder and other finely divided metals, e.g. Raney nickel catalyst, are easily ignited and will burn vigorously.

E.5.3 Metal alkyls

Trimethylaluminium is spontaneously flammable. Butyl lithium and other organolithium compounds are extremely reactive. Tetramethyl and tetraethyl lead are both highly toxic materials and are readily flammable (flash points 38°C and 93°C respectively). "Leaded" fuels containing lead alkyls present a toxic hazard, particularly through the absorption of lead compounds through the skin.

E.5.4 Metal hydrides

The reactivity of metal hydrides with oxygen and hydroxylated solvents (including water) varies greatly. Aluminium hydrides are spontaneously flammable in air, and special precautions should be taken in their use. Lithium hydride, sodium hydride and lithium aluminium hydride are much less reactive to air but react rapidly with water, liberating hydrogen gas, while potassium borohydride is often employed as a reagent in aqueous solution. Metal hydride residues can be destroyed by the addition of ethyl acetate, alcohols or dioxane, followed by water.

E.5.5 Metal phosphides

When in contact with air, metal phosphides liberate very toxic phosphine gas.

E.6 Oxidizing agents — Chlorates and nitrates

When mixed with combustible materials, chlorates and nitrates can form friction-sensitive explosive mixtures, e.g. potassium chlorate mixed with sulfur or phosphorus. Spillages of chlorates and nitrates should be removed for disposal in a controlled environment.

Appendix F (informative)

Properties associated with commonly used hazardous chemicals

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained or else deleted.

F.1 Scope

This Appendix lists some of the properties of the more common hazardous chemicals used in a laboratory and includes recommendations on their use. The list is selective in that attention is directed towards chemicals which should be used with extra care. The appropriate SDS should also be referred to.

F.2 Hazardous chemicals

F.2.1 Amines

All organic amines have harmful properties, but aniline requires special caution because it is volatile, and also because it is readily absorbed through the skin.

F.2.2 Benzene

Benzene is toxic if inhaled or absorbed through the skin and is carcinogenic. Alternative solvents, e.g. toluene or xylene, should be used where possible.

F.2.3 Bromine

Liquid bromine is very volatile and can cause serious burns.

F.2.4 Carbon monoxide

Carbon monoxide is a flammable, odourless, highly toxic gas. Gas monitors are available to monitor carbon monoxide levels in air.

F.2.5 Carbon disulfide

Carbon disulfide is commonly used in the desorption of substances from charcoal. The solvent is toxic if inhaled and can cause damage to the central nervous system.

F.2.6 Carbonyl, nickel carbonyl, iron carbonyl

Nickel carbonyl is an exceptionally toxic gas. Iron carbonyl is a highly toxic liquid.

F.2.7 Chlorinated hydrocarbons

Carbon tetrachloride, chloroform and other chlorinated hydrocarbons are cumulative poisons which can cause liver damage. Breathing the vapour, or contact of the liquid with the skin, should be avoided. 1,1,1-trichloroethane (Methyl chloroform) is a comparatively safe substitute solvent for other chlorinated hydrocarbons.

Chlorinated hydrocarbons should not be used to clean metal immediately prior to welding, as the vapours are converted to toxic phosgene in the welding arc.

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F.2.8 Chromium compounds

Hexavalent chromium compounds can cause skin ulcerations and nasal cancer.

F.2.9 Cyanides, hydrogen cyanide

Inorganic cyanides (e.g. potassium cyanide) are highly toxic. Particular care should be taken when acidifying cyanide solutions as toxic hydrogen cyanide is liberated. Emergency procedures should be prepared in consultation with the local medical authorities.

F.2.10 Ethidium bromide

Ethidium bromide is a strong mutagen commonly used in molecular biology laboratories in dilute solutions. In the event of the solid being used, the generation of dusts should be avoided as it is an irritant to the upper respiratory tract.

F.2.11 Formaldehyde

Pure formaldehyde is a colourless gas and is generally used in laboratories as an aqueous solution of approximately 37 %. Formaldehyde is a carcinogen and a risk assessment should reflect the need for adequate ventilation to minimize exposure.

F.2.12 Hydrofluoric acid, hydrogen fluoride, potassium hydrogen fluoride

Acid fluorides are very damaging to skin tissue and bone. Skin contact with concentrated hydrofluoric acid or inhalation of its vapour has caused many serious injuries, even death. Where hydrofluoric acid is handled, always have calcium gluconate gel antidote available. Handling, storage and use of these materials requires particular attention.

F.2.13 Lead salts and lead-containing dusts

Lead compounds produce serious chronic effects, so breathing their dusts should be avoided. Because of the cumulative effect, regular monitoring of blood levels should be carried out for those exposed to lead compounds.

F.2.14 Mercury

Mercury vapour produces chronic poisoning and harmful amounts can be absorbed through the skin. The use of apparatus with an exposed mercury surface should be avoided except where access to atmospheric air pressure is required, such as in a barometer, dropping mercury electrode and porosimeter. Spill trays should be placed under any equipment containing mercury. A portable mercury-vapour meter or detector tubes should be used to monitor areas where mercury is in use. All spilled mercury should be immediately cleaned up as thoroughly as possible (see [Paragraph C2\(d\)](#)).

F.2.15 Nitrobenzene

Nitrobenzene is a highly toxic liquid and is readily absorbed through the skin or by inhalation.

F.2.16 Phenol

Phenol is used in some syntheses and can cause skin burns. Phenol (and solutions greater than 5 %) have a corrosive action on tissues.

F.2.17 Pyridine

Quite small concentrations of pyridine vapour produce unpleasant debilitating effects. It has a penetrating odour which should be taken as a warning that the vapour concentration is too high.

F.2.18 Sulfur dioxide

Sulfur dioxide is a very irritating, toxic and corrosive gas, generally supplied in a liquefied form in cylinders.

F.2.19 Thallium and its compounds

Serious poisoning can result from the inhalation, or absorption of thallium salts through the skin.

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Appendix G (informative)

Properties associated with commonly used corrosive chemicals

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained, or else deleted.

G.1 Scope

This Appendix lists some of the hazardous properties associated with corrosive chemicals commonly used in the laboratory and includes recommendations on safety procedures to be adopted. For more complete information on safe handling and storage of corrosive substances, see AS 3780 and the SDS for the appropriate chemical.

G.2 Strong acids

G.2.1 Hydrochloric acid, hydrogen chloride

Hydrochloric acid is a corrosive liquid and the gas evolved from the concentrated acid, hydrogen chloride, is a very toxic irritant.

G.2.2 Hydrofluoric acid, hydrogen fluoride

See [Appendix F](#).

G.2.3 Nitric acid, fuming nitric acid

Nitric acid is a highly corrosive oxidizing acid which reacts vigorously with most organic substances. Nitric acid fumes comprise highly toxic nitrogen dioxide.

G.2.4 Sulfuric acid, oleum and chlorosulfonic acid

Sulfuric acid, oleum and chlorosulfonic acid react vigorously with water, the reaction of oleum being especially dangerous. These acids are dehydrating agents capable of removing chemically bound water from organic and inorganic substances. Reactions with organic material often produce charring, with copious emission of sulfur dioxide. In some instances, the reaction evolves flammable gases.

Oleum (fuming sulfuric acid) reacts with vinyl floors, producing copious quantities of sulfur dioxide.

Reactions of some stable materials with sulfuric acid or oleum can produce explosive acids or oxides, such as permanganic acid from potassium permanganate, chloric acid from sodium chlorate or hydrazoic acid from sodium azide.

G.2.5 Acid cleaning mixtures

Acid cleaning mixtures, e.g. chromic/sulfuric acid, aqua regia, fluoride-containing mixtures, present all of the dangers associated with the use of the parent acid. Additional hazards are associated with the presence of toxic hexavalent chromium compounds in chromic/sulfuric acid. Detergents have now replaced acid cleaning mixtures for the majority of applications.

Solutions of chromic acid react very violently with alcohols and some other organic liquids.

G.3 Strong bases

G.3.1 Sodium hydroxide, potassium hydroxide, calcium oxide

Sodium hydroxide, potassium hydroxide and calcium oxide generate heat on contact with water and can attack body tissue. They also react violently with mineral acids. When touched without gloves, these chemicals have an initially soapy or slippery feel, which can falsely lower the impression of their corrosiveness.

G.3.2 Ammonia solutions

Ammonia solution (density at 20°C 0.88 g/mL), a 35 % solution of ammonia in water, has similar properties to those of a caustic alkali. In addition it liberates pungent, toxic ammonia gas. Great care should be taken when opening bottles of ammonia solution as any internal pressure can release an expanding cloud of gas. Ammonia solution should be kept cool and used only in a fume cupboard.

G.4 Halides — Boron trichloride, boron tribromide, silicon tetrachloride, aluminium chloride, titanium chloride

Direct addition of these substances to water produces a violent or explosive reaction. They should not be handled near water or allowed to contact the skin. Spillages should be absorbed with vermiculite and removed to be destroyed with water under controlled conditions.

PUBLIC COMMENTING DRAFT

DRAFT

Appendix H (informative)

Properties associated with commonly used unstable substances

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained or else deleted.

H.1 Scope

This Appendix lists some of the hazardous properties associated with unstable chemicals commonly used in some laboratories and provides recommendations on handling the substances. Further information can be obtained from relevant SDSs.

H.2 Unstable substances

H.2.1 Acetylene and acetylides

Acetylene reacts with salts of silver and copper, and in some circumstances with the metal itself, to form acetylides which are touch-sensitive detonators. Acetylene should not be allowed to come into contact with copper or any alloy containing more than 65 % copper.

H.2.2 Azides and silvering solutions

The use of sodium azide (the only common stable azide) in any chemical procedure may lead to formation of an explosive azide or explosive hydrazoic acid.

The solutions of ammoniacal silver nitrate, commonly used for silvering glass and in some chemical tests, tend to form silver azide on standing, which is explosive. It is essential that the correct procedure is followed in preparing the solution. Within an hour or so of preparation, any unused solution should be treated with sodium chloride to precipitate the silver and destroy any silver azide.

H.2.3 Azo and diazo compounds

Azo and diazo compounds should be treated as dangerously unstable, toxic compounds, unless there is evidence to the contrary.

H.2.4 Chlorates and perchlorates

Most chlorates and perchlorates, including the acids, are dangerously unstable (see [Appendix I](#)).

H.2.5 Chlorides of aluminium, silicon, tin (IV) and titanium

(See [Paragraph G4](#).) Chlorides of aluminium, silicon, tin (IV) and titanium are readily hydrolysed to produce hydrogen chloride gas, and consequently resealed bottles or ampoules of the substances can develop high pressures.

H.2.6 Ethers, dioxane, tetrahydrofuran

Ethers, dioxane and tetrahydrofuran, and other less common substances which contain the ether group, are especially prone to aerial oxidation producing peroxides. Ethers which contain peroxide are liable to explode. Partially filled bottles of ether should not be kept for long periods. When a partially filled bottle of ether is seldom used, it is advisable to safely dispose of the remaining material.

Where viscous liquid is apparent in the ether solution or it contains crystalline solid, this may indicate the formation of peroxide. Formations of peroxides to this extent are dangerous and need to be handled with caution. These solutions and those of unknown history should be disposed of safely and appropriately in accordance with local regulations.

Ethers which contain peroxide should not be distilled as during the latter stages of the distillation, the concentrated residue of peroxide is liable to explode. Even if an ether has been treated to destroy peroxide, the distillation should be stopped when about 15 % of the solvent remains in the flask. Solvent recovery of ether should be avoided; however, if performed, an appropriate stabilizer should be added before storage. Some commercially available products contain a stabilizer.

H.2.7 Monomers

Monomers are chemicals that are generally liquids or gases and are capable of forming heavier, higher molecular weight compounds by self-reaction, i.e. they are capable of spontaneous auto-polymerization.

In transport and storage, monomers are rendered safe by the presence of inhibitor chemicals. Occasionally, accidents occur, e.g. where the more volatile monomer vaporizes and separates from the less volatile inhibitor, followed by condensation.

Auto-polymerization can occur rapidly, with generation of considerable heat, and can result in an explosion. Polymerization reactions can be terminated by free radical scouring through addition of prescribed agents.

H.2.8 Nitro-compound, picric acid, trinitrobenzene

Highly nitrated organic compounds are potentially explosive, but they are comparatively safe if kept damp and stored in a cool place. Any kind of rubbing, scratching or abrasion of the compounds should be avoided.

H.2.9 Peroxides

Concentrated hydrogen peroxide (HTP) should be handled with care. If contaminated with organic or particulate matter, it decomposes very rapidly to produce a spray of material. Inhalation of the spray is unpleasant and continued exposure to the material is dangerous. At the conclusion of reactions using hydrogen peroxide, the excess should be chemically destroyed.

Peroxides can form in bottles (even if unopened) containing organic compounds, particularly after long storage. Ethers are best known for this hazard but accidents have occurred also with medium-chain aliphatic ketones, olefins and aromatic hydrocarbons containing the isopropyl group.

Organic peroxides are generally unstable and may explode violently. They decompose at temperatures below 100°C and any rise in temperature above room temperature considerably increases the risk of explosion. Benzoyl peroxide is comparatively safe if stored damp at room temperature in a cool place. The quantity of organic peroxide stored in any one place shall be strictly limited. Further information on peroxides can be obtained from manufacturers and SDSs.

PUBLIC COMMENTING DRAFT

Appendix I (informative)

Hazards associated with the use of perchloric acid

DRAFTING NOTE: Public comment is requested on whether this Appendix is still relevant and should be retained or else deleted.

I.1 Introduction

Perchloric acid has become an indispensable reagent in some types of chemical analysis. Although numerous accidents and explosions have been reported, many chemists are not sufficiently aware of the hazards connected with its improper use. However, perchloric acid can be used with safety, provided that the user possesses a knowledge of its properties and takes appropriate precautions. This Appendix recommends safe handling procedures for the perchloric acid reagent used for wet digestions, and not for the anhydrous acid. (The pure, anhydrous acid is not encountered in normal laboratory operations.) The SDS should also be referred to.

I.2 Properties of perchloric acid

The properties of perchloric acid are as follows:

- The reagent is generally supplied as a 60 % or 70 % to 72 % (w/w) concentration of HClO_4 in water.
- Perchloric acid forms an azeotropic mixture with water containing 72.5 % HClO_4 , and boiling at 203°C at 101 kPa pressure, therefore the evaporation of an aqueous solution will not produce an acid of concentration greater than 72 %.
- Perchloric acid is a strong acid at room temperature, and contact with the skin, eyes or respiratory tract will produce severe burns.
- As the temperature is raised it becomes an oxidizing acid and a dehydrating agent. At its boiling point, 72 % HClO_4 will react violently with organic matter or other combustible material, but it loses its oxidizing properties entirely when cooled and diluted with water.
- Contact of perchloric acid solution with strong dehydrating agents such as sulfuric acid, phosphorus pentoxide or acetic anhydride may result in the formation of anhydrous perchloric acid which is extremely unstable, and will explode on contact with organic material.
- Vapour from undiluted perchloric acid forms violently explosive mixtures with flammable gases. Where practical, perchloric acid should be used in its most dilute form.
- Pure, anhydrous perchloric acid has been documented to spontaneously explode, particularly on storage.

I.3 Hazards associated with the use of perchloric acid

Reactions of perchloric acid with organic or combustible material usually occur when perchloric acid is added to a sample which has not been sufficiently treated with nitric acid to remove easily oxidized material. Provided that nitric acid is present in sufficient quantity to prevent blackening, the triple mix $\text{HNO}_3/\text{H}_2\text{SO}_4/\text{HClO}_4$ is a safe oxidizing mixture.

Combustible materials, such as sawdust, wood, paper, natural fibre bags, cotton waste, rags, grease, oil and most organic compounds contaminated with perchloric acid solution are highly flammable. Such

materials may ignite spontaneously or explode on heating, by flame, impact or friction. Rinsing the material in cold water will remove perchloric acid and reduce the hazard.

Possible sources of unstable perchlorates are as follows:

- (a) Perchlorate crystals around the tops of reagent bottles stored for lengthy periods after opening.
- (b) Metallic or organic perchlorates deposited in improperly designed fume hood systems.
- (c) Reaction of perchloric acid fumes with grouting material used to seal stoneware hoods.
- (d) Reaction of perchloric acid fumes with lubricants used in blower system of the fume cupboard.
- (e) Reaction of perchloric acid fumes with metals used in ductwork systems of a fume cupboard.
- (f) Reaction of perchloric acid fumes with flammable material deposited in bends or porous construction materials in horizontal runs in ductwork.
- (g) Deposition of perchlorate salts in the burner slot from aspirating aqueous solutions of perchloric acid into an atomic absorption spectrometer.

I.4 Safe working conditions

The following conditions are recommended for the use of perchloric acid in the laboratory:

- (a) Work involving the use of perchloric acid should be carried out in a suitable water scrubbing fume cupboard manufactured in accordance with AS/NZS 2243.8, reserved for this purpose.
- (b) Perchloric acid should not be allowed to contact organic matter of any kind including wooden benches, wooden floorboards or vinyl tiles. The floor material in the vicinity of the fume cupboard should be inert to perchloric acid, non-absorbent and free from cracks. Wax floor polish or other organic finishes should not be used.
- (c) Where perchloric acid is to be used regularly, consideration should be given to setting aside an area of the laboratory solely for the work.
- (d) Perchloric acid should only be stored in designated locations. Bottles of perchloric acid should be stored in watertight trays or containers (and caps) made from inert material and of sufficient size to hold the contents of a bottle. Bottles should be carried in suitable carriers.
- (e) Only minimum quantities of perchloric acid should be retained in the laboratory area.
- (f) Spillages should be neutralized with soda ash and flushed with water.

I.5 Laboratory practice

The following practices should be observed when using perchloric acid in the laboratory:

- (a) The supervisor should ensure that any person intending to use perchloric acid is fully conversant with the possible hazards and is aware of the appropriate safety requirements.
- (b) Stocks of perchloric acid should be maintained at the practicable minimum.
- (c) Where perchloric acid is to be used as a mixed reagent, e.g. with nitric acid, pre-mixing of these reagents for stock should not be performed. Only the immediately required quantity should be mixed.
- (d) Stocks should be examined periodically, and any suspect material diluted with water and disposed of immediately by careful neutralization.

- (e) Organic chemicals should not be placed or used in fume cupboards employed for perchloric acid digestions.
- (f) The nature of materials and containers stored beneath fume cupboards set aside for perchloric acid should be reviewed critically.
- (g) Safety screens or shields should be used by operators carrying out perchloric acid digestions.
- (h) Oil baths should not be used for heating perchloric acid solutions. Glass-to-glass unions, corks, rubber tubes or stoppers, or mineral-based grease should not be used in apparatus for perchloric acid digestions. The following apparatus should be used:
- Heat-resistant reaction beakers, flasks or test tubes.
 - Electric hotplates, cast aluminium heating blocks or sand baths.
- (i) In wet digestions with perchloric acid, the minimum sample quantity consistent with the requirements for analytical precision should be used and the sample should be pre-treated with nitric acid to destroy easily-oxidizable matter. Nitric acid should always be used to pre-treat organic matter, or any material of unknown composition or behaviour prior to treatment with perchloric acid.
- (j) For digestions involving matter which may form an immiscible phase, especially fat, very careful preliminary treatment with nitric acid (or nitric acid and sulfuric acid if permissible) should be carried out.
- (k) Evaporation to dryness should be avoided where possible. Perchloric acid should not be allowed to concentrate above 72 % aqueous solution. However, if complete digestion is required (where all trace of perchloric acid is to be boiled off), a sulfuric acid/perchloric acid/nitric acid digestion mixture should be used.

I.6 Dismantling an exhaust ventilation system suspected of contamination with perchlorates

To dismantle an exhaust ventilation system suspected of contamination with perchlorates requires specialist knowledge and assessment.

Appendix J (informative)

Nanomaterials

J.1 General

Nanomaterial/nanoparticle is defined in [Definition 1.4.22](#). Nanomaterials exist in nature, such as the structures on the wing of a butterfly, the skin of a shark or the surface of a lotus leaf. Throughout history, people have been exposed to nanomaterials, such as smoke, dust, ash and fine clays, through air, food and water.

Nanomaterials fall into three main categories: naturally occurring; incidental; or engineered.

Engineered nanoparticles (ENP) or manufactured nanomaterials (MNM) have been intentionally designed to be in the nanoscale and are being studied or used commercially because of their novel or enhanced properties. This particular size dimension represents a major characteristic of manufactured nanomaterials (MNM). The unique properties of MNM may result in highly desirable behaviour leading to such varying applications as better paints, better drugs and faster electronics. Nanomaterials can display unique physical, chemical, biological and toxicological behaviour, quite different from the larger (macro) form of the same material. Sometimes properties are based on a continuum, e.g. surface area, therefore, not unique but significantly different than for larger particles.

J.2 Common types of nanomaterials

J.2.1 Fullerenes, nanotubes, nanowires

A significant amount of materials in this class are made from carbon. These include the family of compounds derived from the 60 carbon atoms molecule (C_{60}) known as buckminsterfullerene or “buckyball”, as well as the class of materials known as nanotubes. Nanotubes are like elongated versions of the “buckyball” and can exist in single-walled, double-walled or multi-walled configurations.

J.2.2 Metals

There are many examples of nanometals in use today. The most commercially relevant is likely to be nanosilver, which is prized for its potent and broad-spectrum antimicrobial properties. Nanosilver is used in a number of consumer products ranging from spray disinfectants to toothpaste and teddy bears, as well as in many medical applications such as wound dressings and catheters. Nanosilver is even being researched for use in animal feed to reduce the need for conventional antibiotics.

J.2.3 Metal oxides

Another very broad class of materials that include zinc oxide (ZnO) and titanium dioxide (TiO_2), both of which are used in sunscreens. Titanium dioxide is also used to coat so-called “self-cleaning glass”. Cerium oxide (CeO_2) is a fuel additive that promotes greater fuel efficiency.

J.2.4 Semiconductors (quantum dots)

Quantum dots exhibit very bright photoluminescence and can be used as medical imaging agents. Unlike conventional dyes, quantum dots do not degrade quickly and have much brighter luminescence, thus enhancing the signal in a medical image. Their surfaces can be modified to direct them to specific cells in the body, including cancer cells which can aid in disease detection.

J.2.5 Polymeric nanomaterials

Polymeric nanomaterials are small beads made from polymeric hydrocarbons. They can serve as containers for drug molecules and can be designed to deliver the drug to the precise location via surface modification with biomarkers that target a certain type of cell. Polymeric nanomaterials are also used in the cosmetics industry to encapsulate active ingredients and potentially deliver them beneath the epidermis.

J.3 Physical and chemical properties that can change at the nanoscale

The physical and chemical properties of a material at nanoscale do not necessarily duplicate those of the larger (macro) form. At the nanoscale, there may be changes in —

- (a) colour;
- (b) melting temperature;
- (c) crystal structure;
- (d) chemical reactivity;
- (e) electrical conductivity;
- (f) magnetism; and
- (g) mechanical strength.

Not all of these changes will be relevant for every nanomaterial. Each will have its own set of variable properties.

J.4 Toxicity of nanomaterials

The toxicity of MNM largely depends on numerous physical and chemical properties including, size, shape, composition, surface characteristics, charge and rate of dissolution.

There is currently limited information about the long-term health effects in humans from exposure to MNM, their fate in the human body and their ability to induce unwanted biological effects such as generation of oxidative stress. Due to the increasing variants of MNM, data relating to human MNM inhalation studies are available for only a few MNM. This means that, except for a few materials where human studies are available, health recommendations must be based on extrapolation of the evidence from *in vitro*, animal or other studies from fields that involve exposure to nanoscale particles such as air pollution. Current studies are unable to differentiate between exposure to naturally occurring and manufactured nanomaterials.

J.5 Applying a precautionary approach to the choice of risk controls

At this present time, there is uncertainty about the toxic potential of many engineered nanomaterials due to a lack of scientific evidence available. While nanotechnology research activities generate a number of nanomaterials, most are only studied briefly and then discarded.

The challenge becomes how to handle nanomaterials safely when toxic properties are unknown or there is limited information on them. There are a number of possible approaches if there is only a limited understanding of nanomaterial hazards, e.g.:

- (a) Approach 1:
 - (i) Consider what would be a reasonable worst case and determine how severe the hazard could be.

- (ii) Select controls that are appropriate for that hazard severity.
- (b) Approach 2:
- (i) Assume nanomaterials are highly hazardous.
 - (ii) Implement high level engineering controls such as enclosure or isolation.
- (c) Approach 3:
- (i) Identify controls used for the same/similar process with larger particles.
 - (ii) Use more stringent controls such as local exhaust ventilation.

PUBLIC COMMENTING DRAFT

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Appendix K (normative)

ADG class and packing group, and equivalent GHS class

Flammable liquids are assigned to packing groups in accordance with ADG Code criteria which correspond to GHS categories as shown in Table 2.3.2.6 of the Australian Code for the Transport of Dangerous Goods by Road and Rail, Edition 7.5.

NOTE For GHS Category 4, see combustible liquid (1.4.3)

For the ADG Class and relevant GHS class, see Table B1 of the Work Health and Safety (Managing Risks of Hazardous Chemicals in the Workplace) Code of Practice 2015.

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