

Australian/New Zealand Standard™

Safety in laboratories

Part 2: Chemical aspects



AS/NZS 2243.2:2006

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Safety in laboratories

Part 2: Chemical aspects

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CH-026, Safety in Laboratories, to supersede AS/NZS 2243.2:1997.

The objective of this Standard is to provide information, recommendations and procedures involving the use of chemicals which will promote safe working in laboratories.

This edition has been completely reformatted to improve clarity and to incorporate changed information on staff responsibilities, laboratory waste storage and disposal, and compressed and liquefied gases.

The Standard is Part 2 of a 10-part series designed to promote safety in laboratory operations, and is aimed at specific aspects of safety common to chemical laboratories.

The other Parts in the series are as follows:

- Part 1: Planning and operational aspects
- Part 3: Microbiological aspects and containment facilities
- Part 4: Ionizing radiations
- Part 5: Non-ionizing radiations—Electromagnetic, sound and ultrasound
- Part 6: Mechanical aspects
- Part 7: Electrical aspects
- Part 8: Fume cupboards
- Part 9: Recirculating fume cabinets
- Part 10: Storage of chemicals

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.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	4
1.2 APPLICATION	4
1.3 REFERENCED AND RELATED DOCUMENTS	4
1.4 DEFINITIONS	4
SECTION 2 PLANNING FOR CHEMICAL SAFETY	6
SECTION 3 CHEMICAL SAFETY MANAGEMENT	
3.1 GENERAL	7
3.2 MANAGEMENT SYSTEM COMPONENTS	7
3.3 CHEMICAL SAFETY PRACTICES	10
3.4 SPILL MANAGEMENT	12
3.5 FIRE, EMERGENCY AND RESCUE PROCEDURES	14
SECTION 4 SAFE USE OF CHEMICAL SUBSTANCES	
4.1 GENERAL	15
4.2 CHEMICAL HAZARDS	15
4.3 GASES	15
4.4 FLAMMABLE CHEMICALS	17
4.5 TOXIC (POISONOUS) CHEMICALS	20
4.6 CORROSIVE SUBSTANCES	21
4.7 UNSTABLE CHEMICALS	21
4.8 HIGHLY REACTIVE CHEMICALS	21
APPENDICES	
A LIST OF REFERENCED AND RELATED DOCUMENTS	23
B LABEL FOR CHEMICAL WASTES	27
C THE USE OF ABSORBENT MATERIALS AND SPILL KITS	28
D HANDLING OF CRYOGENIC FLUIDS	29
E EXAMPLES OF COMMONLY USED HIGHLY FLAMMABLE CHEMICALS	36
F HAZARDOUS PROPERTIES ASSOCIATED WITH COMMONLY USED HIGHLY REACTIVE CHEMICALS	37
G HAZARDOUS PROPERTIES ASSOCIATED WITH COMMONLY USED TOXIC CHEMICALS	39
H HAZARDOUS PROPERTIES ASSOCIATED WITH COMMONLY USED CORROSIVE SUBSTANCES	41
I HAZARDOUS PROPERTIES ASSOCIATED WITH COMMONLY USED UNSTABLE SUBSTANCES	43
J HAZARDS ASSOCIATED WITH THE USE OF PERCHLORIC ACID	45

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Australian/New Zealand Standard**Safety in laboratories****Part 2: Chemical aspects**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out requirements and recommended procedures for safe working practices in the chemical laboratory. It includes procedures for handling flammable, toxic, corrosive, unstable and highly reactive chemicals and makes reference to the handling of compressed and liquefied gases. The Standard also includes information on hazards associated with working in the chemical laboratory.

1.2 APPLICATION

This Standard is intended to be used in conjunction with AS/NZS 2243.1, which provides requirements and recommendations on matters common to all types of laboratory work. If the requirements of any part of this Standard conflict with any National, State or Territory regulations, the appropriate statutory regulations shall apply.

1.3 REFERENCED AND RELATED DOCUMENTS

A list of referenced and related documents is given in Appendix A.

1.4 DEFINITIONS

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

NOTE: The definitions below may not apply in New Zealand.

1.4.1 Auto-ignition temperature

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

1.4.2 Bund

An 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.

1.4.3 Combustible liquid (Australia only)

Any liquid other than a flammable liquid that has a flash point, and that has a fire point less than its boiling point.

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

- (a) *Class C1* A combustible liquid that has a flash point of 150°C or less.
- (b) *Class C2* A combustible liquid that has a flash point exceeding 150°C.

NOTE: The boiling point is taken to mean that point at which it is no longer possible to achieve the rate of temperature rise required by ASTM D92 for the fire point test.

1.4.4 Material safety data sheet (MSDS)

A document that describes the properties and uses of a material, that is, identity, chemical and physical properties, health hazard information, precautions for use and safe handling information.

NOTE: MSDSs are also known as safety data sheets (SDSs) in New Zealand.

1.4.5 May

Indicates the existence of an option.

1.4.6 Risk assessment

The overall process of estimating the magnitude of risk and deciding what actions will be taken. [Definition source: AS/NZS 4801]

1.4.7 Shall

Indicates that a statement is mandatory.

1.4.8 Should

Indicates a recommendation.

1.4.9 Signal words (Australia only)

Words used on labelling to indicate the relative degree of severity (see NOHSC:2012) of the hazard.

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/NZS 2243.1.)

When designing a laboratory in which chemicals are to be used, risk assessment and hazard and operability studies (HAZOP studies, in Australia, see AS IEC 61882 and, in New Zealand, see the *Approved Code of Practice for Managing Hazards to Prevent Major Industrial Accidents*) 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 2982.1, AS/NZS 2243.10 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/NZS 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 2982.1).
- (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 2982.1).

SECTION 3 CHEMICAL SAFETY MANAGEMENT

3.1 GENERAL

In addition to the laboratory safety and emergency procedures specified in AS/NZS 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 material safety data sheets (MSDSs), 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/NZS 2243.1, the key 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, MSDSs 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. MSDSs are most relevant for the use of chemicals in isolation. Where chemicals are to be mixed, information other than the MSDS will be required, e.g. specific reactivities.

NOTES:

- 1 Legislation may require MSDSs to be available.
- 2 MSDSs 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 and radioactive substances 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

The storage of all chemicals in the laboratory shall comply with National, State or Territory legislation and be in accordance with AS/NZS 2243.10.

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

NOTE: 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 proper 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.

The following requirements apply to maintenance and cleaning operations carried out by non-laboratory personnel:

- (a) Maintenance and cleaning staff shall wear personal protective equipment (PPE) suitable for the hazard.
- (b) Where work areas can be isolated, maintenance and cleaning staff shall be familiarized with procedures for determining the access status of the area.
- (c) Maintenance and cleaning staff shall not dispose of hazardous laboratory wastes.
- (d) Cleaning staff shall not clean benches and the area above bench height without prior instructions.

In addition, the following guidelines are recommended:

- (i) Cleaning staff should not interfere with the operation of laboratory apparatus. Designated power points in the laboratory should be allocated for cleaning equipment.
- (ii) Where cleaning work is to be carried out outside normal working hours, the contact details of a designated person should be accessible to cleaning staff.

3.2.6 Health surveillance

Health surveillance appropriate for any hazardous substances in use shall be conducted and records maintained in accordance with legislation. 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/NZS 2243.1.

The risk assessment process conducted for the laboratory, in conjunction with information from relevant MSDSs 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/NZS 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/NZS 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 and appropriate legislation.

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 (in Australia, refer also to NOHSC:2012) 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 B 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.

Intractable wastes, especially those containing heavy metals, cannot be disposed into the environment.

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

Prescribed wastes, as defined by the relevant authority, shall be disposed in accordance with local regulations.

NOTES:

- 1 Disposal may need to be carried out by a licensed waste collector.
- 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 executed to eliminate or minimize production of fumes, mists and dusts in the work area and 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 MSDSs, 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. The disposal of material into ducts or drains shall be in compliance with National, State or Territory environmental legislation. 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. See AS/NZS 2243.10.
- (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 MSDSs, 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 C 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.

However, 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 C 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

All personnel shall learn the basic procedure for the control of laboratory spills.

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 three spill fractions—

- (a) the bulk of the liquid that remains in an irregular puddle;

- (b) the portion that separates as splashes and rivulets; and
- (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 MSDS 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/NZS 2243.1 for requirements and recommendations concerning fire, emergency and rescue procedures for laboratories.

Adequate 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 *Australian Dangerous Goods Code* (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*.