COMMITTEE CH-026

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Draft for Public Comment Australian/New Zealand Standard

LIABLE TO ALTERATION—DO NOT USE AS A STANDARD

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Safety in laboratories
Part 6: Plant and equipment aspects
(Revision of AS 2243.6—1990)

STANDARDS Australia

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

Draft for Public Comment
Australian/New Zealand Standard

The committee responsible for the issue of this draft comprised representatives of organizations interested in the subject matter of the proposed Standard. These organizations are listed on the inside back cover.

Comments are invited on the technical content, wording and general arrangement of the draft.

The preferred method for submission of comment is to download the MS Word comment form found at http://www.standards.com.au/Catalogue/misc/Public Comment Form.doc. This form also includes instructions and examples of comment submission.

When completing the comment form ensure that the number of this draft, your name and organization (if applicable) is recorded. Please place relevant clause numbers beside each comment.

Editorial matters (i.e. spelling, punctuation, grammar etc.) will be corrected before final publication.

The coordination of the requirements of this draft with those of any related Standards is of particular importance and you are invited to point out any areas where this may be necessary.

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 draft is acceptable without change, an acknowledgment to this effect would be appreciated.

When completed, this form should be returned to the Projects Manager, Carol Foster via email to carol.foster@standards.org.au.

Normally no acknowledgment of comment is sent. All comments received electronically by the due date will be put before the relevant drafting committee. Because Standards committees operate electronically we cannot guarantee that comments submitted in hard copy will be considered along with those submitted electronically. Where appropriate, changes will be incorporated before the Standard is formally approved.

If you know of other persons or organizations that may wish to comment on this draft Standard, could you please advise them of its availability. Further copies of the draft are available from the SAI Global Customer Service Centre listed below and from our website at http://www.saiglobal.com/.

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Draft for Public Comment

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Committee CH-026—Safety in Laboratories

Subcommittee CH-026-06 — Mechanical Aspects

DRAFT

Australian/New Zealand Standard

Safety in laboratories

Part 6: Plant and equipment aspects

(Revision of AS 2243.6—1990)

(To be AS/NZS 2243.6—2XXX)

This draft has been prepared to revise AS 2243.6—1990 and ensure it is applicable to New Zealand as well as Australia. Changes have been made throughout the document and, in addition to comments on specific clauses, comment is requested on the document as a whole. The Committee would appreciate it if you would indicate any topics on which additional requirements or guidance should be included. In particular, the Committee would welcome comment on the need to include requirements specific to the electrical safety of plant and equipment in this Standard.

Comment on the draft is invited from people and organizations concerned with this subject. It would be appreciated if those submitting comment would follow the guidelines given on the inside front cover.

This document is a draft Australian/New Zealand Standard only and is liable to alteration in the light of comment received. It is not to be regarded as an Australian/New Zealand Standard.

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee, CH-026, Safety in Laboratories, to supersede AS 2243.6—1990, *Safety in laboratories,* Part 6: *Mechanical aspects*.

The revision was undertaken to update the Standard to reflect risk management principles and current occupational health and safety approaches and terminology. A new section has been added to include information on planning for use of plant and equipment covering risk assessments, procurement, installation and commissioning of plant and equipment, along with training of persons who will use it. A section on maintenance has also been added.

This Standard is intended for use in conjunction with other Standards of the AS/NZS 2243 series and is applicable to all laboratory situations. Other parts of the series are as follows:

Part 1: Planning and operational aspects

Part 2: Chemical aspects

Part 3: Microbiological aspects and containment facilities

Part 4: Ionizing radiations

Part 5: Non-ionizing radiations—Electromagnetic, sound and ultrasound

Part 7: Electrical aspects

Part 8: Fume cupboards

Part 9: Recirculating fume cabinets

Part 10: Storage of chemicals.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

CONTENTS

Page

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Safety in laboratories

Part 6: Plant and equipment aspects

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out requirements and recommendations designed to promote safe working practice relevant to the operation of plant and equipment in laboratories and describes the nature of the potential hazards. This Standard also covers safe working practices relevant to the use of compressed gas cylinders and cryogenic substances.

1.2 OBJECTIVE

The objective of this Standard is to specify requirements and provide information, recommendations and procedures involving the conduct of operations involving plant and equipment in laboratories that will promote safe working practices.

1.3 APPLICATION

This Standard should be used in conjunction with the appropriate part(s) of AS/NZS 2243 that are relevant to the type of work being carried out in the laboratory. If the requirements of any part of this Standard conflict with any National, State or Territory regulations, the appropriate statutory regulations shall apply.

1.4 REFERENCED DOCUMENTS

A list of documents referenced in this Standard is given in Appendix A.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Competent person

A person who has acquired through training, qualifications or experience, or a combination of these, the knowledge and skills enabling that person to perform a specified task.

1.5.2 Hazard

A source or a situation with a potential for harm in terms of human injury or ill-health, damage to property, damage to the environment, or a combination of these. [AS/NZS 4801]

1.5.3 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 (including dangerous goods and hazardous substances), 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.

NOTES:

1 In a multi-occupancy building, the area occupied by the laboratory may be referred to as the laboratory area.

2 AS/NZS 2982.1 contains definitions of various types of laboratories.

1.5.4 Liquid

1.5.4.1 *Combustible liquid*

A 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:

Class C1—a combustible liquid that has a flash point of 150ºC or less.

Class C2—a combustible liquid that has a flash point exceeding 150ºC.

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.

1.5.4.2 *Flammable liquid*

A liquid that has been defined in the ADG Code/NZS 5433 as a Class 3 liquid.

1.5.5 Material safety data sheet (MSDS)

A document that describes the properties and uses of 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.

1.5.6 May

Indicates the existence of an option.

1.5.7 Plant

Any machinery, equipment (including scaffolding), appliance, implement or tool and any component or fitting thereof or accessory thereto.

1.5.8 Residual current device (RCD)

A device intended to isolate supply to protected circuits, socket-outlets or electrical equipment in the event of a current flow to earth that exceeds a predetermined value. [AS/NZS 3000]

1.5.9 Risk

(In relation to any potential injury or harm.) The likelihood and consequence of that injury or harm occurring. [AS/NZS 4801]

1.5.10 Risk assessment

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

1.5.11 Shall

Indicates that a statement is mandatory.

1.5.12 Should

Indicates a recommendation.

1.5.13 Working in isolation

Work carried out in an area where normal means of contact (e.g. verbal, sight) with other staff are not available, so that the potential risk of existing hazards is increased to the extent that extra precautions are needed. This includes working in isolated areas on or off-site, either during or outside normal working hours.

SECTION 2 PLANNING FOR USE OF PLANT AND EQUIPMENT

2.1 GENERAL

2.1.1 Planning

The best basis of planning for safety is to consider in advance the consequences of every action. Such considerations should include location, services, scale, compatibility, ergonomics and workflow.

2.1.2 Risk assessment

Risk assessment of all operations in the laboratory involving plant and equipment shall be carried out. For further information on risk identification, control and management see AS/NZS 4801 and AS/NZS 60079.10.

When controlling risks, the most effective control measures available should be chosen in order of effectiveness. The hierarchy of controls is as follows:

(a) Elimination of hazards from the laboratory.

(b) Substitution of a substance or process.

(c) Isolation of the hazard.

(d) Application of engineering controls, for example local exhaust ventilation.

(e) Adoption of safe work practices, including documented work methods.

(f) Where other effective means to control the hazard are not practical, use of suitable personal protective equipment.

As part of the risk assessment, the information contained in various regulations and accompanying codes of practice, instruction manuals and the other Parts of this series shall be considered in areas such as chemical safety. Tasks shall be assessed for performance during normal working hours and outside of normal working hours, as the risk is often increased out of hours when the availability of emergency personnel is reduced. Security requirements for the laboratory's activities shall also be considered with respect to access to the laboratory area. This assessment shall also address access to, and operations in, the laboratory pertaining to students, maintenance staff, contractors, visitors (including children), cleaners, security staff and animals (experimental and comparison).

Within particular industries there may be existing methodology together with control levels that apply to the operation of these assessments. In addition, National, State and Territory authorities provide guidance notes on the application of risk assessment procedures to be adopted when implementing and complying with the regulations.

2.1.3 Procurement

Prior to procurement, a risk assessment should be performed in order to identify all potential hazards and ensure that controls are adequate. In addition, the risk assessment carried out in accordance with Clause 2.1.2 should be reviewed to ensure its ongoing validity.

Plant and equipment shall be selected to ensure it is fit for the intended purpose and that design for safe operation has been given adequate attention by the manufacturers. Equipment shall be selected to be suitable for electrical services in Australia or New Zealand, as appropriate, and for the hazardous area zoning of the area in which it is to be installed. Noise requirements should also be specified and either the 'choose-quiet' or 'buy-

quiet' process as outlined in AS/NZS 1269.2 should be implemented. Safety requirements for plant and equipment should be included in the purchasing documentation.

NOTE: Safety issues which should be considered at the time of purchase, include the need for—

(a) special units designed specifically for handling flammable materials (e.g. fitted with flameproof motor) or pathogens;

(b) adequate shielding against failure of moving parts;

(c) an interlocking system that prevents starting unless covers and guards are properly closed and locked, and also prevents access to moving parts whilst it is in motion; and

(d) automatic controls to switch off the equipment when excessive vibration occurs.

2.1.4 Installation and commissioning

The manufacturer's directions for installation shall be followed, or the manufacturer's technical representative shall be requested to install the equipment.

Detailed installation and operating instruction manuals should be obtained from the manufacturer. Instruction manuals should be in clear and concise English and understood before operation of equipment.

Safe operation of equipment is dependent on the correct installation. The following precautions should be observed when installing and commissioning laboratory equipment:

(a) Ensure that the equipment has adequate safeguards and controls to satisfy a risk assessment and relevant standards (see Clause 3.2.3).

(b) Select a safe location with adequate space, ventilation and lighting and separation from other equipment and operations.

(c) Ensure that services are available or provided from appropriate sources after checking the applications for which any existing services have been approved.

(d) Ensure any noise control measures are in place.

(e) Ensure appropriate operating and maintenance procedures are developed and specify any personal protective equipment to be worn during its operation.

(f) Ensure that the equipment is used within the limitations of its design.

(g) Ensure that the equipment is subjected to a commissioning procedure which tests its design capabilities and safeguards.

NOTE: Audit, inspection and maintenance procedures should be implemented to ensure installation precautions remain effective

The equipment shall be installed in accordance with AS/NZS 3000, with particular attention to hazardous zoning.

2.2 TRAINING

Persons who use plant and equipment shall be competent in its use. Such persons shall be made aware of the operating characteristics, basic safe working practices and emergency procedures relevant to the equipment involved, and in particular the need for wearing appropriate protective equipment.

2.3 REQUIREMENT FOR SAFE CONDUCT

Good housekeeping is one of the best aids to safety with mechanical apparatus. This implies the need for tidiness, cleanliness, clear work areas, and proper use and timely maintenance of plant and equipment. The following recommendations apply to good housekeeping practices in the laboratory:

(a) Keep fire escape routes completely clear at all times.

(b) Make appropriate personal protective equipment for eyes, ears, face, hands, feet and respiratory system as specified in AS/NZS 2243.1 available to laboratory personnel. The equipment should be comfortable to wear, and should be selected, used and maintained in accordance with HB 9.

(c) Maintain all safety equipment in the best operating condition, and regularly check and inspect for correct operation in accordance with the manufacturer's instructions.

(d) Secure items such as loose-fitting clothing, ties, jewellery including rings, and long hair (including beards) to keep them out of moving equipment. Sleeves of overalls or working-shirts should either be rolled up above the elbow, or be buttoned tightly at the wrist.

(e) Keep benches, shelves and cupboards clean and tidy. Apparatus and reagents should be cleaned, and put away immediately after use.

(f) Clean up after each stage of an operation. Apparatus which has contained harmful chemicals should be rinsed before being left for final cleaning.

(g) Return all equipment not in use to its proper place in a clean and working condition.

2.4 STORAGE OF WORK MATERIALS

Work materials should be stored in well constructed racks at an access height suitable for use with the materials handling methods employed.

2.5 EMERGENCY MANAGEMENT

Emergency management procedures shall comply with the requirements in AS/NZS 2243.1.

SECTION 3 EQUIPMENT IN GENERAL USE

3.1 USE OF MACHINES

Mechanical apparatus shall be used only within the range of operating conditions for which it was designed. Machines with rotating components are particularly susceptible to stress because, in such apparatus, the centrifugal stresses increase as the speed of the rotor increases.

Movement of machinery parts consists basically of rotary, sliding or reciprocating motion which, individually or in combination, can produce cutting, shearing and crushing injuries. Rotating parts are also capable of inflicting injury by personal entanglement. Dangers from machinery can be minimized by the operator wearing suitable clothing, and by fitting suitable guards, physical barriers and electrical interlocks to the machine to protect both the operator and passing traffic.

3.2 SAFEGUARDING OF MACHINERY

3.2.1 General

An obvious function of a machine guard is to keep the operator's body, fingers, clothing and arms away from the danger points, without impeding the intended operation of the machine, or obstructing vision. This function can usually be met by intelligent design.

Another function, which may be less obvious, is to keep hazardous objects from striking the operator. A grinding wheel guard is an example of this; a suitable guard should be of an appropriate shape and of adequate strength to contain any potential hazard.

A guard can serve a further function in preventing the fitting of an attachment likely to fail. In the case of the grinder this could be an oversize wheel, which would be more prone to disintegration. This aspect of guard functioning also applies to interlocks, where the machine cannot be started or operated unless the guard is correctly in position. The AS 4024.1 series should be consulted for further information on guarding and interlocks.

3.2.2 Hazards to operators

A person may be injured by machinery as a result of—

(a) coming into contact with machinery, or being trapped between the machinery and any semi-permanent or fixed structure;

(b) being struck by, or becoming entangled in or by, any material in motion in the machinery;

(c) being struck by ejected parts of the machinery; or

(d) being struck by material ejected from the machinery.

The use of automatic equipment to move components, materials and substances into and out of machine tools and process machinery should be considered, as this may reduce the hazards to operating personnel. Care should be taken to ensure that the use of automatic equipment does not introduce further hazards, e.g. trapping of operators between the automatic equipment and parts of the machine or materials being processed.

3.2.3 Basic principle of safeguarding

A risk assessment of the hazards involved in the use of equipment shall be carried out in accordance with AS 4024.1. Potentially dangerous machinery parts should be eliminated or effectively enclosed at the design and manufacturing stage of the machinery. If this cannot

be achieved, suitable safeguards shall be used, or provision made for safeguards to be easily incorporated before use.

All mechanical equipment should be fail-safe and, when power is returned after any interruption, the equipment controls should require manual resetting before the equipment can be restarted.

Unless a machine or area is safe by virtue of its position, the machinery should be provided with an appropriate safeguard that eliminates or reduces danger before access to the danger area can be achieved. The following design considerations relating to safeguarding should be taken into account:

(a) Provision should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that the type of work that the machinery will perform will vary.

(b) Movable machinery guards or covers should be interlocked with the drive to the parts being guarded.

(c) Lubrication and routine maintenance facilities for machinery should be located outside the machine working area.

(d) Every mechanism and control forming part of a safeguard should, as far as practicable, be of fail-safe design.

3.2.4 Construction of safeguards

Safeguards should be constructed with observance of the following considerations:

(a) All safeguards should be of robust design and adequate strength.

(b) Guards should be made of metal, timber, laminated or toughened glass, suitable plastics or a combination of these, as appropriate.

(c) Whatever safeguard is selected, it should not be a likely source of injury, such as having trapping or shear points, splinters, or rough or sharp edges.

3.3 FIXED POWER TOOLS

3.3.1 General requirements

The following general requirements apply to the safe use of fixed power tools:

(a) *Competence* Fixed power tools shall be operated by competent persons only.

(b) *Eye protectors* Whenever power tools are used, eye protectors complying with AS/NZS 1337 shall be worn by operators and persons in the immediate vicinity.

(c) *Chuck keys* The chuck key shall be removed from the chuck immediately after the drill bit has been fixed-in or removed.

On and off switches for power control should be designed to prevent accidental starting of machinery, and to facilitate instant cut-off of power by one movement. Emergency stop push-buttons should be installed on fixed power tools. The switches should be in a practical location.

3.3.2 Drilling machines

The following requirements apply to the safe use of drilling machines:

(a) Fixtures, machine vices or workpieces shall be clamped to the table or set against stop bars. Workpieces shall not be drilled while being held with rags or similar materials.

(b) When the flutes of a drill become choked with swarf, the machine shall be stopped before the swarf is removed.

(c) Swarf from drills shall be removed only in accordance with established safe practices using a swarf hook, brush or suitable gloves. Compressed air shall not be used as a forced-blast cleaner.

(d) Hinged guards shall be provided to enclose completely the upper part of drilling spindles, pulleys and belt drives.

(e) The use of gloves when using drilling machines shall be subject to a risk assessment.

3.3.3 Grinding and polishing machines

The following requirements apply to the safe use of both grinding and polishing machines:

(a) Each wheel shall be positioned in a manner such that, when in use, the plane of rotation is not in line with any doorway, passageway, entrance or place where people regularly work or congregate.

(b) The major part of the wheel shall be covered with a fixed guard, with additional adjustable guarding leaving exposed only the portion of the wheel in use.

(c) An eye-screen shall be provided on a bench grinder used for hand-held work. The screen shall always be in place, and be maintained at adequate transparency. In addition to the screen, eye protection (see AS/NZS 1336) shall be worn for grinding and polishing operations.

NOTES:

1 The area of the screen should be large enough to discourage the operator from looking round it.

2 Hearing protection (see AS/NZS 1270) and dust protection devices (see AS/NZS 1715) may also be required.

(d) The work rest shall be maintained in good condition, and adjusted as closely as possible to the wheel, with a maximum clearance of 1.5 mm.

NOTE: The workpiece should never be forced against a cold wheel, as sudden heating may cause the wheel to disintegrate.

(e) The operator shall ensure that wheels are correctly positioned, with no sway (to be checked especially when wheels have been changed). See AS 1788, Parts 1 and 2.

(f) The safe working speed, printed on the label of every wheel, shall not be exceeded.

(g) Operators shall be instructed to stand clear of the plane of rotation when the machine is first started, and until full operating speed is attained.

(h) Grinding on the side of the wheel shall be permitted only where the correct wheel for this purpose is fitted, and where a suitable rest is provided.

(i) The workpiece being ground shall not be held in a glove, apron or any form of pliers, as there is a risk of personal injury if the material is trapped between the wheel and the workpiece.

NOTE: If necessary, a hand-vice or similar locking-grip should be used.

(j) Where a magnetic chuck is used to hold magnetic materials on surface grinding machines, the chuck shall be checked to ensure that its magnetic properties remain adequate.

(k) The grinding wheel shall have its grinding surface dressed at regular intervals, or as necessary.

NOTE: A dressing tool should be available close to the grinder, together with instructions for its correct use.

(l) Regular and frequent cleaning of the area around the grinding and polishing machines shall be carried out to minimize dust hazards.

NOTE: Lubricants should be selected and used in accordance with the manufacturer's instructions.

3.3.4 Linishing machines

The following requirements apply to the safe use of linishing machines:

(a) The abrasive belt shall be examined before use, and a torn or badly worn belt shall be replaced.

(b) Wherever possible, belts shall be so mounted that they rotate away from the operator.

(c) The correctness of the tracking of the belt shall first be checked by rotating the belt by hand, adjusting it if necessary, and finally checking it with a trial run.

(d) Where the shape of the workpiece precludes safe holding by hand, a suitable jig or fixture shall be used. The workpiece shall not be held in a cloth, apron or any form of pliers. The use of gloves shall be subject to a risk assessment.

(e) Care shall be taken to ensure that the workpiece does not become heated to the point where fingers are burnt.

(f) Regular and frequent cleaning on and around the linishing machine shall be carried out.

A linishing machine should be guarded with only the working face of the belt exposed.

NOTE: Some linishers have open belt systems for multipoint sanding and guarding is not possible.

3.3.5 Lathes

The following requirements apply to the safe use of lathes:

(a) Stock bar guards shall be provided, maintained and adjusted so that the bar stock does not project beyond the limits of the guard.

(b) Splash containment shall be provided to prevent lubricating fluid from splashing onto the floor.

(c) No tools, measuring instruments or other objects shall be kept on the moving saddle or lathe bed, or on any part of the machine where vibration could cause them to fall into moving parts.

(d) The chuck key shall be removed immediately after the workpiece has been secured in the jaw.

(e) Where machines are capable of operating the chuck in reverse, the chuck shall not be removed by turning on the power and operating in reverse.

(f) When setting up a workpiece in a lathe chuck, the tool post and tail stock shall be kept clear to allow adequate hand clearance, particularly when sharp pointed tools are mounted on the tool post and into the tail stock.

(g) Swarf shall be kept well clear of the rotating chuck and workpiece to prevent pick-up. The lathe spindle shall be stationary before removing swarf.

(h) Swarf shall be removed using suitable swarf-hook, brush or gloves. Compressed air shall not be used as a forced-blast cleaner.

3.3.6 Metal-cutting guillotines

The following requirements apply to the safe use of metal-cutting guillotines:

(a) Guillotines shall be marked with the maximum gauge of material which can be cut. Reference shall be made to the type of material which may be cut, and a correlation provided between the type of material and the limiting gauge which may be

guillotined. Metal of thickness or hardness greater than the guillotine's capacity shall not be cut.

(b) Guards shall be provided on a metal cutting guillotine to prevent the operator's fingers from contacting the knife or clamp, from either the front or rear of the machine. Electrical or mechanical interlocks shall be used to prevent operation of the machine without the guards in position.

(c) Where two or more persons are using a machine, only one person shall control its operation at any one time. Where long material is being cut and cannot be adequately supported by the worktable, additional supports shall be provided.

(d) Hand-operated guillotines shall be immobilized when not in use, either by removal of the handle, or by the use of a locking pin or similar device.

(e) The shear edges of the guillotine blades shall be maintained in good condition, and blades shall not be used if they are distorted, cracked or badly chipped.

(f) Protective gloves shall be worn to handle cut metal and the scrap metal offcuts.

(g) A container shall be provided for waste material.

3.3.7 Power-driven hacksaws

The following requirements apply to the safe use of hacksaws:

(a) An automatic knock-off switch shall be used at all times and be regularly checked to ensure that it is in good order and correctly adjusted.

(b) Where necessary, splash containment shall be provided to prevent lubricating fluid from splashing onto the floor.

(c) The bow of the hacksaw shall be highlighted in a bright colour, e.g. yellow.

(d) The correct hacksaw blade, appropriate to the type of workpiece, shall be used.

(e) The workpiece shall be securely fixed and adequately supported, and the length of any overhanging workpiece shall be clearly indicated to avoid a tripping hazard. Where it is necessary to have a length of overhanging workpiece held in the hacksaw, a suitable support shall be provided.

3.3.8 Power-driven band saws

The following requirements apply to the safe use of band saws:

(a) An automatic knock-off switch shall be provided for emergencies.

(b) A workpiece pusher, preferably of wood or plastic, shall be used to prevent fingers coming into contact with the band saw blade.

(c) Sleeve cuffs shall be secured close to the wrist when using band saws.

(d) Band saws shall be fully shielded, and exposed only at the cutting area.

(e) Appropriate eye and ear protection shall be worn when using the band saw.

3.3.9 Universal testing machines and testing frames

Hydraulic and pneumatic testing involves inherent dangers from the high forces and rapid motion employed. Unexpected actuator motion can occur while installing specimens, during routine servicing, or at any other time personnel are working with the equipment. Unexpected actuator motion can injure the operator or damage the load cell, grips, fixtures, or valuable specimens. The following requirements apply to the safe use of universal testing machines and testing frames:

(a) Cables shall not be routed across the floor without protection or, strung overhead under excessive strain. Where cables are routed around corners and through wall openings, padding shall be used.

(b) All pressurized hydraulic or pneumatic hoses shall be secured to prevent movement during system operation, and to prevent the hose from whipping about in the event of a rupture.

(c) The test shall be set up, and the actual test performed, so that there is no hazard to operating personnel.

(d) The 'electronic limits' of the instrument shall be set to prevent unexpected excursions of the actuator piston beyond desired regions of operation.

(e) Extreme caution shall be used when loading specimens and when working in the vicinity of the actuator piston.

(f) Eye protection shall be worn or an appropriate safety shield used to minimize the danger from ejected debris.

(g) If required, hearing protection shall be worn or appropriate noise abatement measures or enclosures shall be used.

(h) The height of the table or shield shall be adjusted to suit the workpiece.

(i) Where fitted, gas connections shall not be released unless the gas supply has been disconnected, and any residual pressures have been reduced to zero.

(j) Hydraulic or pneumatic coupling shall not be disconnected without having shut down the hydraulic or pneumatic pumping system, and having checked to see that stored pressure has been discharged.

(k) Where cryogenic fluid is used in the testing equipment, the equipment shall be operated only in a well-ventilated area, to prevent excessive concentration of gas.

(l) The testing machine shall be disconnected from its power source before removing any cover which gives access to rotating machinery, e.g. belts, gears, screws or shafts.

3.3.10 Milling machines

The following requirements apply to the safe use of milling machines:

(a) The guarding and safe use of milling machines shall be in accordance with the requirements of AS 4024.3101.

(b) Splash containment shall be provided to prevent lubricating fluid from splashing onto the floor.

(c) Care shall be exercised when using fast traverse levers, to avoid running the workpiece into the cutter. Removal of the arbor nut by applying power to the machine shall not be attempted.

(d) The workpiece or vice shall be clamped firmly on the table before starting the machine, and, where necessary, supports shall be provided to prevent vibration and chatter.

(e) Operators shall be aware of the characteristics of cutters and the correct type of handling equipment, particularly when using heavy cutters.

(f) Hands and fingers shall be kept well away from moving cutters.

(g) A fly cutter shall be used with a chip guard affixed, and mandrel nuts shall be kept tightened.

(h) The workpiece shall be positioned so that the cutting head does not tend to pull the work piece into the cutter (often referred to as climbing).

(i) Swarf shall not be removed while a cutter is in motion.

NOTE: Compressed air should not be used as a forced-blast cleaner.

3.4 PORTABLE POWER TOOLS

3.4.1 General requirements

The following general requirements apply to the safe use of portable power tools:

(a) If electrically powered, tools shall comply with the requirements of AS 2243.7.

(b) Power tools shall be checked before use to ensure they are in good working condition.

(c) Portable power tools shall be operated by competent persons only.

(d) Eye protectors complying with AS/NZS 1337 shall be worn whenever power tools are used. Ear protection may also be necessary.

(e) A power tool shall be of robust construction and used only for the purpose for which it was designed.

(f) The power tool shall be placed in a suitable store when not in use, after checking for damage to parts and attachments.

3.4.2 Electrical requirements

Electrical requirements for portable power tools are as follows:

(a) Portable electric tools, leads (including extension cords), battery chargers and appliance testers shall be checked for electrical safety by a competent person in accordance with AS/NZS 3760.

(b) The tool shall be provided with non-detachable flexible cable complying with AS/NZS 5000.1. A suitable plug, preferably of an unbreakable type, shall be connected to the flexible cable. All plugs, socket outlets, cables and appliances shall comply with AS/NZS 3100.

(c) Frayed or damaged electrical leads and loose or damaged plugs shall be replaced before the tool is used.

NOTE: Only suitable connectors with overload protection should be used. Double adaptors and piggyback plugs should not be used.

3.4.3 Portable power saws

The following requirements apply to the safe use of portable power saws:

(a) A portable circular saw shall be provided with guards incorporating fixed and automatically adjusting parts which, when in use, cover the saw blade teeth clear of the work, and which, when withdrawn from the work, cover the teeth completely around the periphery of the saw blade.

No device for locking the guard in the retracted position shall be used.

NOTE: Portable circular saw blades should be kept sharp and correctly set to minimize jamming, and should be regularly checked for cracks.

(b) The device provided on the saw for controlling power (e.g. a trigger) shall be such that power is cut off when pressure ceases to be applied.

3.4.4 Portable power drills

The following requirements apply to the safe use of portable power drills:

(a) A portable drill shall be marked according to its function, together with the maximum diameter of the drill bit that the chuck is designed to hold.

(b) Drill bits that have had the shank modified shall not be used.

(c) A chuck key of the correct size shall be provided for use with each portable drill.

3.5 HAND TOOLS

3.5.1 Maintenance and use

All tools shall be properly maintained and serviced, and shall comply with the appropriate standards, where they exist. Many accidents are caused by the improper use of hand tools and by the use of improperly maintained tools. Substitute tools should never be used, e.g. a screwdriver should not be used as a chisel and vice versa.

3.5.2 General recommendations

The following recommendations apply to the safe use of hand tools:

(a) *Workpieces* Work and workpieces should be well supported or clamped.

(b) *Edged tools* An edged tool should be kept sharp, and ground to the correct cutting angle.

(c) *Sharp tools* Any sharp tool, such as a knife or chisel, should be placed in a scabbard or carried in a tool box and should not be carried in the pocket. Where practicable, the cut of a knife should always be made in a direction away from the operator.

(d) *Wood chisel* A wood chisel should be struck only with a mallet, and the direction of cutting should always be away from the operator. Handles should incorporate metal ferrules or other means of preventing splitting.

(e) *Metal-cutting chisel (cold chisel)* The head of a metal-cutting chisel should be dressed by filing or grinding at the first sign of mushrooming. In redressing the head of a chisel, a small radius should be ground at the outer edge of the head. Care should be taken to avoid excessive build up of heat during the dressing operation. Protective screens should be provided to protect persons working nearby.

(f) *Hand saw* A hand saw should be kept sharp and correctly set, to prevent binding. If the free hand is to be used as a guide while sawing, the thumb should be held high on the saw, not on the material being cut.

(g) *Plane* A plane should be kept sharp, and the blade correctly adjusted. The handle should be kept tight at all times. A plane should be stored with the blade drawn back unless adequate protection is otherwise provided.

(h) *Hammer* The handle of a hammer should fit the head tightly and be correctly wedged. The face should be inspected regularly, and any defects remedied, or the hammer head should be replaced. A hammer head of softer material should be used on hard or brittle metal.

(i) *Spanner* A spanner should be checked regularly, and should be discarded when worn, distorted or cracked.

An adjustable spanner should be used only where a correct fitting spanner is not available and, to minimize risk of injury, should be used only in the direction such that the action tends to close, rather than open, the jaws.

The use of an improvised extension to increase the applied torque on a spanner or wrench should not be encouraged.

(j) *Screwdriver* The blade and handle of a screwdriver should be maintained in good condition. The edges of the tip of the blade should neatly fit the slot of the screw. When using a screwdriver, the workpiece should not be held in the palm of the hand.

(k) *File* A file should always be used with a smooth, securely-fitted, crack-free handle covering the tang. The correct type of file should be selected for the job in hand. A

file should be cleaned with a steel file brush, not by being struck against a vice or other metal object.

(l) *Storage* A storage place should be provided for every tool, e.g. in a tool box, on a rack or shadow board, and the tool should be returned to its place when not in use.

3.6 CENTRIFUGES

The following requirements apply to the safe use of centrifuges:

(a) *Competence* Operators shall be competent in the correct use of centrifuges, especially in the necessity for cleanliness, precise rotor balancing and correct use of centrifuge tubes.

(b) *Vibration* Bench top centrifuges shall be securely anchored to prevent movement caused by vibration.

(c) *Excessive speed* Excessive speed relative to the mass being centrifuged shall not be used (see Clause 3.1).

(d) *Location* The centrifuge shall be located where vibration will not cause glassware or apparatus to fall from shelves.

3.7 HEATING EQUIPMENT

3.7.1 Personal safety

The following requirements apply to the safe use of heating equipment:

(a) Suitable gloves and tongs and face or eye protection shall be used when handling hot samples.

(b) Mantles shall be used only with suitable control equipment, so that rated power is not exceeded.

(c) Heating equipment shall be located on a suitable inert base that prevents excessive heat affecting the underlying structure.

(d) A suitable heat-resistant area on which to place hot items shall be provided adjacent to each furnace.

(e) Flammable material shall not be placed where it could be ignited by a heat source.

(f) Warning notices shall be prominently displayed in likely fire or explosion hazard areas.

(g) Correct light-up and shut-down procedures for gas-fired or oil-fired furnaces shall be displayed adjacent to the equipment.

(h) All cords for heating units shall be heat insulated.

3.7.2 Safety features

Safety features which should be considered when purchasing or when using furnaces and other heating equipment are:

(a) Blow-out panels or magnetic latches for pressurized equipment.

(b) Forced draft fans, well-designed convection, or inert gas purging for explosive atmospheres.

(c) Flameproof contactors, controls and switches for equipment to contain, or to be used in, potentially explosive atmospheres.

(d) Sealed thermostats to prevent possible ignition of flammable vapours.

(e) Reliable and well-maintained thermostatic controls, including lock-up adjustment requiring manual reset, that fail only in the safe mode.

(f) Electrical earthing of all exposed metal or electrically conductive cabinets and parts.

(g) Facilities for inert gas purging of mantles, in case of spillages.

(h) Bright indicator light on the heating equipment, and timer switches.

(i) On-off switch with pilot light.

(j) The position that the hot surface of the furnace door will be in when the furnace door is opened.

(k) Ventilation for heat and fume control.

3.8 HIGH PRESSURE EQUIPMENT

High pressure work is hazardous due to the stored energy in the system. The design and construction of pressure vessels is subject to requirements administered by regulatory authorities under National, State and Territory regulations. Designs and any unusual application involving suspected pressure hazards shall be referred to a competent person. Regular inspection of most types of pressure vessels is mandatory, and regulatory requirements shall be checked. (See also AS 1210, AS/NZS 3788, NZ OSH 4270 and AS 4343).

Safety requirements for the use of high pressure equipment are as follows:

(a) Only materials and equipment designed to withstand high pressures, e.g. welded or seamless tubing, and compatible with the intended contents shall be used.

(b) Safety valves and other methods of pressure release, and remote methods of energy cut-off, shall be sited so that their operation cannot injure people or damage equipment.

(c) Safety valves incorporating means of manual release shall be operated regularly, to ensure correct operation. Safety valves shall not be adjusted by unauthorized persons and, where provision is made for locking, shall be kept locked.

(d) Arrangements shall be made so that fired and unfired pressure vessels are inspected by competent persons at regular intervals as specified by the regulatory authority or AS/NZS 3788, as appropriate.

(e) If glass equipment is to be pressurized, calculations of the pressure increase shall be conducted so it can be ensured that the glass is appropriately rated, the glass equipment shall be screened, and full-face protection shall be worn by the operator.

3.9 VACUUM APPARATUS

3.9.1 Design

Care shall be taken in the structural design of vacuum vessels, to ensure that the vessels can withstand the compression applied during evacuation.

3.9.2 Use of vacuum apparatus

Safety requirements in the use of vacuum apparatus are as follows:

(a) Where possible, vacuum apparatus shall be partitioned from the operator by a safety screen. Where a safety screen is impractical, full-face protection shall be worn by the operator.

(b) Wide-bore glass tubing, bulbs and items of up to 1 L capacity shall be strapped with cloth adhesive tape, or with cellulose tape covered with cloth mesh and varnished, or be sprayed with PVC. Larger items shall be encased in a suitable wire screen.

(c) The apparatus shall be examined for cracks and scratches, both before and after filling.

(d) Metal or plastics (PVC) tubing shall be used instead of glass tubing wherever practical, and flexible couplings shall be included in the apparatus when using ground glass unions. Ball-and-socket joints are preferred to cone-and-socket joints.

(e) Rubber bungs shall be large enough to resist being sucked into a vacuum vessel.

(f) Stop-cocks shall be properly lubricated.

NOTE: Stop-cocks should always be operated slowly, and should never be forced.

(g) Where powders or liquids are present in the evacuated apparatus, an in-line trap shall be used to prevent any material entering the vacuum pump.

(h) Exhaust gases from vacuum pumps shall be safely vented.

NOTES:

1 A suitable trap should be provided between the vacuum apparatus and the pump or exhaust system.

2 See AS/NZS 2243.3 for additional requirements associated with vacuum systems for microbiological applications.

3.10 OTHER EQUIPMENT

3.10.1 Equipment features

The following requirements of the list apply to the safe use of equipment, where appropriate:

(a) *Radiation (UV and other)* Ultraviolet-absorbing goggles shall be used where ultraviolet equipment is operated (see AS/NZS 1338), and warning signs shall be posted around the immediate area where the equipment is in use. Where the UV equipment produces ozone, adequate ventilation shall be provided to limit operator exposure. If X-ray, neutron activation, microwave, radiofrequency or similar processes are employed, personnel shall be instructed in the hazards of stray radiation (see AS 2243.4 and AS/NZS 2243.5).

(b) *Open flames—Ventilation* Adequate ventilation and ducting shall be provided for all instruments using open flames, e.g. atomic absorption spectrometers.

(c) *Open flames—Shielding* Apparatus producing flames shall be guarded by built-in shields that will attenuate any explosion, eruption or injurious radiation, and will protect the person using the equipment.

(d) *X-ray radiation* X-ray apparatus shall be shielded to prevent stray radiation, and warning signs shall be clearly displayed.

(e) *Neutron generation* Neutron moisture meters and generators shall have built-in shielding, and adequate directions for use shall be provided. Appropriate warning signs shall be clearly displayed.

(f) *Lasers* Adequate shielding shall be provided for lasers to prevent electric shock, accidental discharge and stray radiation. Refer to AS/NZS 2211.1 for laser safety information.

The following should also be considered:

(i) *Heating* Provision of temperature limit switches to prevent overheating.

(ii) *Immersion heating* Protection of electrical immersion heaters against overheating through failure of thermostatic controls, by use of an automatic cut-off and a low water level cut-off.

3.10.2 Equipment types

Requirements for miscellaneous equipment and processes are as follows:

(a) *Refrigerators* Only refrigerators designed or modified for the purpose shall be used for the storage of flammable liquids. Foodstuffs for human consumption shall not be stored in laboratory refrigerators.

NOTE: Many laboratory explosions have been caused by domestic refrigerators being used for storage of flammable liquids. Leaking vapours reaching one of the many ignition sources within domestic refrigerators may cause a fire or explosion.

(b) *Microtomes* A positive lock shall be provided on microtomes to prevent unexpected operation, and a guard provided to protect the operator from long knives that can project beyond the sectioning area.

(c) *Fraction collectors* Fraction collectors shall be ventilated to exhaust leaks or spills of flammable liquids; explosion-proof construction shall be employed, with a design which keeps ignition sources out of areas where flammable vapours can accumulate. Fraction collectors shall be located in an area where the fire damage potential is minimized. An electronic signal shall be provided to indicate cycle completion.

(d) *Paraffin dispensers* Paraffin dispensers, and vacuum infiltrators for paraffin, shall be fitted with an automatic over-temperature shut-off in series with thermostatic control, so that a thermostat failure will not result in overheating and fire.

(e) *Paper and thin layer chromatography apparatus* The chromatography process and equipment shall be adequately ventilated to remove any flammable, toxic, narcotic or irritating vapours.

(f) *Distillation and zone melting* Where used on a continuous basis, the processes of distillation and zone melting shall have ‘fail-safe’ attachments to prevent possible serious consequences from water pressure changes or electrical failure.

(g) *Bomb calorimeters* The bomb calorimeter is a high-pressure vessel which shall be handled with care at all times. To minimize the risk of damaging the combustion bomb, the characteristics of the reactions to be carried out, i.e. production of corrosive gases, shall be checked prior to use. When in use, bomb calorimeters shall be adequately shielded to protect operators against explosions.

In addition, the following recommendations apply to miscellaneous equipment:

(i) *Ultrasonic baths* Physical contact with the cleaning agent or the inside of the tank should not be allowed whilst ultrasonic apparatus is operating.

(ii) *Tissue processors and automatic staining apparatus* Tissue processors and automatic staining apparatus should be located in a separate room or closet having special exhaust ventilation. The apparatus should be provided with a means of preventing any liquids from spilling onto the floor.

(iii) *Robotics* Laboratory instrumentation that is configured for automated application (such as spectrophotometric devices, microscopes, chemical analysers, dispensers, diluters, mixers, heaters and tissue and cell culture instrumentation) can consist of a number of individual workstations. Generally, workstations are linked with robotic arms and plate movers for passing material and samples.

Consideration for installation requirements such as bench strength, power and work zone should be incorporated into the procurement risk assessment. Operators of robotic equipment should ensure that liquids are suitably positioned and contained in the work zone to prevent spillage and leakage, and suitable clothing and PPE worn to prevent catching and grabbing of hair and clothing.

SECTION 4 COMPRESSED GAS CYLINDERS

4.1 IDENTIFICATION OF GAS CYLINDERS

Gas cylinders shall be identified in accordance with AS 4332.

4.2 HANDLING, USE AND STORAGE

4.2.1 General

A risk assessment shall be conducted to determine appropriate storage and transport arrangements for the compressed gases required by the laboratory.

If a gas leak is suspected or detected, cylinders, gas pipework and equipment shall not be used.

The practices set out below are recommended for the safe handling and storage of high-pressure gas cylinders. Additional precautions may be necessary, depending on the category (toxic, flammable, oxidant or inert) to which the gas belongs, the individual properties of the gas and the process in which it is used.

4.2.2 General precautions

The following practices are recommended:

(a) Only competent persons should handle and use compressed gases.

(b) The identity of the gas should be ascertained prior to its use. Colour codes should not be the only criteria used for identification. If the contents of a cylinder cannot be identified, the supplier of the cylinder shall be contacted.

(c) Cylinder identification labels provided by the supplier should not be removed from the cylinder.

(d) Cylinder valve outlets and regulators for flammable gases are fitted with left-hand threads, while those for non-combustible gases are fitted with right-hand threads (see AS 2473.1). Some imported gases may be supplied in cylinders with ‘foreign’ valve outlets not conforming to AS 2473.1. If in doubt, the gas supplier should be contacted.

(e) The properties and hazards associated with each gas should be identified before using the gas, e.g. by consulting an MSDS.

NOTE: Excess-flow valves or cut-off devices should be used with toxic or asphyxiating gases.

(f) Cylinder keys should be left in the cylinder valve when the gas is in use, to facilitate rapid cut-off in an emergency.

4.2.3 Tubing and piping

Safety requirements for gas piping systems are as follows:

(a) Design requirements and manufacturers’ data shall be carefully checked with particular reference to:

(i) Allowable pressure.

(ii) Tube size.

(iii) Operating temperature.

(iv) Materials of manufacture and compatibility.

NOTE: Compatibility of the material with both the gas it is to carry and the environments through which the piping travels should be considered.

(b) Where a pressure build up in gas lines may cause the gas flow to reverse, non-return valves shall be fitted.

(c) Where condensate may accumulate in the gas lines, the use of catchpots or an inert-gas purge facility shall be considered.

(d) In gas lines where flammable and oxidizing gases can be mixed inadvertently, flame arrestors shall be fitted.

(e) Isolating valves shall be placed at strategic locations in the gas piping system, and be suitably labelled.

(f) To avoid improper connection, all gas pipes and outlet points shall be clearly identified; preferably by colour-coding in accordance with AS 1345. Where danger of explosion due to an incorrect connection exists, non-interchangeable connectors shall be used.

(g) Metallic gas lines shall be used for flammable and oxidizing gases. Copper piping shall not be used for acetylene (see Clause 4.3.3).

NOTE: Certain microbiological applications require the provision of backflow prevention for microbiological safety. See AS/NZS 2243.3.

In addition, the following recommendations are made:

(i) Where permanent piping is not practicable, flexible hoses should be used. Hose lengths should be kept to a minimum. Hoses should be of an appropriate type and pressure rated for the purpose. Hoses should be inspected and tested regularly, and be discarded when faulty.

(ii) Gases should not be piped at cylinder pressure. Piping should operate at the lowest pressure consistent with the end-use of the gas.

(iii) Copper pipes used for cylinder connections should be tested for leaks at a frequency not less than once every two years. A visual inspection should be conducted regularly.

4.2.4 Handling and use

The following practices are recommended:

(a) Wear appropriate gloves, (e.g. leather) when handling cylinders.

(b) Never lift a cylinder by the cap or guard unless the supplier states that it is designed for that purpose.

(c) Use a cylinder trolley or other suitable device for transporting cylinders, even for a short distance.

(d) Leave the valve protection cap/guard in place until the cylinder has been secured against either a wall or bench, or has been placed in a cylinder stand and is ready for use.

(e) Wear suitable body, eye, face and hearing protection.

(f) Where a gas is non-flammable, check for gas leaks using soapy water. Where a gas is flammable, check for gas leaks using either soapy water or a hydrocarbon tester. Where a gas is toxic, use special gas-leak checking procedures specified by the supplier.

(g) Ascertain that an adequate supply of water is available for first aid, firefighting or dilution of corrosive material in the event of a leakage.

(h) Use suitable pressure regulating devices on all compressed gas cylinders.

(i) Before connecting the cylinder for use, ensure that gas in the system cannot back-feed into the cylinder, and that the pressure rating of the complete gas system is adequate.

(j) Do not permit liquefied gas to become trapped in parts of the system, as this may result in hydraulic rupture.

(k) Ascertain that all electrical systems in the vicinity are suitable for service with each gas.

(l) Do not use direct flame or electrical heating devices to raise the temperature of a cylinder. Cylinders should not be subjected to temperatures above 45°C unless the manufacturer and supplier have been consulted.

(m) Do not re-compress a gas or a gas mixture from a gas cylinder, without first consulting the manufacturer.

(n) Do not attempt to transfer gases from one cylinder to another.

(o) Do not attempt to increase the liquid draw-off rate by pressurizing the cylinder, without first checking with the supplier.

(p) Do not use cylinders as rollers or supports, or for any purpose other than to contain the gas supplied.

(q) Do not permit oil, grease or other combustible substances to come in contact with valves of cylinders containing hydrogen, oxygen or other oxidant gases.

(r) Do not subject cylinders to stray electrical current or abnormal mechanical shocks that may cause damage to their valves or safety devices. Cylinders with sticking or damaged valves should be returned to the supplier, with an explanatory note attached.

(s) Test cylinder valves in an open or well-ventilated area before taking them into the laboratory. Open cylinder valves slowly.

NOTE: Rapid opening of valves combined with the presence of contamination in the system can result in an explosion, set off by adiabatic compression in the regulator. Oxygen cylinders are prone to this type of accident. Adiabatic compression of a gas can raise the gas temperature to or past a material's ignition point.

(t) Do not attempt to repair or modify cylinder valves or safety relief devices.

(u) Close the cylinder valve whenever the gas is not required, even if the cylinder is still connected to the equipment.

(v) Replace outlet caps and cylinder caps as soon as the cylinder is disconnected from equipment.

(w) Do not empty cylinders, but leave them with a slight positive pressure (i.e. 200 kPa) and the valve closed, to prevent diffusion of air into the cylinder. This is especially important with flammable gases. When a cylinder is considered to be empty, it should be marked accordingly.

4.2.5 Storage

The following precautions should be taken:

(a) Cylinders should be stored in a purpose-built compound that is well-ventilated, preferably in the open air.

(b) The storage area should be a location free from fire risk, and away from sources of heat and ignition.

(c) The cylinder storage compound should be kept clear, and access should be restricted to authorized personnel only. The compound should be clearly marked as a cylinder store, and appropriate hazard warning signs displayed, e.g. flammable, toxic gas.

(d) Cylinders should be stored upright (where the cylinder is designed for this), and be constrained in a suitable rack or stand.

(e) Cylinders should not be stored in conditions likely to promote corrosion.

(f) Gas cylinders should be segregated in the storage area according to the properties of the various gases, i.e. toxic, flammable, oxidant. Cylinders of toxic gases should preferably be kept in a locked enclosure. Cylinders containing oxygen or other oxidants should be separated from flammable gases by a minimum distance of 3 m, or alternatively by a fire resistant partition.

NOTE: The appropriate separation distance depends on a range of circumstances and the particular gases involved and should be determined during the risk assessment specified in Clause 4.2.1.

(g) The amount of flammable or toxic gases in storage should be kept to a minimum in accordance with AS/NZS 2243.10.

(h) Cylinders containing combustible gases should be segregated and stored away from combustible materials.

(i) Full and empty cylinders should be stored separately, and full cylinders arranged so that the oldest stock is used first.

(j) Gas cylinders containing compressed and liquefied gases should not be stored in a laboratory work area.

4.3 PRECAUTIONS FOR SPECIFIC GASES

4.3.1 General

For most gases, data sheets providing a list of the chemical properties of the gas and precautions to be taken in its use can be obtained from gas cylinder suppliers.

Cylinders shall be secured during use. Cylinders of greater than 2.5 L capacity shall be secured in a vertical position, e.g. chained or clamped to a wall or bench.

For permanent gases, the cylinder pressure indicates the quantity of gas remaining in the cylinder. However for liquefied or dissolved gases, the cylinder pressure varies enormously with temperature, hence weighing the cylinder is the preferred procedure for determining the remaining contents. The withdrawal of dissolved gases, e.g. acetylene, at more than 20% of the cylinder content per hour, entails the risk of contamination of the gas with solvent vapour.

NOTE: AS/NZS 2243.2 and AS 1894 should also be consulted.

4.3.2 Oxygen

Oxygen enriched atmospheres increase the fire risk enormously. For example, if the oxygen content of the atmosphere is increased from 21% to 24%, clothing burns rapidly instead of smouldering.

Grease or oil shall not be used on oxygen cylinders or pipelines, as an explosion can result. Oil-filled or arc/spark generating equipment shall not be stored or installed within an enclosed housing containing oxygen cylinders. Oxygen shall not be used as a substitute for compressed air.

4.3.3 Acetylene

Only regulating valves designed and manufactured for use with acetylene shall be used on cylinders containing acetylene. Pipe fittings made of copper, or alloys containing more than 65% copper, shall not be used for acetylene, to avoid the formation of explosive acetylides. Explosive corrosion products can result with acetylene, even where low copper alloys are used. Traces of mineral acid enhance the formation of explosive acetylides. Further

information on the safe storage and handling of acetylene can be obtained from AS 4332 and AS 4289.

The pressure in any system which provides acetylene gas shall not exceed 100 kPa above atmospheric pressure. The system shall be fitted with a flame arrestor or flashback arrestor. If other gases are involved, non-return valves shall be used. Acetylene cylinders shall always be stored and used in the vertical position.

4.3.4 Hydrogen

Hydrogen gas heats when it expands, and can be ignited by the static charge and discharge produced by a too-rapid opening of the cylinder valve.

4.3.5 Compressed air

Compressed air supplies in workshops and laboratories should be used with caution, as compressed air jets, if misused, can cause serious injuries or death. A jet of compressed air playing on the body can introduce air into the bloodstream, especially if there are small scratches or punctures in the skin.

Compressed air should not be used to dry solvents on the skin, as both air and solvent may enter the bloodstream. Compressed air outlets and pipework should be identified accordingly.

4.4 CRYOGENIC SUBSTANCES

4.4.1 General

Hazards that are encountered in handling cryogenic liquids arise from the intense cold or from the rapid expansion of gas from an evaporating liquid. A small spill of cryogenic liquid can produce a large volume of gas. Detailed procedures for the safe handling of cryogenic liquids are given in AS 1894, AS/NZS 2243.2 and AS/NZS 2243.3.

Eye protection and gloves shall be worn during operations involving the handling of dry ice or the decanting of cryogenic liquids, as skin contact can cause cold-contact burns and frost bite.

4.4.2 Fire hazard

All materials (including jointing compounds) that come into contact with cryogenic liquids should be carefully selected to ensure compatibility, e.g. many materials regarded as safe in air are readily combustible in oxygen-rich atmospheres. Surface finish of materials is also important in the presence of high pressure oxygen.

WARNING: LIQUID OXYGEN FORMS AN EXPLOSIVE MIXTURE WHEN IN CONTACT WITH ORGANIC COMPOUNDS SUCH AS OIL, ASPHALT, WOOD, CARBON, RUBBER AND PLASTICS MATERIALS.

4.4.3 Mechanical failure

All materials used in the construction of equipment that will come in contact with cryogenic substances should be selected to withstand the high pressure and low temperatures; excessive pressure can build up when trapped liquid or cold gases are warmed. Equipment designed for operation at normal temperatures can fail at very low temperatures, e.g. carbon steel is extremely brittle at cryogenic liquid temperatures.

NOTE: The use of glass-lined cryogenic flasks should be fully assessed for all risks.

SECTION 5 HAZARDOUS PROCESSES

5.1 GENERAL REQUIREMENTS

5.1.1 Control of hazardous operations

Hazards associated with operations can often be minimized by substituting a less hazardous procedure. To achieve this objective, a risk assessment shall be carried out to investigate alternative work procedures and evaluate safe working practices before the commencement of the operation. If substitution is impracticable, the operation should be enclosed or modified, to limit exposure of the hazards to the operators.

5.1.2 Hazardous substances

Appropriate safety facilities and equipment should be provided to minimize exposure of laboratory personnel to harmful (e.g. poisonous, corrosive) substances. Where possible, investigations should be carried out with a view to substituting a harmless or less hazardous substance in a procedure.

An inventory of all chemical substances shall be kept in each area where they are used. Chemical names of all materials, safe storage and handling procedures, and procedures for the management of spillages and disposal of wastes, shall be included with this inventory.

5.1.3 Ventilation

In all operations where airborne contaminants are generated, mechanical ventilation should be provided to reduce the contamination to safe levels. Airborne contaminants include metallic vapours and fumes, mists, smoke, dusts, and gases. Airborne contaminants should be ducted to the exterior of the building, and either be removed (by filtration or scrubbing) to conform to the requirements of the appropriate clean air legislation, or, if this is unnecessary, be vented to ensure dispersal and dilution in the external environment. The exhaust duct should be fitted with a discharge stack, or located so that contaminated air is not discharged in the proximity of the inlet air supply.

Local exhaust ventilation is preferable to dilution ventilation. Dilution ventilation should only be used where the contaminant emission is well dispersed and where the contaminant is generated at a uniform rate. For further details, see AS 1668.2.

5.1.4 Protective clothing and apparatus

Personal respirators shall be worn in all locations where airborne contaminants are not removed by ventilation. (See AS/NZS 1715). Protective clothing and suitable gloves shall be worn to protect against skin damage and absorption of toxic substances.

5.1.5 Ignition sources

Smoking shall be prohibited in the laboratory area, and in areas where flammable gases and liquids are stored.

5.2 SOLDERING AND BRAZING

5.2.1 Soldering of electronic components

Local ventilation should be provided in areas where soldering is carried out, since the fumes from most solder fluxes are irritating, corrosive or toxic.

5.2.2 Brazing

Brazing materials containing metals which produce toxic fumes at brazing temperatures (e.g. in particular, silver alloys containing cadmium) should only be used when absolutely

necessary (see AS/NZS 1167.1). Where local ventilation cannot be provided, respiratory protection shall be worn by operators.

5.3 WELDING AND CUTTING

5.3.1 General

Welding and thermal cutting of plastics or metal materials shall only be undertaken by competent persons.

NOTE: A hot work permit may be required.

5.3.2 Welding

The health hazard from a welding operation depends on the toxicity of the materials involved (types of metal, flux, coating), the duration and location of the process, and the ventilation provided for the job. The following requirements apply to the safe welding practice:

(a) The atmosphere in the cutting area shall be free of flammable gases, liquids and vapours.

(b) Welding helmets, hand shields or goggles, as appropriate, shall be used by the operator.

NOTE: For details of recommended practices and appropriate eye protection, see AS/NZS 1336, AS/NZS 1337 and AS/NZS 1338, Parts 1, 2 and 3.

(c) Welders shall wear clean, fire-resistant gloves and apron, and clothing with collar and sleeves buttoned. Long trousers, woollen socks, spats and robust full-cover footwear shall be worn to protect the lower limbs from slag burns.

(d) Screens shall be used in accordance with local regulations to protect employees adjacent to the welding areas from ultraviolet rays.

(e) Welding barriers or shields shall be placed to contain sparks and molten metal within the welding area.

(f) Caution shall be observed when using electric arc welding equipment in damp or moist areas, to avoid potentially lethal electric shocks.

(g) Localized exhaust ventilation shall be provided to remove excessive fumes.

WARNING: TOXIC EMISSIONS SUCH AS OZONE, CARBON MONOXIDE, OXIDES OF NITROGEN, AND FLUORIDES ARE FORMED DURING WELDING. TOXIC FUMES. (COMPOUNDS OF CHROMIUM AND NICKEL, FOR EXAMPLE), ARE RELEASED WHEN WELDING MANY METALS.

5.3.3 Plasma cutting

The requirements for welding in Clause 5.3.2 apply also to plasma cutting. Hearing protection shall be worn when excessive noise levels are encountered. A water bath, if incorporated, should be maintained at the correct level and kept clean, either by periodic changing of the water or by water treatment to prevent fouling.

5.3.4 Cutting and thermal welding of plastics

Toxic fumes can result from the heat generated in plastics materials when cutting with power tools or when welding by heat. Local exhaust ventilation shall be provided for cutting and welding operations involving plastics.

5.3.5 Radiofrequency dielectric plastics welders

Radiofrequency (RF) plastics welders operating in the frequency range 10 MHz to 100 MHz should be adequately shielded, to protect operators from stray electromagnetic radiation. Correct earthing procedures shall be followed.

5.3.6 Solvent welding of plastics

Solvents used in the welding of plastics should be considered toxic; consequently skin contact and inhalation of fumes should be avoided. Local exhaust ventilation shall be provided to remove solvents from the welding area, and appropriate gloves shall be worn by operators. See AS/NZS 2161.1 for guidance on the selection and use of gloves and AS/NZS 2243, Parts 1 and 2 for information on storage of flammable solvents.

5.4 DEGREASING

5.4.1 Hazards

Electric arc welding should not be carried out near degreasing operations, as ultraviolet radiation emitted from the welding process can react with the degreasing solvents to produce toxic phosgene. Most solvents used in degreasing operations are toxic by skin absorption and inhalation. Relevant safety information and safety equipment shall be available to operators. For further information see AS 2661.

5.4.2 Fume and dust extraction

Back, side or down-draught ventilation shall be used to prevent inhalation of solvent fumes and dusts from degreasing operations. Air movement should not be directed into the operator's breathing zone (see the American Conference of Government Industrial Hygienists *Industrial Ventilation Handbook*).

5.4.3 Skin care

Skin contact with degreasing solvents should be avoided. It is recommended that 'VITON' gloves be selected in accordance with AS/NZS 2161.1 and the MSDS for the solvent and that gloves be worn when handling chlorinated hydrocarbon degreasing solvents. Degreasing solvents can cause serious degreasing of the skin; they should not be used as hand cleaners. Removal of grease and dirt from hands is made easier by applying lanolin-type cleaning creams before work begins. Skin areas that have come in contact with chemicals should be washed, irrespective of the chemical's concentration and hands should be washed upon leaving the laboratory.

5.5 CUTTING AND GRINDING OILS

Contact with cutting or grinding oils is hazardous and should be avoided, as dermatitis can result. Skin areas that have come in contact with chemicals should be washed, irrespective of the chemical's concentration and hands should be washed upon leaving the laboratory. Soiled protective overalls should be laundered at the end of each working day.

5.6 GLASS WORKING

The following precautions should be observed:

(a) To break glass tubing or rod, the tubing should be held in a cloth near a scratch produced by a sharp file or glasscutter. Large diameter tubing can be cracked, in a safe manner, by placing a red-hot rod or wire on a scratch mark that rings the tubing.

(b) Glass rods and the ends of glass tubing should be rounded (fire-polished) in a flame, to remove any sharp edges or projections.

(c) Where tubing or rod is to be passed through a bung, it should be lubricated with water before insertion. Hand protection should be worn. The palm of the hand should never be used to push the glass tube through the hole; if any significant force is required, the hole should be enlarged.

(d) Special eye protection, containing lenses manufactured from infrared absorbent glass, should be worn in glass-heating operations.

(e) Long lengths of glass tubing should be carried upright.

(f) Broken glassware should be disposed of in a container reserved for the purpose.

(g) Tubing should be cut from glassware before removal.

SECTION 6 MAINTENANCE

6.1 GENERAL

All maintenance shall be conducted by competent persons in accordance with the equipment manufacturer's instructions and the procedures for the laboratory or organization.

It is likely maintenance staff will not be totally familiar with the operation and the hazards of the laboratory. Maintenance staff may be contractors or manufacturers' service agents. The maintenance staff should be advised of key health and safety requirements, generally before the first day of work so that they can come prepared. Such requirements could include the need for enclosed footwear and eye protection in laboratories.

The maintenance staff should be under the overall control of an on-site laboratory host while working in the laboratory. There should be regular and frequent interaction between the on-site laboratory host and the maintenance staff. Before work commences the maintenance staff shall be advised of the laboratory hazards and also the hazard their work can pose to the laboratory staff in the area.

Where formal contracts or service agreements are put in place to cover maintenance work, the documents should include health and safety expectations, monitoring and responsibilities.

Where contractors or service agents are utilized, the criteria used to select and manage contractors or service agents should include and assessment of their health and safety performance.

Equipment should be checked after maintenance to ensure it is performing correctly.

6.2 HAZARDS TO MAINTENANCE STAFF

While automated equipment has much to offer in preventing accidents to operators, it can also create hazards when any maintenance work is being performed by maintenance staff.

Machinery shall be isolated from the power source, which may include a compressed air supply, and de-energized whenever maintenance is being undertaken. Where maintenance staff cannot be protected by interlocking guards or other safeguards available to the operator, a strict 'permit to work' system, which ensures that the power supply and hydraulic systems cannot be restored inadvertently while repair work is proceeding, should be instituted. Where equipment must be operated with safety interlocks disabled to allow for equipment adjustment during maintenance, a risk assessment shall be conducted prior to the maintenance task commencing. Maintenance staff should be made aware that some machines have stored energy, and that movable parts should be restrained or the energy confirmed to have been dissipated before commencing work.

Laboratories are likely to contain hazardous substances. As a result, before maintenance work commences, equipment should be cleaned and decontaminated and the maintenance staff advised that this has occurred.

No equipment should be removed from a laboratory by a maintenance staff unless the removal has been approved by the person responsible for the laboratory. All equipment should be cleaned and decontaminated before removal.

Maintenance tools and testing equipment should be cleaned before and after use in laboratories. In some instances, tools may need to be fumigated before and after use, for instance in Physical Containment Level 3 and Physical Containment Level 4 facilities and clean rooms.

Maintenance staff should be advised of the risks of turning off equipment or power supplies for equipment items they are not directly working on.

APPENDIX A

LIST OF REFERENCED DOCUMENTS

(Normative)

AS	
1210	Pressure vessels
1345	Identification of the contents of piping, conduits and ducts
1668	The use of ventilation and airconditioning in buildings
1668.2	Part 2: Ventilation design for indoor air contaminant control
1788	Abrasive wheels
1788.1	Part 1: Design, construction and safeguarding
1788.2	Part 2: Selection, care and use
1894	The storage and handling of non-flammable cryogenic and refrigerated liquids
2243	Safety in laboratories
2243.4	Part 4: Ionizing radiations
2243.7	Part 7: Electrical aspects
2473	Valves for compressed gas cylinders
2473.1	Part 1: Specifications, type testing, and manufacturing tests and inspections
2661	Vapour degreasing plant—Design, installation and operation—Safety requirements
4024	Safety of machinery
4024.1	Part 1: Safety of machinery (series)
4024.3101	Part 3101: Materials cutting—Milling machines (including boring machines)—Safety requirements
4289	Oxygen and acetylene gas reticulation systems
4332	The storage and handling of gases in cylinders
4343	Pressure equipment—Hazard levels
AS/NZS	
1167	Welding and brazing—Filler metals
1167.1	Part 1: Filler metal for brazing and braze welding
1269	Occupational noise management
1269.2	Part 2: Noise control management
1270	Acoustics—Hearing protectors
1336	Recommended practices for occupational eye protection
1337	Eye protectors for industrial applications
1338	Filters for eye protectors
1338.1	Part 1: Filters for protection against radiation generated in welding and allied operations
1338.2	Part 2: Filters for protection against ultraviolet radiation
1338.3	Part 3: Filters for protection against infra-red radiation
1715	Selection, use and maintenance of respiratory protective devices

AS/NZS		
2161	Occupational protective gloves	
2161.1	Part 1:	Selection, use and maintenance
2211	Safety of laser products	
2211.1	Part 1:	Equipment classification, requirements and user's guide (IEC 60825-1:2001, MOD)
2243	Safety in laboratories	
2243.1	Part 1:	Planning and operational aspects
2243.2	Part 2:	Chemical aspects
2243.3	Part 3:	Microbiological aspects and containment facilities
2243.5	Part 5:	Non-ionizing radiations—Electromagnetic, sound and ultrasound
2243.10	Part 10:	Storage of chemicals
2982	Laboratory design and construction	
2982.1	Part 1:	General requirements
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)	
3100	Approval and test specification—General requirements for electrical equipment	
3760	In-service safety inspection and testing of electrical equipment	
3788	Pressure equipment—In-service inspection	
4801	Occupational health and safety management systems—Specification with guidance for use	
5000	Electric cables—Polymeric insulated	
5000.1	Part 1:	For working voltages up to and including 0.6/1 (1.2) kV
60079	Electrical apparatus for explosive gas atmospheres	
60079.10	Part 10:	Classification of hazardous areas (IEC 60079-10:2002 MOD)
HB 9	Occupational personal protection	
NZS		
5433	Transportation of dangerous goods on land	
ASTM		
D92	Test method for flash and fire points by Cleveland open cup tester	
ACTDG	(Advisory Committee on the Transport of Dangerous Goods)	
ADG Code	Australian code for the transport of dangerous goods by road and rail	
OSH	(NZ Department of Labour Occupational Safety and Health Service)	
4270	Approved Code of Practice for Pressure Equipment (Excluding Boilers)	
American Conference of Government Industrial Hygienists		
Industrial Ventilation Handbook		

*** END OF DRAFT ***

PREPARATION OF JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

Joint Australian/New Zealand Standards are prepared by a consensus process involving representatives nominated by organizations in both countries drawn from all major interests associated with the subject. Australian/New Zealand Standards may be derived from existing industry Standards, from established international Standards and practices or may be developed within a Standards Australia, Standards New Zealand or joint technical committee.

During the development process, Australian/New Zealand Standards are made available in draft form at all sales offices and through affiliated overseas bodies in order that all interests concerned with the application of a proposed Standard are given the opportunity to submit views on the requirements to be included.

The following interests are represented on the committee responsible for this draft Australian/ New Zealand Standard:

Australian Industry Group
Australian Institute of Occupational Hygienists
CSIRO
Department of Labour, New Zealand
Department of Primary Industries, Vic.
Environmental Science and Research, New Zealand
Ministry of Agriculture and Forestry, New Zealand
Ministry of Economic Development, New Zealand
National Association of Testing Authorities, Australia
National Measurement Institute, Australia
New Zealand Chemical Industry Council
New Zealand Microbiological Society
RMIT University
Royal Australian Chemical Institute
Victorian WorkCover Authority
WorkCover New South Wales

Additional interests participating in preparation of Standard:

Gas Safety Consultant

Monash University

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

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