# Safety Engineering & Technical Services Pty Ltd

*OCCUPATIONAL HEALTH, SAFETY & ENGINEERING CONSULTANTS*

ABN: 90 003 112 945


27 March 2017

The Manager
Jacobs
100 Christie Street
ST LEONARDS NSW 2065

Attention: Mr Peter Boase

Dear Sir,

**re: Planning Matters - Contribution to the Statement of Environmental Effects Relating to Wastes and Hazards Associated with the Proposed Molecular and Life Sciences Building – University of Wollongong**

This letter of advice has been prepared pursuant to your request to contribute to the Development Application submission seeking planning approval for the proposed new Molecular and Life Sciences Building to be constructed on the Main Campus at the University of Wollongong.

## EXECUTIVE SUMMARY

This advice:

- describes the nature and quantities of goods and substances that will be present at the Molecular & Life Sciences building, and
- identifies hazards posed by the presence of hazardous chemicals and describes the means (generally through compliance with relevant Australian Standards, University policies, and other codes of practice) by which those hazards are to be managed
- provides a reasoned conclusion that State Environmental Planning Policy 33 (SEPP 33) does not apply to proposed facilities, and
- concludes that the proposed facilities devised for the storage, handling and use of hazardous chemicals (dangerous goods), have been designed to comply with all relevant legislative requirements and in accordance with best practice

principles for the management of risk to health and safety, and will, as a consequence, secure a level of safety and environmental performance described in the relevant standards and codes of practice applying to laboratory facilities.

## SCOPE FOR THE PROVISION OF THE ADVICE IN THIS REPORT

The following tasks were specifically excluded from the scope:

- the identification of any hazardous materials (such as asbestos, lead or fiberglass) that may be present in the facilities to be demolished
- any design advice and certification of facilities in respect of Class 7 dangerous goods (radioactive substances) if any may be present
- any quantitative risk assessment studies.

## A DESCRIPTION OF THE FACILITIES RELEVANT TO THIS REPORT

The proposed site is bounded by Building 32 [Illawarra Health and Medical Research Institute (IHMRI) to the north] - a site ring road, and Building 43 Science Teaching Facility (STF) to the east, Building 42 (The Sciences Annex) and Science Road to the south and Building 41 (Faculty of Science, Medicine & Health) to the west.

The proposed project involves providing a building with the following functional elements:

- accommodation for researchers: 15 groups in PC2 labs and support spaces, with modular, flexible and efficient space
- Cryo-TEM suite: housing a Cryo-TEM FEI Krios microscope (or similar), FEI Tecnal screening microscope (or similar), Focussed Ion Beam milling preparation device,
- PC2 laboratory and other preparation space
- newly-equipped and purpose designed flow cytometry, fluorescence and light microscopy suites, which articulate directly with cell and molecular support laboratories
- an Animal House with holding space for 1500 rodents/aquatics cages, procedural and support space
- Atmospheric Chemistry roof-top platform with horizon view to the east and laboratory spaces located below the roof-top platform
- office accommodation, Masterclass room and leaching laboratory, meeting spaces, networked back of house with adjacent facilities

- services including:- electrical sub-station; electrical switch room; lift motor rooms; boiler; an Essential Services generator system; exit pressurisation systems, kitchen exhaust systems, and a fire control sprinkler/pump room.

Additionally, as part of the project works, the following facilities/alterations will be provided:

- a new Chemical Storage building for MLS and Building 41 to accommodate (externally) two cryogenic gas supply vessels (a 1500 L bulk tank for liquid nitrogen, and a 240 L vessel for liquefied carbon dioxide), flammable liquid storage with a capacity of 450 L (maximum), and storage for reserve stock of corrosive substances (acids & base/neutral substances) each having a maximum capacity of 100 L
- a new gas cylinder storage cage for keeping up to 40 x G-size cylinders under Minor Storage provisions as specified in AS 4332-2004, servicing the requirements for the storage of reserve stock of gases for Buildings 41, 32, and the new MLS Building activities.

The proposed new building will be composed of two wings (North Wing and South Wing) linked at ground level by an informal learning terrace, by bridge links at levels 01, 02, 03, and 04, and with a bridge link to the adjacent IHMRI building (Building 32) at Level 01.

The **North Wing** will house the following facilities:

- Ground Level: Cryogenic Transmission Electron Microscope (Cryo-TEM) microscopy suite, other advanced microscopy suites and a lab and rooftop platform for Atmospheric Chemistry.
- Levels 01, 02 & 03 biological laboratories and accommodation and offices,
- Level 04 animal (rodent and aquatic) holding and support facilities, and a shell space for future research laboratory expansion
- a Plant Room and an Upper Plant Room above Level 04.

The **South Wing** will house at:

- Ground Level Entry /Foyer, Loading Dock and associated office, a Laboratory store, a meeting room, and 4 service areas (Electrical Sub-Station, Electrical Switch Room, Gas Metering room, an Emergency Generator plant and a Fire Sprinkler/Pump room)

- Mezzanine Level a Breakout Room
- Level 01 Conference space and amenities
- Level 02 Central Breakout space
- Level 03 Meeting Rooms and amenities
- Level 04 Atmospheric Chemistry laboratory space and office
- Plant Level – Roof Atmospheric Chemistry Platform & Future Telescope.

**DRAWINGS**

This advice is based on the following drawings:

IA12600-00SD-RB-DRG-0101 Rev E - SITE PLAN -PROPOSED
IA12600-00SD-RB-DRG-1100 – Rev E – GROUND LEVEL PLAN
IA12600-00SD-RB-DRG-1105 – Rev E – MEZZANINE LEVEL
lA12600-00SD-RB-DRG-1110 – Rev E- LEVEL 01 PLAN
IA12600-00SD-RB-DRG-1120 - Rev E -LEVEL 02 PLAN
IA12600-00SD-RB-DRG-1130 – Rev E - LEVEL 03 PLAN
IA12600-00SD-RB-DRG-1140 – Rev E - LEVEL 04PLAN
IA12600-00SD-RB-DRG-1150 – Rev E - PLANT LEVEL ROOF
IA12600-00SD-RB-DRG-1160 – Rev E - UPPER PLANT LEVEL
IA12600-00SD-RB-DRG-1170 – Rev E – ROOF PLAN
IA12600-00SD-RB-DRG-5001 – Rev E – SECTION AA
IA12600-00SD-RB-DRG-5002 – Rev E – SECTION BB
IA12600-00SD-RB-DRG-5003 – Rev E – SECTION CC

**NATURE & QUANTITIES OF THE HAZARDOUS CHEMICALS BEING KEPT AT MLS**

A schedule of storage depots with annotated comments has been developed and is attached to this report (as Appendix A).

The activities to be conducted within the wet laboratory spaces in the North Wing (Levels 01, 02 & 03) and in the South Wing (Atmospheric Chemistry – Level 04) are substantially new activities for the staff of Wollongong University. This has created a situation where there has been an absence of precedent in determining data on the nature and quantities of hazardous chemicals being handled. In order to make a sensible estimate, the activities being conducted at IHMRI and the recently completed Science Teaching Facility, as well as the author's experience in providing advice to

other like facilities at other Universities, have been used in developing data for this report.

Following from this, it is expected that the main hazardous chemicals to be stored, handled and used at the facility are:

Flammable liquids

- acetone
- diethyl ether
- acetaldehyde (ethanal)
- ethanol
- ethyl acetate
- heptane
- hexane
- isopropanol
- methanol

Combustible liquids

- ninhydrin (NCADG)
- dimethyl sulfoxide

Toxic substances

- dichloromethane

Acids

- sulphuric acid, nitric acid
- formic acid
- acetic acid
- trifluoroacetic acid

Table 1 on the following page summarises the relevant physical properties of volatile flammable and toxic substances being kept and that were considered for their potential for nuisance level emissions from ventilation stacks.

None of these substances triggers any EPA published concern. The ventilation system creates a massive dilution effect that will ensure that any time-weighted average exposure will be a substantial margin lower than any published atmospheric contaminant standard..

| Substance | Chemical formula | MW [g/g-mol] | F.P. [$^0$C] | LFL [%v/v] | UFL [%v/v] | Vapour Press [mm Hg] | Vapour density [air=1.0] | Ignition temp. [$^0$C] | TWA [ppm] | STEL [ppm] | Odour threshold [ppm] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| acetone | $CH_3COCH_3$ | 58.08 | -20 | 2.5 | 12.8 | | 2.0 | 465 | 500 | 1000 | 20 |
| diethyl ether | $C_2H_5OC_2H_5$ | 74.12 | -45 | 1.9 | 36 | 538.0 | 2.6 | 180 | - | - | 0.33 |
| acetaldehyde (ethanal) | $CH_3CHO$ | 44.05 | -38 | 4 | 55 | 760 | 1.52 | 175 | 20 | 30 | 0.21 |
| ethanol | $C_2H_5OH$ | 46.07 | 13 | 3.3 | 19 | 58.6 | 1.6 | 363 | 1000 | - | 100 |
| ethyl acetate | $CH_3COOC_2H_5$ | 88.10 | -44 | 2.2 | 9 | 96.1 | 3.04 | 427 | 300 | 400 | 3.9 |
| heptane | $H_3C(CH_2)_5CH_3$ | 100.2 | -4 | 1.1 | 7.0 | 40.0 | 3.52 | 223 | 400 | 500 | 400 |
| hexane | $CH_3(CH_2)_4CH_3$ | 86.17 | -22 | 1.1 | 7.5 | 150.3 | 3.0 | 225 | 500 | 1000 | 130 |
| isopropanol | $(CH_3)_2CHOH$ | 60.09 | 12 | 2.0 | 12.7 | 44.8 | 2.07 | 425 | 400 | 500 | 22 |
| methanol | $CH_3OH$ | 32.04 | 11 | 6.0 | 36 | 125.9 | 1.1 | 464 | 200 | 250 | 8.9 |
| dimethyl sulfoxide | $(CH_3)_2SO$ | 78.13 | 87 | 3.5 | 42 | 0.398 | 2.7 | n/a | - | - | n/a |
| | | | | | | | | | | | |
| dichloromethane | CH2Cl2 | 84.93 | n/a | 12 | 19 | 353 | 2.93 | 558 | 50 | - | 250 |

***Table 1 List of Potentially Volatile Hazardous Chemicals to be kept and their properties***

**Operating statutory compliance**

Licences issued pursuant to Chapter 3 of the *Protection of the Environment Operations Act* are issued for Scheduled Premises and Scheduled Activities under the Act. The University does not fall within the definition of a Scheduled Premise nor does it conduct any Scheduled Activities.

As a consequence, the activities to be conducted in the Molecular and Life Sciences Building are not required to be licensed by the EPA.

## SPECIFIC PLANNING MATTERS

A critical element of the process for preparing this report, is the review of matters particularly referred to in Regulation 228 sub-clauses (j), (l), and (m) of the *Environmental Planning & Assessment Regulation 2000.* These sub-clauses require assurance that the proponent has properly considered specific hazards in the design of the facilities so that they are fit-for-purpose and adequate to maintain an acceptable level of safety. It is part of a process for ensuring that all the implications of the intended usage of hazardous chemicals are fully described before any consent is granted.

The MLS building, its operations and facilities that are the subject of a current Development Application), do not fall within any of the Schedule 3 activities prescribed as being designated development, pursuant to the *Environmental Planning & Assessment Regulation 2000.*

Even taking a liberal interpretation of Item **9** of the Schedule in relation to the definition of "**Chemical industries and works (for) …commercial … research**", the annual throughput of dangerous goods is well below the threshold limit of 1,000 tonnes per year of dangerous goods nor will the facility store toxic substances in excess of manifest quantities as prescribed in the *Work Health and Safety Regulation 2011.*

Further, although there is storage of chemicals at the MLS building, the threshold limit quantities under Item *10 – Chemical storage facilities* are vastly in excess of the proposed maximum storage limits to be kept.

Notwithstanding that the proposed facilities are not designated development, certain high hazard activities are additionally required to undergo a more rigorous process of safety

assurance than others of inherently lower risk potential as part of the development consent process.

These high hazard activities are identified by a screening process pursuant to a planning instrument, State Environmental Planning Policy 33 (SEPP 33). All development proposals are required to determine whether SEPP 33 applies.

**The Applicability of State Environmental Planning Policy 33 (SEPP 33) to the MLS Building Project**

State Environmental Planning Policy (SEPP) 33 is an enabling instrument that links safety and pollution control performance, to the permissibility of an industrial proposal.

SEPP 33 applies to proposals that fall under the policy's definition of:

- '**potentially hazardous industry**' - where the quantities of dangerous goods or transport movements involving dangerous goods exceeds the threshold limits described in the document *Applying SEPP 33*, or
- '**potentially offensive industry**' - a proposal that, in the absence of safeguards, would emit a polluting discharge which would cause a significant level of offence.

**Assessing whether a proposal is potentially hazardous industry**

The screening process relies on a sorting procedure related to the nature and quantity of dangerous goods present on the site of the proposed development.

Dangerous goods are a group of substances that have been recognised as having some immediate public safety threat due to their hazardous properties. Dangerous goods have been listed in a number of national and international publications (in Australia this list is set out in the *Australian Dangerous Goods Code* – currently in the 7$^{th}$ edition - version 7.4).

A system of classification and labelling of dangerous goods has been adopted by Australia which is consistent with systems used throughout most of the world. This system has been devised to help people quickly recognise dangerous goods and their properties and hazard potential.

All dangerous goods that are handled or transported must be accurately classified into classes that reflect their characteristics (it being the responsibility of the manufacturer or importing agent to ensure that the dangerous goods are accurately classified).

Dangerous goods are divided into nine '**classes'** (and in the case of dangerous goods of Classes 1, 2, 4, 5 and 6 these classes are further subdivided into '**divisions**'). Each 'class group' is comprised of substances which have similar properties or hazards. Goods having more than one hazardous property are classified under their primary class and where they have some additional hazard, they are also assigned a '**subsidiary risk**'.

An example occurring frequently in laboratory areas is glacial acetic acid that is assigned to Class 8 corrosive substances with a subsidiary risk of Class 3 since it has a flash point below the threshold for flammability.

Substances within Classes 3, 4, 5, 6 and 8 are further subdivided into **Packing Groups** (abbreviated as PG) to indicate their relative inherent risk (PG I - high risk, PG II - moderate risk, and PG III - least risk).
The various dangerous goods classes are:
**Class 1 – Explosives** - are substances and articles used to produce explosions or pyrotechnic effects.

**Class 2 – Gases** - includes gases which are compressed, liquefied or dissolved under pressure. Some gases have subsidiary risk classes (i.e. other risk characteristics such as 'flammable' or 'corrosive'):

- Division 2.1 - Flammable gases are gases which ignite on contact with an ignition source (such as acetylene, hydrogen, LP gas)
- Division 2.2 - Non-flammable gases are gases which are neither flammable nor poisonous (such as oxygen, nitrogen, medical air, argon)
- Division 2.3 - Poisonous gases are gases liable to cause death or serious injury to human health if inhaled - such as ammonia, chlorine, carbon monoxide

**Class 3 - Flammable liquids** – are liquids which can be ignited and will burn on contact with ignition sources

**C1 & C2 combustible liquids** – are liquids that will burn (often fiercely) when they are heated and ignited – C1 combustible liquids are of relatively lower flashpoint and include

liquids such as diesel fuel, olive oil and other vegetable oils while C2 combustible liquids have a high flashpoint and include substances such as lubricating and hydraulic oils

**Class 4 - Flammable Solids** – are solids that have characteristics that pose a risk of fire and/or explosion and includes:

- Division 4.1 - flammable solids that are easily ignited and readily combustible - such as nitrocellulose, phosphorus, matches, hexamine;
- Division 4.2 - spontaneously combustible substances - such as aluminium alkyls, white phosphorus);
- Division 4.3 - substances emitting a flammable gas when wet, or which react violently with water (such as aluminium phosphide, calcium carbide).

**Class 5 – Oxidising substances** – are substances that can promote or exacerbate the effect of fire and include

- Division 5.1 - Oxidizing agents other than organic peroxides (such as calcium hypochlorite (pool chlorine), ammonium nitrate, hydrogen peroxide); and.
- Division 5.2 - Organic peroxides, (liquid or solid) (such as methyl ethyl ketone peroxide, benzoyl peroxides, cumyl hydroperoxide).

**Class 6 – Toxic and Infectious Substances** - (this classification does not include poisonous gases), and are further classified as being either:

- Division 6.1 - Toxic substances - which may be liquids or solid) and which are liable to cause death or serious injury to human health if inhaled, swallowed or absorbed through the skin (such as cyanides, arsenic compounds), or which are harmful to human health (such as low toxicity pesticides).
- Division 6.2 – are Infectious substances (such as vaccines, pathology specimens).

**Class 7 – Radioactive Substances** – are substances that either alone, or in a combination of substances, emit ionising radiation (such as uranium, radioisotopes).

**Class 8 – Corrosives** - are substances (either solids or liquids) which may harm living tissue or damage equipment - such as hydrochloric acid, sodium hypochlorite (liquid pool chlorine), sodium hydroxide, and lead acid batteries.

**Class 9 - Miscellaneous Dangerous Goods** - are substances that are not classified elsewhere but which are known to have a safety risk when being transported - such as molten naphthalene, molten bitumen, polyester beads, and lithium batteries.

**Findings arising from the presence of dangerous goods being stored and handled at MLS**

The dangerous goods described in APPENDIX A include:

- cryogenic liquefied nitrogen and liquefied carbon dioxide in a new structure (the Chemical Store building to the south west of the main MLS building – 1,500 L in the case of LN2 and 240 L in the case of LCO2
- compressed gases in cylinders (flammable, non-flammable compressed and oxidizing gases and a very small quantity of toxic gases – less than 50 L water capacity) – with an aggregate capacity of less than 2,000 L water capacity
- flammable liquids of Packing Group I, II & III – less than 870 L in aggregate
- Class 5 (oxidizing substances and organic peroxides) – less than 120 L in aggregate
- Class 6.1 toxic substances – less than 120 L in aggregate, and
- Class 8 corrosive substances – less than 440 L in aggregate.

This inventory does not include small quantities of bench stock (less than 15 L in any 50 $m^2$ area)

It has been confirmed that no radioactive wastes of Class 7 (radioactive substances), or any infectious wastes are to be generated or kept in the building.

Based on the quantities of goods listed in APPENDIX A, and in accordance with the outcome of the screening method for potentially hazardous development summarised in Table 2 overleaf, the provisions of SEPP 33 do not apply to the proposed development

| **SEPP 33 applies if** | **SEPP 33 Threshold** | **Actual** |
|---|---|---|
| Class 2, Division 2.1 flammable gases exceed the threshold limit for a given separation distance as described in Appendix 4 – Figure 6 of the document *Applying SEPP 33* | For a separation distance of 120 m, the limit is 8 tonnes | Actual quantity to be kept does not exceed 500 L water capacity – SEPP 33 does not apply |
| Class 2 non-flammable gases, non-toxic gases, and cryogenic liquids exceed limit described in Appendix 4 - Table 3 in *Applying SEPP 33* | No limit is set | SEPP 33 - does not apply |
| Class 2, Division 2.3 toxic gases exceed the threshold limit as described in Appendix 4 -Table 3 in the section Risk Screening in the document *Applying SEPP 33* | 5 tonne limit | Maximum 50 L water capacity – SEPP 33 does not apply |
| Class 3 dangerous goods (flammable liquids) exceed the lower threshold limit) and are not sufficiently separated from the boundary by the distance given in the section Risk Screening - Figure 9 of the document *Applying SEPP 33* | Lower threshold of 2 tonnes (assuming goods are of PG I | Less than 850 kg maximum - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |
| Quantity of goods of Class 4 substances exceeds threshold limit | Threshold quantities:<br>• 1 tonnes | None reported but in worst case there may be say 25 kg - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |
| Quantity of goods of Class 5.1 substances exceeds threshold limit | Threshold quantities:<br>• 5 tonnes | Less than 120 L - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |
| Quantity of goods of Class 5.2 substances exceeds threshold limit | Threshold quantities:<br>• 10 tonnes | None reported but in worst case there may be say 20 kg - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |
| Quantity of goods of Class 6.1 exceeds threshold limit | Threshold quantities:<br>• 0.5 tonnes for PG I;<br>• 2.5 tonnes PG II/III | Maximum quantity 120 L - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |
| Quantity of goods of Class 8 exceeds threshold limit | Threshold quantities:<br>• 5 tonnes for PG I<br>• 25 tonnes PG II;<br>• 50 tonnes PG III | Maximum quantity 440 L - Quantities below SEPP 33 threshold limit - SEPP 33 does not apply |

| SEPP 33 applies if | SEPP 33 Threshold | Actual |
|---|---|---|
| Number of significant transport movements meeting the specified criteria are exceeded | Number of traffic movements of dangerous goods greater than 1 tonne capacity exceed the frequencies set in the screening threshold | SEPP 33 does not apply – number of transport movements are below threshold limit (the only scheduled dangerous goods delivery above 1 tonne capacity is the bulk liquid nitrogen supply tanker, expected to be present on site every 6 weeks |

Table 2 – Applicability of SEPP 33 for potentially hazardous industry

**Assessing whether a proposal is potentially offensive industry**

The primary consideration in assessing whether any proposal falls within the 'potentially offensive industry' category is whether the consent authority is satisfied that there are adequate safeguards to ensure that any emissions from a facility can be controlled to a level at which they are not significant. Where proposed activities do not require a licence pursuant to protection of the environment legislation, or where they do require a licence but in the opinion of the environmental regulator the proponent can fully meet its licence requirements, a proposal is not deemed to be 'offensive industry'.

I am advised that no licence is required pursuant to Chapter 3 of the *Protection of the Environment Operations Act* hence the proposed MLS inventory of hazardous chemicals will not affect the University's current status. Pursuant to this, the proposed development is not potentially offensive development in accordance with the screening method for the application of SEPP 33.

**Conclusion on the applicability of SEPP 33**

As a consequence of being neither potentially hazardous nor potentially offensive industry, SEPP 33 does not apply to the proposed hazardous chemicals storage upgrade project.

## THE PROPOSED STORAGE, USE, AND MANAGEMENT OF HAZARDOUS MATERIALS

The design of the facilities for the receiving, storage, handling and use of hazardous materials, and the proposed operations of the Molecular and Life Sciences activity, have been designed in accordance with:

- the National Construction Code 2013
- the NSW *Work Health and Safety Act* 2011 and the Work *Health and Safety Regulation 2011* (particularly Chapter 7 – *Hazardous Chemicals)*
- the various standards relating to the storage and handling of specific classes of dangerous goods, including:
  - AS 1894-1997 *The storage and handling of non-flammable cryogenic and refrigerated liquids*
  - AS/NZS 4332-2004 *The storage and handling of gases in cylinders*
  - AS 1940-2004 *The storage and handling of flammable and combustible liquids*
  - AS/NZS 4452-1997 *The storage and handling of toxic substances,* and
  - AS 3780-2008 *The storage and handling of corrosive substances.*
- standards covering the classification of hazardous areas that describe the spaces from which ignition sources must be excluded, particularly
  - AS/NZS 60079.10.1- 2009 Explosive Atmospheres – *Part 10.1 : Classification of areas – Explosive gas atmospheres (IEC 60079-10-1, Ed. 1.0(2008) MOD)*
- the publication *Managing risks of hazardous chemicals in the workplace code of practice - July 2014*– WorkCover NSW.

## REQUIREMENTS FOR THE SAFE STORAGE OF THE HAZARDOUS CHEMICALS TO BE KEPT IN THE PROPOSED MOLECULAR & LIFE SCIENCES BUILDING

Each of the appropriate design standards for a specific class of dangerous goods (other than those goods to be kept in bulk storage arrangements such as tanks), provides for a break point between what is termed ‘Minor Storage’, and ’package’ or ‘cylinder’ storage, where these quantities are exceeded.

### Storage of gases

The Minor Storage limits for gases in cylinders, are:

- Division 2.1 flammable gases – 500 L cylinder water capacity (about 10 x G-size)

- Division 2.2 compressed flammable gases - 2,000 L w.c. (about 40 x G-size)
- Division 2.2, Sub-Risk 5.1 oxidising gases – 1,000 L w.c. (about 20 x G size), and
- Division 2.3 toxic gases – 50 L w.c. (1 x G-size cylinders),

with additional limitations that not only must these sub-class limits not be exceeded, the aggregate quantity is not to exceed 2,000 L, and that the total capacity of cylinders of gases within a building are not to exceed a single minor storage limit in any 200 $m^2$ of floor area.

The design of each gas store where cylinders in an aggregate quantity less than Minor Storage threshold limits must conform with the requirements of Section 2 of AS 4332-2004, including:

- ensuring that the cylinders are kept away from any artificial sources of heat, e.g. radiators, boilers or steam pipes, clear of combustible materials, vegetation and refuse for a distance of not less than 3 m from any cylinder
- all cylinder stores shall be provided with adequate ventilation at all times
- the ventilation system shall—
  (i) be capable of diluting and removing any vapour or gas from the store to levels within workplace exposure limits and below any possible explosive levels;
  (ii) provide sufficient fresh air from the outside to reduce any risk of asphyxiation;
  (iii) ventilate the atmosphere within the store, at both high and low levels relative to the floor; and
  (iv) ventilate or mechanically exhaust directly to the outside, to a location away from building entrances, doors or windows, air conditioning intakes, sources of ignition and areas where people are likely to congregate.
- different divisions of gases must be segregated within the store, but need not be separated.
- the floor should be flat, solid, and constructed from non-combustible materials – it should drain away from the cylinders
- stores of Class 2 gases in cylinders shall be separated from other dangerous goods stores by a minimum distance of 3 m and be located not less than 1 m from any door, window, air vent or duct - the indoor use and storage of gas cylinders should be avoided wherever possible.
- where it is impractical to provide an outdoor cylinder store, the keeping of cylinders indoors shall be restricted (the total capacity of gas in cylinders allowed for any particular indoor location shall include cylinders in use, spare cylinders not in use,

and used cylinders awaiting removal; the total capacity of the gases kept shall not exceed one minor storage quantity per 200 $m^2$ of floor area)

- Minor Stores having an aggregate capacity of less than 1000 L (i.e. 20 x G-size cylinders) may be protected with a single, permanently connected water hose, provided that it is capable of depositing water on any part of the store

The ventilation requirement will be met by either—

(i) a natural ventilation system, as specified in Clause 4.3.2 of AS 4332-2004; or

(ii) a mechanical ventilation system, as specified in Clause 4.3.3.

A naturally ventilated store complies if it is designed so that:

- there are two opposing external sides that are open from floor to ceiling
- one external side is open, provided that the length of the open side is at least twice the distance of that wall from the opposite side
- vents have been provided in at least one pair of opposing external sides provided that—
  - (i) the distance between the opposing external walls does not exceed 10 m;
  - (ii) in every two metre length of the opposing external walls, there are at least two vents; one positioned immediately above the floor and the other positioned immediately below the ceiling;
  - (iii) the total area of the vents per metre length of wall shall be at least 0.1 $m^2$; and
  - (iv) the vents shall be evenly distributed.

Care should be taken to ensure that any nearby embankments, excavations or retaining walls do not compromise the effectiveness of a natural ventilation system.

The design for any mechanical ventilation system must meet the following requirements:

- exhaust ventilation must be provided.
- the minimum system capacity is required to be
  - for stores in which cylinders are kept but no gases are transferred..... 0.005 $m^3$ per sec per $m^2$ of floor area, or
  - for stores where gases are transferred.....0.0075 $m^3$ per sec per $m^2$
- the air velocity at the air entry register shall be at least 5 m/s.

- where localized exhaust ventilation is used, not more than 75% of its capacity can be located at any one point - at least 25% of the capacity shall be available to ventilate the remainder of the store.
- any air intake or exhaust duct shall terminate in the open air, at distances of at least—
  - 2 m from any opening to a building;
  - 4 m from the outlet of any chimney or flue; and
  - 3 m above the ground.
- the ventilation system needs to be designed such that it operates:
  - continuously; or
  - for sufficient time to allow two complete air changes before entry.

The proposed scheme for the Gas Cylinder Depot will incorporate all these design provisions as safeguards.

AS 1894-1997 *The storage and handling of non-flammable cryogenic and refrigerated liquids* describes the requirements for keeping vessels containing liquid nitrogen indoors. In addition to specifying the minimum ventilation rate (10 $m^3$/min per 1,000 $m^3$ of vessel full gas volume), it specifies the requirements for gas transfer.

The proposed scheme for the storage of cryogenic gases at the Chemical Store adjacent to MLS is for the storage location to be outdoors.

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<u>Managing the hazard posed by oxygen depletion in gas usage areas</u>

Gases such as nitrogen, sulphur hexafluoride and carbon dioxide can pose a significant risk of asphyxiation through oxygen depletion in user spaces.

It is proposed that oxygen depletion monitoring with alarm facility (in case a release of cryogenic nitrogen) and sulphur hexafluoride high concentration monitoring and alarm (in case of a release of sulphur hexafluoride) will be provided in the Cryo TEM space.

All areas where gas is being used in indoor spaces will be reviewed as part of the detailed design process.

**Storage of packaged dangerous goods**

Packaged dangerous goods of Class 3 (flammable liquids), Class 5, Division 5.1, Class 6, Division 6.1 (toxic substances), and Class 8 (corrosive substances) are to be kept on the MLS premises.

These generally fall within one or more of the following storage situations:

- Class 3 flammable liquids in approved (to AS 1940) flammable liquid storage cabinets
- Class 5, Division 5.1 oxidising substances in an approved to AS4326-2008) cabinet
- Class 6, Division 6.1 toxic substances in an approved (to AS/NZS 4452-1997) storage cabinet
- Class 8 corrosive substances in corrosive cabinets (approved to AS 3780-2008)
- Wastes that may be flammable liquids, or corrosive liquids (up to 100 L), segregated to prevent any incompatibility issues, kept as Minor Storage on spillage trays on open shelving

Storage of flammable liquids

The facilities for storing flammable liquids are required to comply with AS 1940 *The storage and handling of flammable and combustible* liquids. There are two 'permitted' storage 'regimes' for packaged flammable liquids:- Minor Storage; and, storage within a purpose designed facility (either a flammable liquid cabinet, or in a flammable liquid package store).

The Minor Storage limits for flammable liquids within laboratories is 50 L per 50 $m^2$ of floor area for the aggregated quantity of PG I & PGII, and 100 L per 50 $m^2$ of floor area of PG III. This limit is to allow for only small amounts of 'bench stock'.

*Flammable liquid storage in approved cabinets*

AS 1940 permits cabinets up to 850 L capacity per 250 $m^2$ of floor area on a ground floor and 250 L per any 250 $m^2$ of floor area.

Cabinets of greater capacity than 100 L seriously limit the presence of ignition sources in the vicinity of the space where they are placed (for closed packages, the hazardous atmosphere standard describes an ignition source exclusion zone that is 3 m laterally to a height above floor level of 1 m above any opening to the cabinet).

AS/NZS 2982-2008 further limits under-bench cabinets for flammable liquids to a maximum capacity of 30 L.

Notwithstanding this, cabinets of up to 100 L maximum capacity may be placed under-bench (contrary to the restriction mandated in AS/NZS 2982) if an equivalent level of safety to that which would be secured by having a lesser maximum inventory can be demonstrated.

The vehicle for doing this is via a risk assessment process, and the acceptance of a risk control protocol that includes measures such as:- not keeping any PG I high hazard materials; keeping only closed packages in the cabinet; not decanting at any cabinet; and limiting the maximum package size to 2.5 L.

Ventilation of cabinets is usually not required (nor is it generally desirable) and is not proposed for MLS.

*Storage of packaged dangerous goods of classes other than Class 3*

The threshold limits for minor storage of goods of Classes 5.1, 6.1 & 8 are:

| DG Class | Threshold limit values kg(L) | | | Class Standard |
|---|---|---|---|---|
| | PG I | PG II | PG III | |
| 5.1 | 50 | 250 | 1,000 | AS 4326-2008 |
| 6.1 | 10 | 100 | 1,000 | AS/NZS 4452-1997 |
| 8 | 50 | 250 | 1,000 | AS 3780-2008 |

In addition to the above threshold limits specified in the individual dangerous goods class standards, AS/NZS 2243-2004 *Safety in laboratories –Part 10: Storage of chemicals* limits the capacity for any chemical storage cabinet used in a laboratory to store hazardous chemicals of classes other than 4.1, 4.2, 4.3, 5.1 or 5.2, to 250 L.

**HAZARDOUS ATMOSPHERE ZONING**

Spaces within the laboratories where flammable liquids and gases are being handled and used, may generate flammable/explosive vapour-in-air, gas-in-air or aerosol mist-in-air mixtures that are capable of being ignited by a source of heat or by some other ignition source.

There are three zonal classifications for these hazardous spaces:

- **Zone 0** – a place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods frequently
- **Zone 1** – place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally; and,
- **Zone 2** - place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

In general, the specific occupancy approach to area classification is undertaken using the methodology in AS/NZS 60079.10.1-2009.

**Flammable gas storage and in-use installations**

Flammable Gas Cylinder Storage

Where heavier than air flammable gases are kept, AS/NZS 60079.10.1-2009 describes a hazard zone that is:

0.5 m above and 0.5 m laterally from any cylinder valve and extending to a distance of 1.5 m laterally from the base of the cylinder …….. **Zone 2**

For lighter than air flammable gases, AS/NZS 60079.10.1-2009 describes the following hazard zones

Where the aggregate gas cylinder capacity is:

| | |
|---|---|
| Less than 30 m3 (i.e. < 5 G-size cylinders) | **Non-Hazardous** |
| Greater than 30 up to 90 $m^3$ for a lateral distance of 1.5 m | **Zone 2** |
| Greater than 90 up to 600 $m^3$ for a lateral distance of 3 m | **Zone 2** |
| Greater than 600 $m^3$ for a lateral distance of 5 m | **Zone 2** |

**Flammable liquids**

Flammable liquid cabinets

AS/NZS 60079.10.1-2009 describes the following hazard zones for an approved (to AS 1940-2004) flammable liquid cabinet:

Interior of the cabinet ……..**Zone 1**

Exterior of the cabinet together with any vent provided on the cabinet, from ground level to 1 m above and 3 m laterally …….**Zone 2**

*(Note that AS 1940-2004 provides additional specificity to the meaning of 1 m above in that it uses the words '…from floor level to a height of 1 m above any opening in the cabinet including the door'.*

Approved cabinets for indoor use can be as large as 850 L capacity (although any cabinet with a capacity greater than 250 L must be located at ground level).

The hazard zone described above while being applicable to all sizes, is not necessarily the situation for smaller capacity cabinets. AS/NZS 60079.10.1-2009 the *Scope* of AS/NZS 2430.3.3 states that the zone determined in accordance with that standard are '*not representative'* for flammable liquids *'in …quantities up to 100 L in closed containers'*, the clear inference being that for lesser capacity cabinets, the zone is less conservative than that described above

While the hazard zone described above can generally be tolerated for cabinets from 100+ L to 250 L capacity, there has been a need to challenge the conservative presumption of the large hazard zone for smaller capacity under-bench cabinets to permit the reasonable conduct of normal laboratory activities within the various user spaces.

Alternative design schemes to those that strictly meet all the requirements of a standard are acceptable provided that the performance result is at least the same, or better, than that which would have been secured had the arrangement in the standard been strictly adopted. Performance results can be compared by a process of formal risk assessment. To facilitate the consultation process for a risk-based case for a reduced zone in the case of under-bench flammable liquid storage cabinets of less than 100 L capacity, a draft risk assessment has been prepared as described in APPENDIX C.

This risk assessment accepts that a lower height hazard zone that extends from floor level to the top of the bench counter under which it is placed, will yield a low risk result provided that an operating protocol is adopted that reduces risk. It takes into account factors such as the limitations on the hazard level of materials to be kept, relatively small container size, capability of quickly de-energising ignition sources, and the likely mechanism of loss of containment.

Pre-empting the result of the consultation to be done by University of Wollongong personnel from this risk assessment process, a reduced height of the hazard zone for an under-bench cabinet to the top of the cabinet (given only closed containers in the cabinet and the mechanism of release of flammable liquid being a package breaking as it struck the floor) would yield the following classification for cabinets less than 100 L.

Interior of the cabinet …….. **Zone 1**
Exterior of the cabinet together with any vent provided on the cabinet, from ground level to 1 m above floor level and 3 m laterally …….…… **Zone 2**

Given that fixed ignition sources will not be placed within an exclusion zone of 300 mm above the top face of the bench, the effective exclusion zone within the 3 m lateral distance from the cabinet, extends to a height of about 1200 mm.

Decanting of flammable liquids in the Ground Level Store

Decanting is permissible in the Chemical Store structure subject to excluding ignition sources from any deemed hazard zone, and maintaining any exposure to harmful vapours below statutory exposure limits.

With efficient vapour capture at the point of decanting and by confining the spread of any leak or spill in its immediate vicinity, the hazard zone associated with decanting has been reduced so that it remains essentially within the envelope for a flammable liquid store for packages that are not opened (consistent with a calculation based on the ACGIH publication *Industrial Ventilation - A Manual of Recommended Practice – 26th edition).*

The practical effect of decanting is that the zoning classification of the entire room space within the Chemical Store is elevated from **Zone 2** to **Zone 1**. A **Zone 2** space is deemed to exist external to the room, resulting in the following zoning:

Entire internal space within the Basement Level
Decanting Area …… **Zone 1**
External to the Decanting Point, laterally for 3 m,
to a vertical height of 1.5 m above floor level ..…… **Zone 2**

General laboratory spaces where flammable liquids are handled

Where flammable liquids in small quantities (say less than 2.5 L are kept or in use on bench spaces, subject to no materials of high hazard – such as Category 1 flammable liquids including diethyl ether and carbon disulphide), any fixed ignition sources need to be excluded from :

- The space from the top of the bench to a height of 300 mm above the bench and 300 mm laterally from the edge of the bench …….. **Zone 2**
- The entire space within the laboratory room where flammable liquids are used to a height above finished floor level of 300 mm ……. **Zone 2**

Items such as refrigerators and ice-makers, a dish-washer etc, need to be placed outside of the identified hazard zones.

These measures are to be incorporated in to the detailed design of the MLS facilities.

## WASTES

This section of the report describes:- a commitment to develop a plan for the likely waste streams to be generated during construction, the likely waste streams arising from the operation of the MLS building activities, and the measures to be implemented to minimize, reuse, recycle and safely dispose of this waste.

### Construction Wastes

A Waste Management Plan (Construction) will be prepared as part of the Construction Environment Management Plan. This plan to be prepared prior to the commencement of any demolition and construction works by the contractor undertaking the works, will, in addition to describing the objectives of the plan, detail the involvement of the waste contractor and any other specific requirements as identified during the pre-planning of demolition and construction works.

This separate study will address the waste streams likely to be generated, including those that may contain hazardous chemicals expected to be created during demolition and construction (including the hazardous materials present in any buildings and facilities to be demolished as already identified in the University's asbestos register).

Wherever practicable, measures will be implemented to minimise, re-use, and recycle any construction and demolition wastes.

Where this cannot be reasonably achieved, wastes will be disposed of responsibly and in full compliance with all statutory requirements, using licensed waste transport and waste disposal contractors with fully compliant documentation to prove due diligence has been exercised over the transport, custody and disposal processes.

### Waste from Operations

Waste generated in the teaching and research laboratories is segregated generally into categories of:

- Solid waste, with details of the solid on the label of the container including broken glass, along with contaminated gloves and paper towel into specific cardboard boxes, and labelled – for MLS, say less than 15 kg/month
- Liquid waste aggregated from compatible unknown mixtures, segregated by dangerous goods class and by group as follows:
  - Halogenated solvent waste – for MLS, say 20 L/week

  - Non-halogenated solvents – for MLS, say 15 L/week;
  - Aqueous heavy metals – for MLS, say 10 L/month;
  - Corrosive substances – for MLS,say 15 L/week;
  - Aqueous acidic liquids – for MLs, say 15 L/week;
  - Liquid mineral oil – for MLS, say 5 L/fortnight; and
  - Toxic liquids – for MLS, say 10 L/week.
- Sharps – a small quantity of sharps that may be chemically contaminated are put into yellow sharps containers and labelled
- On occasion as chemicals become inactive or contaminated, bottles of that chemical are disposed of as provided by the supplier.

There are no biohazard wastes, cytotoxic wastes or radioactive wastes generated in MLS.
Chemical wastes are to be conveyed by the laboratory generating that waste to the Shared Screened Loading and Secure Waste Enclosure at Building 32 as soon as containers are full. Accumulation is not permitted in the laboratory spaces.

All wastes generated on Campus (and that will include the waste streams to be generated by the MLS activity), are disposed of responsibly at approved waste disposal activities in accordance with the University of Wollongong's written Policies and Guidelines, and in full compliance with all relevant legislation for waste transport and disposal, consistent with the University's Environmental Management Plan, and in accordance with procedures devised and maintained for managing all waste streams generated at the University.

In order to estimate the volume of wastes for MLS activities, the data for wastes collected in, and disposed of from, the existing facility at Building 32 has been used as a baseline, on the assumption that MLS will contribute an additional 50% to the volume, based on the existing stream currently being generated in two buildings (B41 and Building 32). Underpinning this strategy were where laboratory and support activities are of a nature and scale similar to that proposed for MLS.

The disposal of all of these streams will be in accordance with the University's *Environmental Management Plan*.

| *Type of waste* | *Existing B32 & B41* | *Estimated MLS* | *Estimated total - new facility* | *Comments* |
|---|---|---|---|---|
| Cardboard (recyclable) | 1 x 1.5 m cardboard emptied fortnightly | 0.7 m3 | 2 $m^3$/fortnight | Separated for recycling by an approved contractor |
| Office paper (recyclable) | 4-8 office paper Sulo bins collected week (each Wednesday) | 2-4 office paper Sulo bins collected week (each Wednesday) | 6-12 office paper Sulo bins collected week (each Wednesday) | Separated for recycling by an approved contractor |
| Confidential Documents | 2-10 confidential waste Sulo bins collected fortnightly | 1-5 confidential waste Sulo bins collected fortnightly | 3-12 confidential waste Sulo bins collected fortnightly | Confidential papers for shredding are placed in bins for pick up shredding and recycling by an approved contractor (in peak periods such as at examination time, pick up is weekly) |
| Co-mingled glass, plastic, aluminium/steel | 6 x 240 L Sulo bins collected weekly (each Thursday) | 3 x 240 L Sulo bins collected weekly (each Thursday) | 9 x 240 L Sulo bins collected weekly (each Thursday) | waste is transferred to a transfer station for sortation and thence to landfill |
| General Waste (including putrescible waste) | 6 x 240 L Sulo bins collected each weekday | 3 x 240 L Sulo bins collected each weekday | 9 x 240 L Sulo bins collected each weekday | Waste is picked up by an approved waste transporter and is conveyed to a transfer station for sortation and thence to landfill |
| Clinical waste | 1-2 x 240 L bins each containing ~ 20 kg collected fortnightly | ½- 1 x 240 L bins each containing ~ 10-20 kg collected fortnightly | 2 x 240 L bins each containing ~ 20 kg collected fortnightly | Note that this waste is pre-treated (autoclaved) and is not infectious |

Table 2 Effect of proposed MLS development on waste streams

| | | | | |
|---|---|---|---|---|
| Cytotoxic wastes | 1 x 120 L Sulo Bin containing about 15 kg contaminated clothes etc. | None expected | 1 x 120 L Sulo Bin containing about 15 kg contaminated clothes etc. | Currently collected fortnightly |
| Chemical wastes | | | | As reported earlier in the text |
| Polystyrene | 2 baled bags emptied on demand – about every 8 weeks | 0.7 of a baled bag | 2 baled bags emptied about every 4 weeks | Total held will not increase – simply the pick-up will be at more frequent intervals |

Table 2 (continued) Effect of proposed MLS development on waste streams

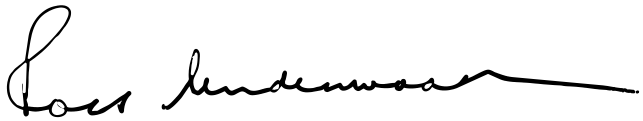
**GENERAL CONCLUSION**

The proposed facilities for the storage, handling and use of hazardous chemicals and wastes, have been designed so as to be in compliance with statutory requirements and consistent with best practice principles for the management of risk to health and safety posed by the materials to be kept and used.

Should you need to clarify any of this advice, or raise any other issues, I would be happy provide further assistance.

I thank you for the opportunity of providing advice in these matters.

Yours sincerely
Safety Engineering & Technical Services Pty Ltd



Ross Underwood, MIEAust, CPEng, MSIA, MAIDGC
General Manager

# APPENDICES

## APPENDIX A DANGEROUS GOODS INVENTORY DETAILS

## APPENDIX B HAZARDOUS ATMOSPHERE ZONING DETERMINATION

## APPENDIX C WHO PROVIDED THIS ADVICE?

## APPENDIX A DANGEROUS GOODS INVENTORY DETAILS

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments |
|---|---|---|---|---|---|
| | | | | | |
| **Ground level** | | | | | |
| Gas cylinder store at B32 | Mixed divisions 2.1; 2.2 2.2/5.1 and 2.3 | n/a | Cylinders of flammable gas (hydrogen, methane, ethylene), non-flammable gases (nitrogen, helium, argon, carbon dioxide, sulphur hexafluoride), oxidising gases (oxygen, nitrous oxide) and small quantities of toxic compressed gases (carbon monoxide, ammonia) | 2,000 L water capacity | • is to comply with Section 2 of AS-4332-2004 Mi*nor Storage of gases, the conditions being:*<br>• no more than 50 L water capacity (1 x G size equivalent) Division 2.3 toxic gas<br>• no more than 1,000 L (20 x Gize equivalent) of Division 2.2/5.1 oxidising gases, and<br>• no more than 2,000 L ;(40 x G size equivalent) all gases in aggregate |
| Wastes enclosure near B32 – Chemical wastes section | 3 | III | Flammable (non-halogenated) liquids | 100 L | • Mixed wastes of UN 1993 containing substances such as ethanol, isopropanol, acetone) – to be kept in a flammable liquid cabinet |
| | 6.1 | III | Mixed liquid halogenated solvent (dichloromethane, chloroform wastes | 100 L | • Mixed wastes of UN 2810 – to be kept in a toxic substances cabinet |
| | 6.1 | III | Mixed heavy metal wastes | 50 L | • Mixed wastes of UN 3287 – to be kept on bunded shelving |
| Bulk liquid storage tank for Liquid Nitrogen (LN2) | 2.2 | n/a | Liquefied nitrogen | 1,500 L water capacity | • gaseous nitrogen to be reticulated to MLS laboratory spaces<br>• proposed co-stowage with liquefied carbon dioxide<br>• separated from an adjoining flammable liquid storage cabinet and a corrosives cabinet |

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments |
|---|---|---|---|---|---|
| Bulk liquid carbon dioxide storage vessel (LCO2) | 2.2 | n/a | Liquefied carbon dioxide | 240 L water capacity | • gaseous carbon dioxide to be reticulated to MLS laboratory spaces<br>• proposed co-stowage with liquefied nitrogen<br>• separated from an adjoining flammable liquid storage cabinet and a corrosives cabinet |
| Cryogen store CRYO-TEM 1 | 2.2 | n/a | Liquefied nitrogen in a Dewar flask | 20 L water capacity | • for servicing the CRYO-TEM microscope<br>• the room housing the CRYO-Tem instrument has oxygen depletion alarm |
| Cylinder store CRYO-TEM | 2.2 | n/a | Sulphur hexafluoride | 100 L water capacity | • 2 x G size cylinders - 1 x duty; 1 x standby<br>• This room space also has a sulphur hexafluoride gas monitoring and alarm system |
| Flammable liquids storage cabinet located in the Chemical Store building to the south-west of the South Wing | 3 | II/III | Flammable liquids of PG II & PG III such as ethanol, n-propanol, acetone, toluene, and methanol | 450 L | • No storage and no decanting of any PG I flammable liquid (such as diethyl ether<br>• Storage cabinet to be constructed for internal building use (i.e. double skin, no ventilation openings)<br>• Cabinet to be earthed and any decanting arrangement is to be purpose designed to avoid potential for electrostatic discharge<br>• The cabinet is to be placed on a concrete plinth with a spillage 'well' in front of the cabinet capable of holding a 20 L spill so as to be suitable for limited decanting |
| Corrosive substances cabinet/s in the Chemical Store building | 8 | II/III | Acids and base neutral corrosive substances | 2 x 100 L | • 100 L cabinets (2) to be provided within the chemical store for keeping reserve stock of acids such as sulfuric, hydrochloric, nitric, and phosphoric acids - (1 cabinet) and the second cabinet for keeping reserve stock of base/neutral substances *( such as sodium hydroxide, potassium hydroxide, hypochlorite etc.) |

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments | |
|---|---|---|---|---|---|---|
| **LEVEL 01 – North Wing** | | | | | | |
| Flammable liquid storage cabinet 1-FLCA | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Flammable liquid storage cabinet 1-FLCB | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Flammable liquid storage cabinet 1-FLCC | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Flammable liquid storage cabinet 1-FLCD | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | 8 |
| Oxidising substances cabinet 1-OXA | 5.1 | II/III | Oxidising substances | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Toxic substances cabinet 1-TOXA | 6.1 | II/III | Toxic substances | 30 L | • Under-bench unit | |
| Corrosive substances cabinet 1-CCA | 8 | II/III | Corrosive substances – acids | 30 L | • Under-bench unit | |

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments | |
|---|---|---|---|---|---|---|
| Corrosive substances cabinet 1-CCB | 8 | II/III | Corrosive substances – base/neutral substances | 30 L | Under-bench unit | |
| **LEVEL 02 – North Wing** | | | | | | |
| Flammable liquid storage cabinet 2-FLCA | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | 8 |
| Flammable liquid storage cabinet 2-FLCB | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | 8 |
| Flammable liquid storage cabinet 2-FLCC | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Flammable liquid storage cabinet 2-FLCD | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Oxidising substances cabinet 2-OXA | 5.1 | II/III | Oxidising substances | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height | |
| Toxic substances cabinet 2-TOXA | 6.1 | II/III | Toxic substances | 30 L | • Under-bench unit | |
| Corrosive substances cabinet 2-CCA | 8 | II/III | Corrosive substances – acids | 30 L | • Under-bench unit | |

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments |
|---|---|---|---|---|---|
| Corrosive substances cabinet 2-CCB | 8 | II/III | Corrosive substances – base/neutral substances | 30 L | • Under-bench unit |
| **Level 03 – North Wing** | | | | | |
| Flammable liquid storage cabinet 3-FLCA | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Flammable liquid storage cabinet 3-FLCB | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Flammable liquid storage cabinet 3-FLCC | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Flammable liquid storage cabinet 3-FLCD | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Oxidising substances cabinet 3-OXA | 5.1 | II/III | Oxidising substances | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Toxic substances cabinet 3-TOXA | 6.1 | II/III | Toxic substances | 30 L | • Under-bench unit |
| Corrosive substances cabinet 3-CCA | 8 | II/III | Corrosive substances – acids | 30 L | • Under-bench unit |
| Corrosive substances cabinet 3-CCB | 8 | II/III | Corrosive substances – base/neutral substances | 30 L | • Under-bench unit |

| Room Name/Facility | DG Class | PG | Hazardous contents | Q'ty | Comments |
|---|---|---|---|---|---|
| **Level 04 – South Wing** | | | | | |
| Flammable liquid storage cabinet 04S-FLCA | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Flammable liquid storage cabinet 04S-FLCB | 3 | I/II/III | Flammable liquids such as diethyl ether, acetone, ethanol, isopropanol, methanot | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Oxidising substances cabinet 3-OXA | 5.1 | II/III | Oxidising substances | 30 L | • Under-bench unit<br>• Ignition sources to be excluded from space around cabinet for 3 m laterally to bench top height |
| Toxic substances cabinet 3-TOXA | 6.1 | II/III | Toxic substances | 30 L | • Under-bench unit |
| Corrosive substances cabinet 3-CCA | 8 | II/III | Corrosive substances – acids | 30 L | • Under-bench unit |
| Corrosive substances cabinet 3-CCB | 8 | II/III | Corrosive substances – base/neutral substances | 30 L | • Under-bench unit |

**NOTES:**

1. PG Packing Group – a measure of the relative hazard of a dangerous good of Class 3, 4, 5, 6, 8 & 9 –
   *(PG I goods are those of highest hazard, PG II goods are of moderate hazard, and PG III are goods of relatively low hazard)*

2. There is no Code requirement to provide direct ventilation connections to storage cabinets.

# APPENDIX B HAZARDOUS ATMOSPHERE ZONING DETERMINATION

| **Flammable liquid storage** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flammable liquid storage in approved cabinets up to 450 L | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | | | 9 | 10 | 11 | 12 |
| | Source of release | | Flammable material | | | | | Ventilation | | | Hazardous area | | | |
| No. | Description | Location | Grade of release | Ref | Operating temp & press | | State | Type | Degree | Avail'ty | Zone (0.1.2) | Zone extent m. | | Ref. |
| | | | | | $^0$C | kPa | L | | | | | lateral | vertical | |
| 1 | Flammable liquids in package sizes less than 4 L (or less than 2 L in the case of any PGI substances) being stored in approved (to AS 10940-2004) flammable liquid cabinets under-bench with a capacity of less than 100 L | Underbench flammable liquid cabinets in laboratory spaces in North Wing Levels, 01, 02, 03 and South Wing Level 04 | Secondary | AS/NZS 60079.10.1-2009 | Amb't | Amb't | Liquid | Mech'l | Med'm | Fair | Zone 1<br>Zone 2 | Interior of cabinet<br>Exterior of cabinet to 3 m | Interior of cabinet<br>Exterior of cabinet to a height the lower of 1 m above floor level or level with laboratory working bench height | AS/NZS 60079.10.1-2009 Clauses ZA.5.2.3(c) for lateral spread – height set in consideration of correspondence from Dr John McCracken of McCracken Consulting (this resource can be sighted on request) |
| 2 | Flammable liquids stored in approved (to AS 10940-2004) flammable liquid cabinets from 100+ L to 450 L | Chemical Store south west of South Wing | Secondary | AS/NZS 60079.10.1-2009 | Amb't | Amb't | Liquid | Mech'l | Med'm | Fair | Zone 1<br>Zone 2 | Interior of cabinet<br>Exterior of cabinet to 3 m | Interior of cabinet<br>Exterior of cabinet to a height 1 m above any opening | AS/NZS 60079.10.1-2009 Clauses ZA.5.2.3(c) |

| **Flammable liquid decanting** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | 9 | 10 | 11 | 12 |
| | Source of release | | Flammable material | | | | Ventilation | | | Hazardous area | | | |
| No. | Description | Location | Grade of release | Ref | Operating temp & press | State | Type | Degree | Avail'ty | Zone (0.1.2) | Zone extent m. | | Ref. |
| | | | | | $^0$C kPa | L | | | | | lateral | vertical | |
| 3 | Flammable liquids being decanted from 20 L containers to smaller capacity packages within a purpose designed ventilated enclosure | Flammable liquid storage cabinet of 450 L capacity in Chemical Store enclosure while decanting is being undertaken | Primary | AS/NZS 60079.10.1-2009 | Amb't Amb't | Liquid | Mech'l | Good | Good | Zone 1<br>Zone 2 | Interior of Decanting Store<br>Outside of Zone 1 but within space 8 m laterally from point of decanting | 1.5 m above point of decanting | AS/NZS 60079.10.1-2009 Clauses ZA.5.2.4(a) |
| | Gas cylinder Store – Ground Level –For future proofing, assuming both lighter and heavier than air flammable gases may be present | Gas Store near B32 | Secondary | AS/NZS 60079.10.1-2009 | Amb't Amb't | Gas | Natural | Med'm | Fair | Zone 1<br>Zone 2 | Interior of Store<br>Exterior of Store to a distance measured that is the greater of 5 m laterally from the outermost cylinder/s | Interior of store<br>Exterior of Gas Store to 1.5 m | AS/NZS 60079.10.1-2009 Clauses ZA.6.4.2.6(c) & ZA.6.4.2.6(e) for lighter than air gases, and Clauses ZA 6.5.2.15 & ZA 6.5.2.18 |

## APPENDIX C WHO PROVIDED THE ADVICE IN THIS REPORT?

This report was prepared by Ross Underwood, a graduate mechanical engineer with postgraduate qualifications in industrial engineering from the University of New South Wales, with over 49 years of experience in industrial practice.

The first 12 years of his professional career were spent in the petrochemical industry where he was involved in a variety of different functions including engineering maintenance, major new plant construction, project work associated with energy conservation and improving environmental performance, and chemical plant production management. He then spent 3 years managing reconstruction works at the Pyrmont Sugar Refinery, before being appointed as Personnel and Administration Manager for a major manufacturing activity, a position he held for 5 years.

In 1986 he established Safety Engineering and Technical Services Pty Ltd, a safety consulting and engineering contracting/consulting business. His company has undertaken a substantial number of consulting tasks in safety management for a very diverse range of private sector industrial and government clients including what was then the NSW WorkCover Authority.

Ross has conducted specific training programs and seminar sessions in safety awareness, accident investigation & other safety skills at all organisational levels. He was formerly accredited by WorkCover NSW as a trainer in workplace consultation, building industry induction, hazardous substances and risk management courses. He has trained management & employee safety committee representatives from over 80 different organisations. He has lectured in OH&S for both undergraduate and postgraduate students at the universities of UNSW, Sydney, Western Sydney and the University of Technology. He has undertaken longer term engineering contracting/consulting assignments in the brewing, building and manufacturing/industrial, warehousing and transport, government and military sectors.

His particular areas of expertise include:- dangerous goods storage, handling and transport matters; laboratory design; occupational health and safety performance auditing; construction management; plant & machinery safety, maintenance; industrial relations; accident investigation; workplace and safety system auditing; product packaging and labelling; and, the formulation and maintenance of safe work systems (including the preparation of emergency response and environment management plans). He has also been involved in the pre-planning and design of a number of major manufacturing plant and warehouse projects and has prepared risk and hazard analyses as part of the process for securing development approval for these facilities. He has provided a number of expert opinion reports for litigated matters related to oh&s and dangerous goods matters.
He has provided specialist advice on dangerous goods and more general occupational health and safety issues associated with several major building/re-building projects most

recently including:- the Ingham Health Research Institute at Liverpool Hospital; the Hunter Medical Research Institute; the Australasian Institute for Innovative Materials at the University of Wollongong; a Veterinary Diagnostic laboratory at Charles Sturt University at Wagga Wagga; the Special Operations Working Accommodation Upgrade Project; the 171 Aviation Squadron (Blackhawk helicopter) Relocation Project; HMAS CRESWELL Redevelopment at Jervis Bay, the ASC Shipyard Redevelopment, and the upgrade of HMAS PENGUIN – all for the Australian Defence Forces; and, the major redevelopment of the University of New South Wales North Mall (including new facilities for Applied Science and Chemistry)

Ross has contributed as an author to a number of technical journals and to the CCH International *Occupational Health & Safety Manual*, the *Plant Safety* manual, the *OHS Manager- The Hands on Guide* and the *2003 Australian master OH&S & environment guide*.

He is a Member of the Institution of Engineers, Australia, a Member of the Safety Institute of Australia, a Chartered Member of the Australian Human Resources Institute, and a founding member of the Australasian Institute of Dangerous Goods Consultants.

He has completed Certificate IV courses in Workplace Safety, and Workplace Assessment and Training, and the Risk & Liability Management short course convened by Engineering Education Australia.