Safety Engineering & Technical Services Pty Ltd

OCCUPATIONAL **H**EALTH, **S**AFETY & **E**NGINEERING **C**ONSULTANTS

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8 August 2009

The Project Manager
S2F Pty Ltd
21-31 Goodwood Street
RICHMOND VIC 3121

Attention: Mr Julian Scanlan (Project Team Leader – S2F)

Dear Sir

Re: Project 4750 - Occupational Health & Safety and Dangerous Goods Matters – Contribution to the Development Application Report – Hunter Medical Research Institute

EXECUTIVE SUMMARY

The following advice is provided as a response to a request for a contribution for inclusion in the suite of reports being prepared for submission in support of the Development Application for the Hunter Medical Research Institute project, on matters within my sub-consultancy specialty area.

The advice based on the latest information available at the time the report was prepared covers the following matters:

- the safe storage and handling of chemicals (including hazardous substances and dangerous goods – other than infectious substances of Division 6.2 and radioactive material of Class 7)
- comments on the determination of hazard zones and the allowable placement of equipment
- the reticulation of gases (especially the measures required to minimise the potential for fire, explosion, asphyxiation, toxic release) and the requirement for, and the arrangement of, gas detection protective systems (if any are required)
- emergency equipment requirements for the storage and handling of dangerous goods (including fire extinguishers and fixed fire protection), and emergency eyewash and shower equipment
- identification of confined spaces, and
- statutory dangerous goods and OH&S signage.

The report includes:

- a description of the nature and quantities of goods to be kept and used at the proposed facility
- a reasoned conclusion that State Environmental Planning Policy 33 (SEPP 33 does not apply

- a description of the requirements for the safe storage handling and use of the various classes of dangerous goods to be kept at the facility, including a list of the mandated and other requirements applying to those goods
- conclusions reached that the proposed manner of storage, handling and use of dangerous goods at the proposed facility complies with statutory obligations as described in the report.

REFERENCES USED IN PREPARING THIS REPORT

The advice is based on a review of the following drawings (being the architectural drawings that together have been prepared so that they are entirely consistent with the town planning set of drawings to be submitted with the development application bearing a 'T' prefix):

- Drawing No A0111 – Rev 6 – Overview Plan Level 1
- Drawing No A0121 – Rev 6 – Overview Plan Level 2
- Drawing No A0131 – Rev 8 – Overview Plan Level 3
- Drawing No A0141 – Rev 6 – Overview Plan Level 04
- Drawing No A1211 – Rev 7 – West Wing Reference Plan Level 1
- Drawing No A1212 – Rev 7 – East Wing Reference Plan Level 1
- Drawing No A1222 – Rev 6 – East Wing Reference Plan Level 2
- Drawing No A1231 – Rev 8 – West Wing Reference Plan Level 3
- Drawing No A1232 – Rev 6 – East Wing Reference Plan Level 3
- Drawing No A1233 – Rev 7 – POD Reference Plan Level 3
- Drawing No A1242 – Rev 6 – East Wing Reference Plan Level 04
- Drawing No A1243 – Rev 6 – POD Reference Plan Level 04

A number of legislative instruments, standards and codes have been considered in developing the design options selected, including:

- the NSW *Occupational Health and Safety Act* 2000 and the *Occupational Health and Safety Regulation* 2001 (particularly Part 6 – *Hazardous* substances and Part 6A *Dangerous goods)*
- 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 5026 *The storage and handling of Class 4 dangerous goods* (note that this standard is only a consultation draft and is therefore only used for guidance)
    - AS 4326-2008 *The storage and handling of oxidising substances*
    - AS 2714-2008 *The storage and handling of hazardous chemical materials – Class 5.2 substances (organic peroxides)*
    - AS/NZS 4452-1997 *The storage and handling of toxic substances*
    - AS 3780-2008 *The storage and handling of corrosive substances, and*
    - AS/NZS 4681-2000 *The storage and handling of Class 9 (miscellaneous) dangerous goods and articles*
- The standards covering the design and operation of laboratories and equipment for use in laboratories, particularly:
    - AS/NZS 2982.1-1997 *Laboratory design and construction – Part 1: General requirements* (especially Section 7 - Storage of hazardous substances), and
    - The AS/NZS 2243 series of standards *Safety in Laboratories*

  - AS 4775-2007 *Emergency eyewash and shower equipment*
- The standards covering the classification of hazardous areas, particularly:
  - The AS/NZS 2430 series of standards *Classification of hazardous areas* that describe the spaces from which ignition sources must be excluded and
  - AS/NZS 60079.10-2004 *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas (IEC 60079-10:2002 MOD)* and
- The *Code of Practice – Storage and Handling of Dangerous Goods* (2005) – WorkCover NSW.

NATURE AND QUANTITIES OF GOODS BEING STORED AND HANDLED AT THE FACILITY

The materials stored and used and the processes employed were determined through the administration of user questionnaires, verified by meetings. The usage of the facility has been described by others elsewhere in the DA submission design report. The quantities of hazardous materials (i.e. dangerous goods), not including goods that are either of Class 6.2 (infectious substances) or are Class 7 (radioactive), are described in the Table 1 (for the East Wing Building), Table 2 (West Wing Building), and table 3 (combustible liquids). As a principle, any dangerous goods of any other classes or divisions of dangerous goods have not been listed if their quantity is less than 10% of the minor storage limit (the concept of minor storage being explained later in this section). Goods falling within the exclusion include small quantities of Class 4 solids (Division 4.1 - flammable solids, Division 4.2 – goods liable to spontaneous combustion and Division 4.3 – goods that in contact with water emit flammable gasses). In the small quantities that are proposed to be kept these goods are of low hazard, and are in any event subject to rudimentary precautions and control measures of a similar nature to precautions required for non-hazardous goods.

East Wing (not including combustible liquids as described in Table 2)							
Level	**Dangerous goods class/division**						
	Division 2.1 flammable gas	Div 2.2 & 2.2/5.1 gases	Div 2.2 cryogenic liquefied	Class 3 Flammable liquids	Class 5.1 Oxidising substances	Class 6.1 Toxic substances	Class 8 Corrosive substances
Level 1 (flammable liquid store)	-	-	-	1,500 L	-	-	-
Level 1 (decanting room)	-	-	-	-	-	250 L	250 L
Level 1(mixed class store)	-	-	-	-	30 L	500 L	1,000 L
Level 1 (gas store) *water capacity in cylinders*	50 L *2 x H_2 G-size*	1,400 L *(28 cylinders)*	-	-	-	-	-
Level 1 (cryogenic gas store)	-	-	1,680 L *(7 x 240 L N_2)*	-	-	-	-
Level 1 (yard)	-	-	CO_2 - 7,000 L N_2 *7,000* *water capacity*	-	-	-	-
Level 2	-	-	-	400 L	-	200 L	300 L
Level 3	-	-	-	400 L	-	200 L	300 L
East Wing Building aggregate	100 L	1,400 L	15,680 L	2,300 L	30 L	1,150 L	1,850 L

Table 1 – Dangerous Goods Inventory Details for East Wing Building

Combustible Liquid Storage for the Emergency Generator	**Capacity**
Fuel tank in Generator Plant Room	1,000 L
Underground Storage Tank	9,000 L

Table 2 – Combustible Liquid Storage – East Wing – Level 1

West Wing							
Level	**Dangerous goods class/division**						
	Div. 2.1 flammable gas	Div 2.2 & 2.2/5.1-	Div 2.2 cryogenic liquefied	Class 3 Flammable liquids	Class 5.1 Oxidising substances	Class 6.1 Toxic substances	Class 8 Corrosive substances
Level 1	-	-	-	30 L	-	-	30 L
Level 2	50 L *1 x H_2 G-size*	50 L	-	200 L	-	100 L	200 L
Level 3	100 L *1 x H_2; 1 x CH_4 G-size*	250 L	-	200 L	-	100 L	200 L
Level 4	-	-	-	200 L	-	100 L	200 L
West Wing Building aggregate	150 L	300 L	-	630 L	-	300 L	630 L

Table 3 – Dangerous Goods Inventory Details for West Wing Building

SEPP 33 applies if	**Threshold**	**Actual**
Class 2 non-flammable gases and cryogenic liquids exceed limit described in Table 1 in the section Risk Screening - Figure 9 of the document *Applying SEPP 33*	No limit is set	SEPP 33 does not apply
Class 3 dangerous goods are not sufficiently separated from the boundary by the distance given in the section Risk Screening - Figure 9 of the document *Applying SEPP 33*	In the case of Class 3 PG II/PG III flammable liquids, the lowest threshold limit below which SEPP does not apply is 2,000 L	SEPP 33 does not apply: • Largest storage situation is 1,500 L (see analysis in text)
Quantity of goods of Class 5.1 exceeds threshold described in Table 1 of the screening method	Threshold quantity is 5 tonnes	SEPP 33 does not apply – quantities below threshold limit
Quantity of goods of Class 6.1 exceeds threshold limit	Threshold quantities 0.5 tonnes for PG I; 2.5 tonnes PG II/III	SEPP 33 does not apply – quantities below threshold limit
Quantity of goods of Class 8 exceeds threshold limit	Threshold quantities 5 tonnes for PG I; 25 tonnes PG II; 50 tonnes PG III	SEPP 33 does not apply – quantities below threshold limit
No of significant transport movements meeting the specified criteria are exceeded	No of traffic movements of 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

Table 4 – Applicability of SEPP 33

I am advised that:- no highly hazardous processes (such as solvent distillation or hydrogenation) are being conducted the activities being confined to those typically undertaken in a medical research laboratory; and, that goods of Packing Group I (high hazard) are stored or handled only in very small quantities.

APPLICABILITY OF STATE ENVIRONMENTAL PLANNING POLICY 33 (SEPP 33)

SEPP 33 applies to any proposal where the quantities of dangerous goods or transport movements involving dangerous goods exceeds the threshold limits described in the document Applying SEPP 33.

In the case of HMRI, the only issue that has any potential to trigger the process is the quantity of flammable liquids of Class 3. The reason for this is that the trigger point is set by the quantity of flammable liquids stored and used, and the distance of that inventory from the site boundary.

Having a tight 3 m boundary distance limits the quantity of flammable liquid to be kept to a 2,000 L limit to avoid triggering the application of the planning policy procedural requirements.

The screening method do not specifically state how multiple discrete storage areas of the same hazard class (in this instance flammables) should be considered (i.e. whether they need to be aggregated when deciding whether SEPP 33 applies).

Based on the principles underpinning the screening method used to determine whether SEPP 33 applies, I have concluded that:

- it is entirely reasonable to separate the inventory of flammable goods in the East Wing from those kept in the West Wing as there can be no possible fire synergy between the inventory in the two wings; and
- it is entirely reasonable to not aggregate the inventory of flammable liquids that are on separate floors of the same building (for the same considerations of lack of fire synergy).

The outcome of these conclusions is that the largest inventory per floor for consideration against the screening criteria is the 1,500 L being kept in the flammable liquids store. This is below the threshold screening limit, thus the storage of flammable liquids within the facility does not trigger SEPP 33.

On the basis of the information supplied, and in accordance with the reasoning described above and in Table 4, I have concluded that SEPP 33 does not apply.

THE PRINCIPLES OF SAFE STORAGE AND HANDLING OF CHEMICALS (INCLUDING DANGEROUS GOODS AND HAZARDOUS SUBSTANCES) THAT ARE INCORPORATED IN THE DESIGN OF THE HMRI FACILITY

The NSW *Occupational Health and Safety Act 2000* and the *Occupational Health and Safety Regulation 2001* dictate the legislative compliance obligations for the safe storage and handling of hazardous substances and dangerous goods in NSW. In particular Parts 6 – *Hazardous Substances* and 6A - *Dangerous Goods* contain specific provisions that are additional to the general obligations to identify hazards and to control risks.

Specific requirements apply in regard to the design of facilities for the storage and use of dangerous goods, where simple risk management principles must be incorporated that include:

- keeping incompatible (ie goods that can interact or react dangerously) apart – it is a general rule that goods of different dangerous goods classes are incompatible (and in some cases may interact dangerously) and must be kept separately – while there are known dangerous combinations of goods within the same class (such as strong acids/strong alkalis, acids and hypochlorites)
- eliminating ignition sources from the vicinity of spaces where flammable liquids, gases, vapours, or solids may be present
- providing sufficient ventilation to prevent the build up of flammable and explosive vapours and gases, or the presence of any atmospheric contaminant that could adversely affect people's health
- keeping dangerous goods separated from areas where people congregate or work and restricting access of unauthorised people
- providing suitable containment for any spillage or leakage of the goods, and some basic fire protection, environmental protection and personal protection measures (including equipment such as extinguishers, safety showers, flash-back arrestors and the like).

The pragmatic approach generally taken by laboratory designers is to satisfy the requirements of the individual dangerous goods class standards, and then to check off the design proposal against the laboratory requirements (which in most instances place further limitations on the design arrangement). It should also be appreciated that the use of standards as a design 'solution' is a deemed-to-comply strategy that requires some validation.

In practice, if standards are applied inflexibly in every respect for all installations, the operational and facility constraints may be totally unworkable or impracticable. For these situations other options developed using a risk-based approach may be adopted based on risk management principles, provided that the performance result will be equivalent to the level of safety prescribed in the standards. Risk assessment based solutions that are at variance with those prescribed by a standard, are essentially a formalised decision by the occupiers of premises (and the owner of dangerous goods) to implement a proposed arrangement subject to full implementation of all risk control measures and strategies considered in the risk assessment. Such arrangements may be based on expert advice pursuant to exercising due diligence, but the responsibility for accepting any specific risk control strategies cannot be delegated.

PARTICULAR ISSUES INCORPORATED IN THE PROPOSED DESIGN ARRANGEMENT.

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.

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 gas cylinder store located on Level 1 East Wing has been designed in accordance with the principles described in AS 4332 – 2004 for minor storage quantities. The following gasses (the largest cylinder size being G) in aggregate capacity of up to 30 x G size cylinders will be kept:

- Division 2.1 – hydrogen and methane (maximum of 2 G-size)
- Division 2.2 – argon, helium, nitrogen, carbon dioxide (maximum of 20 x G size)
- Division 2.2/5.1 – oxygen, air (maximum of 8 x G-size)

Gas cylinder storage in laboratory spaces

Not surprisingly, the standard deprecates this practice. As a consequence, the facility design arrangement has been predicated on eliminating the storage of reserve cylinders in laboratory spaces (i.e. those not in immediate use) and limiting the number of cylinders connected for use so far as is reasonably possible (consistent with the operational requirement, the rate of consumption, the ease of supply or re-supply, and other considerations such as the need to reduce manual handling risk).

It is not possible to arbitrarily nominate a limit on the number of cylinders that may be kept in a particular space as a control measure of what is acceptable as minor storage and is also acceptable as a risk management strategy. AS/NZS 2243.10-2004 rightly states that ' …*the inadvertent release of gas from cylinders kept connected for use in laboratories shall be considered with respect to any potential hazard such as asphyxiation, oxygen-enrichment, or other hazardous effects of the gases'*. – [Clause 4.2.1].

The design adopted fro HMRI is based on minimising the hazard of fire and explosion posed by flammable gases. The standard for determining hazard zoning suggests that a hazardous atmosphere need not be considered if the gas quantity is less than 30 m^3 (@ STP conditions) – the equivalent of about 4 x G size cylinders. Specific ventilation arrangements are to be provided to ensure that gases that are very much lighter than air (such as hydrogen and methane) that have a tendency to layer within a space, will be purged from any space where they might otherwise accumulate so that they cannot reach their lower explosive limit

Gas-monitoring and shut-off interfaces are to be provided subject to the outcome of a risk assessment, a process to be undertaken in consultation with the users. This latter exercise is required under the hazard identification, risk assessment, and risk control measures prescribed in the *Occupational Health and Safety Regulation* 2001, as part of the employer's/occupier's obligations prior to occupation of the building.

Gas monitoring coupled with automatic power shut-off is a control measure for situations where leakage of gas into the laboratory space such that it could reach its lower explosive limit in air cannot be reasonably excluded.

Similarly, room spaces where asphyxiant gases may accumulate in quantities sufficient to pose any credible risk of dangerous oxygen deficiency (AS/NZS 4332-2004 suggests 18% oxygen content as a 'danger' level although this is clearly a margin above the lethal concentration of about 8%), are to have automatic gas shut-off..

The risk assessment in the case of laboratory spaces where there are a small number of cylinders (say 1 or 2 cylinders) of flammable gas mixtures with a low constituent percentage (%) of flammable gas, and where the credible leakage rate is assessed as being low - certainly at a level that precludes the formation of a mixture at or above the lower explosive limit (LEL), will not be provided with gas monitoring.

For situations where pure hydrogen is present, it is my understanding that the current proposal is to provide gas detection unless it can be established that any possible leakage rate is so low and that the ventilation system is such that it is not possible to form a flammable atmosphere.

Other measures that will be provided include fitting gas outlet solenoid valves on the cylinder outlets downstream of the gas regulator for each flammable gas supply line, interlocked to shut-off on 5% LEL as detected by the gas-monitoring equipment, and operational measures such as ensuring that the work instruction includes manually shutting of gas supply at the cylinder outlet valve unless the gas from the cylinder is in-use.

Cryogenic gas storage areas

Rooms or compartments where cryogenic gases are kept represent a risk of asphyxiation in the event of a loss of containment (release of gas).

The fire resistance level of the walls and floor of any gas storage room may be the same as other building elements having a lesser fire rating - say FRL 120/120/120) unless there is a requirement posed by an adjacent dangerous goods storage facility for some higher rating.

Other features of the proposed HMRI installation are that:

- cryogenic vessels and compressed gas cylinders are separated by distance (say 1 m)
- the room will be ventilated in accordance with Section 4 of AS 1894-1997, and
- a gas monitoring and alarm system will be installed to provide protection from the risk of potential asphyxiation.

The bulk liquid nitrogen and bulk carbon dioxide storage tanks

In accordance with the provisions of AS 1894 – 1997 the bulk cryogenic nitrogen (refrigerated liquid) and carbon dioxide above ground storage tanks (each of 7,000 L water capacity), are to be located within a screened lockable enclosure external to the building that it is:

- at least 2 m from the boundary
- at least 1 m from the adjoining building compartment and
- at least 3 m from any other dangerous goods storage depot.

The electrical equipment for power or instrumentation for the bulk storage tanks is subject to location and other minimum specification requirements.

Storage of packaged dangerous goods

Packaged dangerous goods of classes 3 (flammable liquids), 4 (flammable solids), 5 (oxidising agents and organic peroxides), 6.1 (toxic substances), 8 (corrosive substances) & 9 (miscellaneous dangerous goods) are to be kept at HMRI.

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

- the storage of Class 3 flammable liquids in an approved (to AS 1940) package store with no co-stowage allowed of other goods (the arrangement provided on Level 1 East Wing)
- the storage of packaged dangerous goods of Classes 4, 5, 6, 8, & possibly 9, each class being separately stored in approved cabinets (of a type, and placed in accordance with the requirements of each of the respective storage and handling standards for each class of dangerous goods)
- the keeping of minor storage quantities of dangerous goods (as specified in each of the relevant class standards) to the requirements and under the conditions for minor storage as specified in those standards, not necessarily in an approved cabinet.

Storage of flammable liquids

The facilities for storing flammable liquids comply with AS 1940 *The storage and handling of flammable and combustible* liquids. There are two 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

Given that the quantities of flammable liquids to be kept in a laboratory space generally exceed minor storage limit thresholds, recourse is to be made to the use of approved flammable liquid cabinets. AS 1940 permits cabinets up to 850 L per 250 m^2 of floor area on a ground floor and 250 L per any 250 m^2 of floor area.

AS/NZS 2982.1-1997 further limits under-bench cabinets for flammable liquids to a maximum capacity of 30 L. Larger capacity under-bench cabinets may be adopted subject to a risk assessment to validate deviance from the provisions of AS/NZS 2982.1.

Other than possible capacity limitation issues, the placement of cabinets in relation to ignition sources (such as from laboratory apparatus & electrical equipment) does limit location options. Ventilation of cabinets is usually not required (nor is it generally desirable).

It is proposed that the capacity and location of cabinets will fully comply with the requirements of AS 1940-2004. Cabinets of up to 100 L maximum capacity may be placed under-bench subject to 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.

Flammable liquid package store

This store will have a maximum storage capacity of 1,500 L and is to be constructed in accordance with the full specification of Section 4 of AS 1940-2004.

It is proposed that all packages of flammable liquids will be kept in lockable approved flammable liquid cabinets within the store to provide segregation and security of the goods according to user group.

Given that decanting is to be undertaken elsewhere and not within the store, ignition sources (non hazard rated electrical equipment) must be excluded from the interior of the store and from the space external to the store, for a lateral distance of 3 m for a height above floor level of 1 m (this hazard zone is described in more detail later in this report). In order to maintain future flexibility in the materials to be kept, any electrical fittings within the hazardous space associated with the store are to have a Gas Group rating IIB with a temperature rating of T4.

Mechanical ventilation is required to meet the requirements of AS 1940-2004 (this is generally an inlet and exhaust arrangement with an exhaust fan to maintain negative pressure within the room. The ventilation is to be arranged to either run 24/7 or be interlocked with the lights. Where any ventilation ductwork passes through other building spaces it is to be fire-protected (the code requires a 3-hour fire rated protection level however given the practical difficulties in achieving this, an alternative design solution is to provide a fire damper in any ducting penetrations having the same FRL rating as the building element of the store that is being penetrated).

As sprinklers are installed, the spillage bund within the store is to be capable of retaining not only the prescribed 25% of the aggregate maximum storage quantity up to 1,500 L (300 L) plus the contents of the largest package (20 L), but also 20 minutes of the full output of the fire sprinkler heads installed within the room space.

Storage of packaged dangerous goods of classes other than Class 3

The threshold limits for minor storage of goods of Classes 5.1, 5.2, 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
5.2	-	20 (largest pack size of 5)	-	AS 2714-2008
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* describes a limit of 50 L capacity for any chemical storage cabinet used in a laboratory to store chemicals of classes 4.1, 4.2, 4.3, 5.1 or 5.2, and up to 250 L for other chemicals.

None of the above quantity constraints for these classes of dangerous goods will be exceeded.

Mixed Class Dangerous Goods Store

A central store has been provided on Level 1 of the East Wing to keep goods of classes 5, 6.1 and 8 in separate approved storage cabinets, with additional cabinets used for Class 8 corrosives to separate acids and alkalis to ensure proper segregation of any incompatible or dangerously reactive combinations. In accordance with AS/NZS 2243.10-2004 each cabinet is to be separated from any adjoining cabinet by an air gap of 250 mm.

I have appended a brief 'compendium' of precautions that must be taken for any co-stowage arrangements, based on the consolidated minor storage provisions of the standards for classes 5.1, 6.1 and 8 dangerous goods. These co-stowage precautions are for small quantities of goods of the different classes (5.1, 6 & 8) kept in open shelving conditions, and are not therefore directly applicable to the segregation of the goods into separate cabinets. Any risk assessment process could reasonably include these precautions as control measures to arrive at an acceptable risk rating for the proposed store arrangement. Additionally, any installed sprinkler system serves to greatly reduce the risk of any serious incident developing from an incipient stage.

A small quantity of Class 9 (miscellaneous) goods are to be kept. These are generally marine pollutants and can be safely co-stowed with Class 6.1 toxic substances subject to confirmation that there are no incompatibility issues associated with this practice.

Storage of combustible liquids

An emergency generator set is to be provided that is fuelled by petroleum distillate (diesel). Fuel tanks are generally exempt from dangerous goods requirements. The maximum capacity of such tanks is, however limited to 1,000 L (the restriction applies to any tank installed 'indoors').

An underground bulk storage tank with a capacity of 9,000 L is to be provided as backup storage. This tank is to be specified so as to meet all installation requirements for underground petroleum storage systems (UPSS) as per current EPA requirements.

There is no hazard zone associated with a C1 combustible liquid unless it is heated to near its flash point. There is no boundary separation distance specified for the 1,000 L day tank or for the underground tank (although there are some separation constraints between the tank and any foundations – a minimum of 1 m being specified). As a consequence of the lack of any hazard zone, there is no need for fire separation from the tank to the boundary.

Decanting Room

A fire-rated compartment has been provided for decanting packaged goods of Classes 3 (flammable liquids), Class 6.1 (toxic substances) and Class 8 (corrosive substances) from larger to smaller containers. A ventilated decanting bench is to be provided within the room. While the primary intent of the room space is to provide a ventilated facility to reduce personal exposure to the vapours created by the substances being decanted, given that exposure standards are substantially less than the lower explosive limit for

flammable liquids, the ventilation will limit the extent of any hazardous atmosphere outside of the room.

The space within the room has been designated to be a Zone 1 hazardous atmosphere.

Spillage retention capability is to be provided including an allowance for sprinkler system operation

Flammable liquids will not be stored within the room (being drawn from the adjoining flammable liquid storage room as needed and any containers being returned afor storage within that room on completion of any decanting operation.

Class 6.1 and Class 8 dangerous goods (up to a maximum capacity of 250 L of each class) will be kept within approved storage cabinets within the room space.

Storage of Wastes (other than clinical wastes)

Class 3 flammable wastes will be stored within a cabinet in the flammable liquid storage room.

Class 6.1 and Class 8 wastes will be stored in cabinets within the decanting room.

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.

Ensuring safety in the case of flammable gas and vapour mixtures relies heavily on eliminating potential ignition sources from any ‘hazardous spaces.

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.

Where these zones are deemed to exist, ignition sources must be excluded.

There are usually problems in determining the extent of the likely presence of flammable and explosive gas and vapour in air mixtures in the laboratory spaces and in the fume cupboards of buildings such as the HMRI Building.

From experience users often ask what limitations need to be placed, if any, on their proposed operations (i.e tell us what we can and can’t do based on best practice elsewhere). The primary issue for safety assessors, is establishing specific

information from the users (i.e. tell us exactly the full range of activities and substances that you have an intention of working with) and then the likely safety implications from those intended uses can be assessed. This is the process that has been followed for the HMRI facility.

In the absence of any specific controls or limitations, substantial parts of many laboratory spaces would be rated as being Zone 1 unless any safety hazard can be proven not to exist. This is clearly an unacceptable situation to the users because it would mean the elimination of all ignition sources (heated and heating appliances and non explosion protected electrical equipment and instruments). Not unreasonably, while the users appreciate that some control measures and precautions must be employed, they are looking to do the range of activities done in like facilities elsewhere.

Compounding this, there is now a safety-critical flaw in copying so-called best-practice research and educational laboratory situations elsewhere, since they are in all probability based on presumptions about potential risk that are often largely untested.

Among the reasons against the simple adoption of the arrangements used elsewhere (in so-called 'best practice' situations) for the HMRI project are factors such as:

- the substantial recent shift in the methodology for assessing the risk of a flammable or explosive mixture being present in situations where flammable liquids and gases are being stored and handled. This has been prompted by the introduction of new standards based on IEC standards (introduced 2002 and then modified in 2004) to guide the assessment process based on risk management principles, rather than on any *ad hoc* and pragmatic lower cut-off thresholds where it could be assumed that no significant hazard existed
- an acknowledgement (now incorporated into the safety determination process in the mandated assessment standards) that there may be credible threats to the health and safety of persons in certain situations, involving materials in quantities that are at, or below, the 'old' arbitrary threshold standards
- laboratories such as the HMRI facility were not in the past required to consider risks below these thresholds (i.e. any in-use inventory of 2.5 L or less did not require an assessment).
- the requirement to undertake hazard identification and risk management has not been as explicit as it has become since the introduction of amended dangerous goods legislation in NSW (from 1 September 2005).

The two pre-requisites to properly managing (i.e. eliminating or at least minimising) the risk of this occurring is to either:

- avoid the formation of any flammable or explosive mixture, or
- where it is not practicable to eliminate the possibility of a flammable or explosive mixture being present within a particular space, to exclude any ignition source from that space.

There are 3 particular situations where these principles need to be applied for the HMRI facility:

- spaces or compartments where flammable gases and flammable liquids are to be stored
- fume cupboards where it is intended to conduct experiments and other operations using flammable liquids and flammable gases, and
- laboratory bench operations involving flammable liquids or gases.

The proposed design arrangements for the HMRI Building that may generate a hazardous atmosphere include:

- a ventilated storage compartment in which a number of cylinders will be connected to manifolds for reticulation to laboratory spaces that will also be used for storage of reserve gas cylinders
- a ventilated fire-rated storage room for keeping flammable liquids
- a ventilated room for the decanting of flammable liquids (with a possible use for the decanting of other substances)
- possible in-laboratory storage of gas cylinders within working room spaces
- approved flammable liquid cabinets for the storage of flammable liquids.

The hazard zone associated with each of these facilities has been considered. In assessing the extent of any hazardous situation, both normal and credible abnormal situations must be considered.

As an example. in a no-flow situation (through say ventilation system failure), a more extensive hazardous atmosphere is likely to exist than when the installed ventilation system is running. Measures to manage risk must be a combination of the responses and performance of the designed and installed hardware, and the operational arrangements and practices (software) that are devised and maintained.

Some design arrangements specified in the relevant Australian Standards (such as for the flammable liquid store and the decanting room) are robust, and fail-safe (for example, the rating of the light fittings within these spaces means that they are not ignition sources and do not need to be isolated in the event of a ventilation failure or a large loss of package containment).

Other design features of the HMRI Building infrastructure are also control measures based on hardware solutions, notwithstanding that there may be no strict code requirement to do so, including:

- the provision of manual electrical isolation switches to de-energise ignition sources (general power circuits only, lighting and other building services excluded) from spaces where some immediate danger may exist in the event of a release of flammable vapours or gases through accident or malfunction
- the installation of flammable vapour detectors and low-oxygen detectors linked to alarm and building security systems, and
- isolation points for reticulated gases in the event of fire or some other abnormal situation by means of manually and/or automatic isolation interlocks.

<u>Flammable gas storage and in-use installations</u>

Gas Cylinder Store

While the initial requirement for keeping flammable gases in the gas cylinder store as advised by the users would result in the space within the gas cylinder store being non-hazardous, thi would not be the case if more than 4 cylinders of flammable gas were to be kept. It is therefore prudent to design the store for a greater inventory of flammable gases (both lighter and heavier than air flammable gases need to be considered). The situations described below apply for a quantity of up to 10 x G-size cylinders and are based on AS/NZS 2430.3.4-2004 *Classification of hazardous areas – Part 3.4: Examples of area classification – Flammable gases:*

For 'lighter than air flammable gases':

Interior of storage room …….. **Zone 1**

Exterior of storage room measured 2 m laterally from any opening, to a height from ground level to 1.5 m vertically above any opening to the room …….. **Zone 2**

For 'heavier than air flammable gases:

Interior of storage room ……..… .**Zone 2**

Exterior of storage room measured 1.5 m laterally from any opening, to a height from ground level to 1 m vertically above any cylinders …… …… **Zone 2**

The hazardous zone is the margin around the above spaces when they are overlaid.

Equipment to be installed within hazardous spaces described above must have a Gas Group rating of IIC and a temperature rating of T4.

Flammable gas cylinders in laboratory spaces

AS /NZS 2430.3.4-2004 regards any installations where there are less than 4 x G-size gas cylinders containing 'lighter than air flammable gases' that are connected for use in inadequately ventilated areas as being **non-hazardous**, while for heavier than air gases, a **Zone 2** hazard zone is described as being the space 0.5 m above and 2 m laterally from any cylinder valve and extending to floor level.

Where more than 4 x G-size cylinders may be kept in a small ventilated compartment maintained at negative pressure in relation to the laboratory space, the design arrangement is influenced by factors such as:

- the likelihood that less than 4 cylinders will actually be connected for use at any one time.
- Whether cylinders not in-use would be isolated at the cylinder outlet valve as part of good-practice operating procedures.
- the likelihood that any release of gas may migrate from the cylinders within the compartment to the laboratory space outside the cylinder storage compartment.

Gas industry codes for consumer installations generally regard low pressure reticulation and connection points as being non-hazardous.

A hazard zone is not created by non-flammable gases. There is, however a need to consider the location of gas cylinders in relation to flammable liquid cabinets (a separation distance of 5 m is required) and combustible materials.

<u>Flammable liquids</u>

Flammable liquid package store

AS/NZS 2430.3.3-2004 describes the following hazard zones where packages are not opened (the situation applying to the flammable liquid store at Level 1, East Wing):

The interior of the room …… **Zone 2**

Note that AS 1940 describes an ignition source exclusion zone as existing for a lateral distance of 3 m outside the room, this is usually considered to be ***Zone 2*** *for a height of 1 m above finished floor level*

Decanting of flammable liquids within a room or compartment

The extent of the hazard zone depends on the physical characteristics of the materials being decanted.

In the decanting room at HMRI (Level 1 East Wing), a decanting bench is provided within the room space with enhanced ventilation (of say at least twice the quantum of ventilation specified for a flammable, liquid package store in AS 1940-2004). The disposition of the ventilation openings (immediately above decanting bench top height and at low level on the side of the bench where vapours may 'spill') will result in efficient vapour capture – a feature that not only minimises the risk of a spread of vapours, but also will result in low exposure to vapour for the decanting operator. A spillage tray or sump (to be an integral part of the decanting bench) further serves to reduce the potential spread of vapours

The location and ventilation of the decanting bench and the spillage control measures, allow the lateral extent of the hazard zone outside the storage room to be discounted from the 8 m distance specified in AS 1940-1993 to a lesser distance of 5 m measured from the decanting point as specified in AS/NZS 2430.3.3 for decanting.

Flammable liquid cabinets

AS/NZS 2430.3.3-2004 describes the following hazard zones:

> 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'.*

It should also be noted that, in general AS 1940-2004 defers to AS/NZS 2430 in relation to hazard zoning determination, and that 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 the actual zone is less conservative (smaller) than that described above

While the hazard zone described above can generally be tolerated for cabinets from 100+ L to 250 L capacity , there is usually a need to challenge the conservative nature of the large hazard zone determination for smaller cabinets (and particularly for under-bench units).

Modelling based on the principles for the spread of flammable vapours as described in AS/NZS 60079.10-2004, coupled with some agreed (by the users) protocols that incorporate control measures such as limitations on the hazard level of materials to be kept, minimising container size to no greater than 2.5 L, providing capability of quickly de-energising ignition sources and devising procedures for doing so, allows the exclusion zone for fixed ignition sources to be safely reduced.

While the lateral spread of the hazard zone is maintained at the 3 m distance specified in AS/NZS 2430.3.3-2004, the height of the hazard zone for an under-bench cabinet in a ventilated laboratory, will not exceed to the top of the cabinet or at least to bench top height (given only closed containers in the cabinet and the mechanism of release of flammable liquid being a package breaking as it struck the floor).

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 for any fixed ignition sources within the 3 m lateral distance from the cabinet, extends to a height of about 1200 mm.

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), any fixed ignition sources must 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**

Note that this may not exclude the future placement of equipment that may incorporate an ignition source on the bench or in the exclusion zone above the floor. This must however be subject to hazard identification and risk assessment in each instance to verify whether such placement is acceptable. The acceptability of the future placement of such equipment, will be enhanced by having the capability of readily shutting down (de-energising) all ignition sources in an emergency (such as may result from a spill or leak of flammable liquid).

Items such as refrigerators and ice-makers, a dish-washer etc, are to be placed on top of the bench counters. The safety of such placement relies on the location of any power switches to the equipment so a user has some discretionary capability to quickly isolate ignition sources in the event say of a spill.

OTHER DESIGN ISSUES

Ceiling construction

Any laboratory space where there is any credible risk of a significant loss of containment of a lighter than air gas such as hydrogen, should be sheeted rather than tiled so that the ceiling is gas/vapour-tight, to prevent the possibility of escape of gas and migration of a flammable mixture within the ceiling space.

For these spaces, the ceiling plenum should not be used for return air as there is a risk that in a loss of containment incident, flammable gas may contact an ignition source.

Bunding of chemical storage areas

There is a requirement to provide spillage control retention capability in areas where liquid chemicals are kept (other than in small quantities). The strategy of storing goods of dangerous goods classes 3, 5.1, 6 & 9 in approved storage cabinets effectively provides localised spillage control in the cabinet base. Where quantities of dangerous goods to be kept are so small that a storage cabinet is not warranted trays should be provided.

Where the retention quantum is not specified, in order to maintain good housekeeping in chemical storage areas a reasonably foreseeable spillage quantity needs to be retained. It is suggested that unless there is some other credible and obvious loss of containment

event, the most likely worst case scenario would be say the breakage of a carrier basket containing 4 x 2.5 L glass Winchesters, a quantity not exceeding 10 L.

Construction requirements for the Decanting Room

While it is not mandatory to provide added levels of protection for this space, the activities within the Decanting Room are known to be of higher potential fire-risk than those conducted elsewhere within other laboratory areas. Fixed ignition sources are not to be installed within the Decanting Room – all electrical equipment is to be suitably rated for installation within a hazardous zone (the space being regarded as having a hazardous area rating of Zone 1).

In recognition of this higher potential fire-risk the room is to be designed to the standards specified for a flammable liquids storage and handling area with walls and doors with an FRL of 240/240/240, and the ceiling with an FRL of 180/180/180.

Ventilation is to be provided that ensures that the room space will be maintained below any hazardous concentration of vapour (flow-rates being generally determined on the basis of ensuring that the atmosphere within the room space will always be maintained so that it is below 25% of the exposure standard). This will ensure that sufficient ventilation exists to maintain any flammable vapour in air concentration below 10% of the lower explosive limit for the worst case flammable solvent being decanted.

Fire protection equipment

In addition to the equipment provided to comply with the BCA requirements, fire extinguishers are to be provided to meet the requirements of the relevant individual dangerous goods storage and handling standards for each dangerous goods class. In recognition of the risks associated with decanting, a foam and a dry powder extinguisher is to be provided.

Emergency eyewash and shower equipment

All laboratory spaces are provided with emergency eyewash and shower facilities, positioned in accessible locations that require no more than 10 seconds of elapsed travel time to reach. The shower is located on the same level as the hazard and the path of travel is to be free of obstructions that may inhibit the immediate use of the equipment. Where possible extremes in the temperature of the water supply to the emergency facilities may be experienced, measures are to be taken to ensure the adequate functioning of the unit, as well as providing an acceptable temperature of water to the users.

Interlocking and alarms for the Building Air Conditioning System

In consideration that occupant safety outside usual working hours when all installed systems may not normally be programmed to be in operation and where few people (or even a person working alone) are present within the Building, could be an issue, air handling systems must operate to provide some minimum assured ventilation flow to the occupied workspaces.

An appropriate design solution is to interlock the air handling system to the lighting in each air handling zone. Any failure of the air handling system with the unit controls in the in-service condition, is to be fitted with a visual and audible alarm as a means of alerting

people present within the building space that they may not be fully protected from the hazards of oxygen deficiency or harmful exposure to airborne contaminants.

Confined spaces

The only confined spaces identified in the design are lift shat pits (these are generally regarded as being restricted entry, controlled spaces) and the effluent pits.

Statutory dangerous goods signage

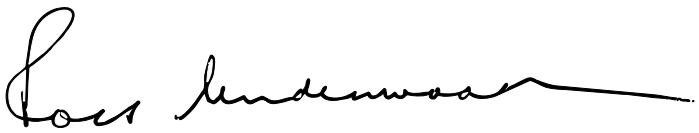
The inventory of dangerous goods for the HMRI facility exceeds the manifest level as described in Part 6A of the *Occupational Health and Safety Regulation 2001.* Statutory signage (site, building and dangerous goods depot placarding) must be provided. Other obligations ensue fro keeping manifest quantities of dangerous goods (including keeping a manifest, providing emergency information and submitting a notification advice to WorkCover in respect of the goods to be kept).

GENERAL CONCLUSION

Based on the analysis of the design as described in this report, the proposed facilities for the storage, handling and use of dangerous goods and hazardous substances as described in this report, will be in compliance with all relevant legislative requirements, having been designed in accordance with best practice principles for the management of risk to health and safety posed by the materials to be kept and used, and will secure a level of safety performance described in the relevant standards and codes of practice applying to facilities.

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

Yours faithfully
Safety Engineering & Technical Services Pty Ltd



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

ATTACHMENT A Minor Storage Conditions - oxidising , toxic, and corrosive substances

The following requirements are to be generally observed:

a) dangerous goods must not be stored close to heating or an ignition source, e.g. a stove, heating appliance, light switches, welders, or similar ignition sources.

b) packages containing dangerous goods must:
- be kept closed when not in use
- only be opened or decanted in a well-ventilated area and away from any potential ignition source
- be suitable for the purpose

c) the method of transferring liquids to the point of use must be chosen so that the possibility of spillage or fire is minimised - transferring or moving open containers of dangerous goods should be avoided.

d) packages containing dangerous goods must not be pressurised to transfer the contents unless the package is specifically designed to take the pressure.

e) dangerous goods must not be stored or used where they may jeopardise escape from a building in the event of fire.

f) persons who handle dangerous goods must be properly instructed in the hazards involved and in the use of emergency equipment.

g) no combustible waste material or residues are to be left in and near areas where dangerous goods are stored or decanted.

h) materials that might interact dangerously with each other must be kept apart so that the risk of interaction is minimised, e.g. flammable liquids must not be stored with oxidising agents, hypochlorite must be kept away from acids;

i) a supply of water shall be available at a nearby location to any chemical storage facility;

j) adequate ventilation shall be provided for package storage and handling areas;

k) packages shall be kept on surfaces which, in the event of spillage, are resistant to damage by the contents of the packages;

l) appropriate spillage-retention measures shall be provided at locations where packages are likely to be opened or their contents transferred;

m) any spills or leaks shall be cleaned up immediately, and disposed of responsibly, spilled and leaked material shall not be returned to its original packaging;

n) the contents of a package shall not be transferred to any other container for storage unless the latter is suitable for the storage of the dangerous goods concerned, and is clearly and exclusively marked to indicate the identity and hazard potential of that substance;

o) appropriate personal protective equipment shall be worn by any person involved in product transfer operations e.g. decanting or filling

p) storage areas shall be secured against unauthorised entry.

q) except in residential premises where dangerous goods are not kept for resale, the occupier shall provide an adequate first aid kit and appropriate personal protection equipment (reference should be made to the material safety data sheet (MSDS) for the substance being kept);

r) the occupier shall ensure that containers of dangerous goods are securely stacked or are suitably restrained from falling

ATTACHMENT B – 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 40 years 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 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 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 Special Operations Working Accommodation Upgrade Project; the

171 Aviation Squadron (Blackhawk helicopter) Relocation Project, HMAS Creswell Redevelopment at Jervis Bay, and the ASC Shipyard Redevelopment– 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.