AS 4343—2005

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Australian Standard™

Pressure equipment—Hazard levels

STANDARDS Australia

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Australian Standard™

Pressure equipment—Hazard levels

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PREFACE

This Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee ME-001, Pressure Equipment to supersede AS 4343—1999.

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

The objective of this revision is to include improvements suggested by users of this Standard.

The changes made to Table 2 are corrections only and do not indicate changes originating from changes in the source documents.

Significant changes are as follows:

(a) Section 2, Procedure added to guide use of Table 1.

(b) Table 1, Part 2, Vacuum vessels has been modified to enable selection of an appropriate hazard level similar to the criteria for pressure vessels.

(c) Table 1, Note 4 (a) (iv) has been modified to allow for inherent portability of vessels having volumes not greater than 200 L.

(d) Table 1, Note 4 (a) (v) has been added with regard to human-occupancy pressure vessels.

(e) Table 1, Note 5 has been modified to cater for high pressure and volume.

(f) Appendix B has been changed from a normative to an informative Appendix.

(g) A foreword has been added to give background to assist in the interpretation and use of the Standard and in risk assessment.

As in the previous edition, it is intended that this Standard replace the hazard level section of AS 3920.1, *Assurance of product quality*, Part 1: *Pressure equipment manufacture* which is under revision, to cover the conformity assessment provisions.

In determining and allocating the hazard level values, input has been received from regulatory authorities and users, and the practices adopted in industrialized countries and those in the European Union Pressure Equipment Directive have been taken into account.

The impact of this revision is expected to be negligible, except to resolve a number of issues raised in the use of the Standard, and to facilitate its use.

Adoption of this revision is intended to be by agreement of various parties concerned. It is not intended to be retroactive.

For regulatory purposes, its use must be in accordance with the requirements of the applicable Regulatory Authority, e.g. in some States and Territories the unrevised Standard may apply until regulations are amended.

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

Statements expressed in mandatory terms in Notes to Tables are deemed to be requirements of this Standard.

CONTENTS

Page

FOREWORD

GENERAL

With the increasing importance of this Standard, which is referenced in most laws relating to pressure equipment in Australia and is used in New Zealand, Committee ME-001 requested inclusion of this background information to—

(a) assist in the understanding, interpretation and use of the Standard;

(b) record in more detail its important requirements and so supplement Clause 2;

(c) discuss its origin, development from AS 3920.1 and its relationship to other Standards;

(d) provide a comparison with EU-PED (Ref. 1) to avoid confusion in trade; and

(e) advise on the standard's use for purposes other than originally intended.

WHY WAS THIS STANDARD NEEDED?

In 1978, the late Alex Wilson AM, Chief Metallurgist, Electricity Commission of NSW, asked a new Chief Inspector of Boilers to clarify the law that required Government design approval, manufacturing inspection, registration and in-service inspection by government or licensed Inspectors, for a 30 L × 1 MPa air receiver, but did not require this for 660 MW, 16 MPa high-temperature steam turbine, which was potentially far more hazardous.

The 1962 'Boiler and Pressure Vessel Regulations' in NSW covered all equipment above or below atmospheric pressure, except vessels forming part of domestic cold water supply or those containing liquid below 100°C when pressure was due solely to height of liquid. By various exemptions, this was not applied to most small or very low-pressure equipment for practical reasons and because hazards were extremely low.

Obviously, a more logical and reasonable basis was needed.

By 1978, most regulations in Australia were still mainly based on boilers and air receivers associated with mines. Major developments after World War II had greatly increased pressure equipment types and numbers used in industry and by the public, e.g. mains pressure hot water heaters, gas cylinders, automotive LP Gas pressure vessels and many other types of consumer equipment. These serially produced vessels, which are now addressed by AS 2971—2002, *Serially produced pressure vessels*, (first issued in 1987), are used by millions in Australia and very few serious accidents have occurred, those that have occurred being mainly due to misuse or inadequate protection.

The existing regulations were similar across Australia but varied in important details and needed to be improved and unified to cover the burgeoning consumer market in pressure equipment.

Also in the 1970s, the world recognized the value of Quality Assurance (QA) systems to enhance quality management and hence safety. This was introduced into ASME Section VIII in 1973 but was not recognized in Australian pressure equipment regulations or Standards, although in effect was partly used by inspectors.

The main problem then was how to improve the total system of pressure equipment Standards and achieve the following:

(a) Relate hazards (pressure, volume, content fluid type, temperature) to regulatory controls in design verification, fabrication, inspection, and design and equipment registration. In-service inspection was not considered at the time.

(b) Accommodate the new move by advanced industries to quality assurance.

(c) Continue to meet governments' desire to ensure that risk levels of occupational (and public) safety and health are low.

(d) Make the system consistent across Australia.

After 1995, these functions were largely deregulated and made self-regulatory by industry itself as part of a major shift of philosophy on the role of government. This aimed to provide more flexibility, reduce cost to industry and the public, and use legal prosecution to maintain a very low risk record.

BACKGROUND TO THE STANDARD

General

As the pressure (p) and volume (V) of pressure equipment increase, the pressure energy also increases; and as this energy increases, probability and potential consequences of any serious failure also increase. This was clear from the major disasters, that had occurred with pressure equipment since the 1800s. One boiler explosion killed 1800 persons, while in the 1980s about 500 were killed in Mexico City in a gas vessel explosion and nearly 4000 in a toxic gas vessel explosion in Bhopal. These and other pressure equipment failures also resulted in billion dollar losses around the world.

Such accidents were far more complex than anticipated from just pressure and volume considerations; and so this made it difficult to simply quantify hazards and, particularly, to introduce into regulations a radically new concept of varying controls according to hazard or risk.

However, in 1980, a German engineer advised that German Pressure Equipment Law had just made significant step forward. A copy of the legislation in German legal terminology was made available but was not translated. It contained the term with '$p \times V$' and importantly, it also gave clear evidence that a regulatory authority had tackled the problem of hazard quantification.

This was a key to resolving Alex Wilson's request and the application of quality assurance (QA).

During the early 80s, the above ideas were developed for a solution relating the level of design verification, fabrication inspection and QA to different hazard levels. This involved:

(a) Review of many major failures and their consequences around the world, which showed that contents and the location or exposure of the equipment must be taken into account as well as pressure and volume.

(b) Review of world practices, which showed that ASME had based their exclusions on p and V.

(c) Finding more rational lower hazard limits when special regulatory requirements should apply;

(d) Use of QA on a trial basis to maintain safety and reduce costs to Government and industry by—

    (i) authorizing fabricators to transfer plate identification marks themselves using QA; and

    (ii) full QA with intermittent Government audit and inspection for a large fabricator in a remote area where economic inspection was difficult.

(e) Preliminary use of the above ideas to improve and unify requirements in AS 1210, *Pressure vessels*.

ME-001 support

The above ideas and work were supported by Committee ME-001 in 1984, provided that QA was not mandatory. Also it was agreed that new work include:

(a) A Standard on small, low hazard serially produced pressure vessels. This resulted in AS 2971–1987, probably the first ME-001 true performance standard. This partly involved the control and hazard concept with the introduction of '$p \times V$' criteria.

(b) A Standard to cover in-service inspection of pressure equipment—i.e AS 3788—1990, which also adopted in part the '$p \times V$' criteria for different types of vessels.

(c) Revision of AS 1210, which resulted in the 1989 edition but did not directly cater for QA or $p \times V$—because of the work in progress on AS 3920.1.

The first draft of AS 3920.1 in 1987 was aimed specifically at pressure vessels and was to be added to AS 1210. Its basis at the time, which did not refer to 'risk', was, briefly as follows:

(a) Probability of deaths with all pressure vessels should be at a very low level, e.g. 'less than one death per year from the 100 000 vessels' (e.g. as in Australia, probability of about 10^{-6} per vessel per annum).

(b) Regulatory controls for QA, inspection etc to be increased to reduce probability of failure (P_F) when the hazards (or consequence of failure) (C_F) increased, in order to achieve a very low probability of fatality or serious consequence with any vessel.

(c) AS 1210 technical requirements primarily aimed to achieve a consistent very low probability of failure for all vessels, i.e. like most PE Standards throughout the world.

Committee ME-001 accepted the concept and agreed it should also cater for other pressure equipment i.e. boilers and pressure piping. Gas cylinders were outside the scope of the committee but nevertheless successful gas cylinder practice would be taken into account as a guide. QA was not mandatory.

AS 3920.1—1993

Initial drafts of AS 3920.1, made in 1988 and 1989, were reviewed by ME-001 who formed Sub-Committee ME-001-21. This Committee first met in 1991 to develop AS 3920.1 to provide methods to assure the quality of pressure equipment for different hazard levels. This was submitted for public comment in November 1991.

The title of AS 3920.1, issued in 1993, was '*Assurance of product quality*—Part 1: *Pressure equipment manufacture*'. It was probably the first National Standard in the world to address this particular problem. It provided the flexibility needed by industry by having 12 different control methods that could be used with 5 different hazard levels.

EU Development

In the latter stage of development of AS 3920.1, ME-001-21 learnt of similar proposals being developed for a European Union-Pressure Equipment Directive for Conformity Assessment requirements, a new term that embraced inspection and QA controls. Later, in 1997, the EU finally adopted their approach with $p \times V$ and contents into two groups only (not four as in AS 3920.1, which included 'lethal' and 'non-harmful contents'). They also had not covered location, which ME-001 felt was important and this was subsequently proven by a billion dollar failure in 1998 in USA. There, one vessel ruptured in a large plant and destroyed four more vessels, seriously injuring about 30 people in the blast and from the contents, and damaging a town nearby.

The EU later identified their groups I, II, III, IV as Hazard Categories – similar to but not the same as AS 3920.1, Hazard Levels D, C, B, A, respectively.

The EU draft was partly used to fine-tune the draft for AS 3920.1 prior to ballot.

FUNDAMENTAL BASIS OF AS 3920.1

Hazards

Almost all pressure equipment is hazardous, i.e has the potential to harm, or cause injury or illness, or damage to plant, property, the environment and business.

Controls

Failure to control pressure equipment hazards is almost always due to human inadequacy and has resulted globally in many minor to catastrophic incidents. These clearly show the need for suitable controls. These controls primarily aim to mitigate the probability of failure, but sometimes also to minimize the consequences by various means of emergency response and safeguarding.

Concept

When issued, AS 3920.1 (the forerunner of AS 4343) embraced the above ideas and the concept that:

> '*as the hazard (or consequence of failure) with pressure equipment increases, controls (OHS, regulations, inspection, QA etc) should increase to provide a very low risk*'.

This Standard only applied to new construction.

Pressure equipment and risk

Standards for pressure equipment such as AS 1210 have technical requirements aimed to give a very low probability of failure (P_F) for all classes of vessels; and they are not related to different consequences of failure, except for equipment with lethal contents. Hence risk (R) is controlled to a very low value. This value of R is primarily determined and accepted by society, governments and industry, based on national and global safety performance.

Numbers of PE (N)

The number of vessels of a given design in service (N) influences the national risk. It has only a slight effect on the factors determining hazard levels; but it was significant in determining the hazard level limits, which influence the conformity assessment controls needed. This recognized that society wants low risk for individual items of pressure equipment, and also for the total numbers particularly those used by the public. Typical world failure rates are 10^{-5}/PE/year for complex industrial pressure equipment. However, with 10^7 gas cylinders and more smaller equipment, this would mean 100 to 1000 serious failures per year in Australia which is unacceptable.

DEVELOPMENT OF AS 4343

Amendment 1 to AS 3920.1 (1995)

After 18 months initial use, industry identified that an excessive range of equipment with HL-C would require registration and significant national expense.

Thus the upper limit of HL-C was tripled, and HL-B and HL-C for lethal fluids, were increased by multiples of 30 and 10 to make the system consistent.

Hazard levels for boilers, previously based on rated MW, used the same $p \times V$ basis as pressure vessels to avoid anomalies with fired vessels. It includes the ×3 factor for fired equipment to simplify use.

Piping hazard levels were adjusted similarly to vessels, and other editorial improvements made.

Amendment 2 to AS 3920.1 (1999)

This major amendment resulted from changed philosophy of Australian governments to provide flexibility to industry and adopt a performance-based approach rather than prescriptive details such as technical details and when and how QA etc. should be applied. This generally followed the approach in the National Standard for Plant–1994, which adopted the increasingly recognized 'risk management' concept.

NOTE: Risk management was also taken up in ME-001 Standards with provisions in AS/NZS 3788 (1996), *Pressure equipment—In service inspection* and AS 1210 (1997).

Thus the Hazard Levels were transferred to the new AS 4343, and revision of AS 3920.1 was commenced to provide for 'Conformity Assessment', a new term introduced by ISO/IEC in 1994 and which was being adopted worldwide, for pressure equipment to include design verification, fabrication inspection, quality management (rather than quality assurance), and other checks.

AS 4343

AS 4343 was issued in 1999 and comprised of the Hazard Level section of AS 3920.1 with some improvements, such as the following:

(a) Modified hazard levels for vacuum vessels.

(b) Addition of an extensive Table 2, based on an earlier document trialled in industry for 2 years, which classified most fluids to simplify the use of the Standard.

(c) An equation to facilitate use by computer.

(d) General improvements to enable the Standard to be directly referenced by authorities Australia-wide without conflicting with new government philosophy.

AS 4343—2005

This new edition makes further improvements in the light of extensive use. These and their basis are identified in the Standard's Preface and this Foreword.

SOME GENERAL FEATURES OF THE STANDARD

Separate standard

Issuing a separate standard on hazard levels facilitates its use for a variety of purposes, within PE Standards and regulations across Australia. This is consistent with ME-001's philosophy and should also simplify the revision of AS 3920.1 and use of AS/NZS 3788 and other Standards.

AS 4343 does not make any drastic changes that would have altered practices or increased costs and continues to provide a practical generic method for determining the level of hazards.

AS 4343 has been developed with the full co-operation of industry and regulators and input from a wide range of industry to ensure compatibility. As a result, it is comparable with international practice and assists authorities and industry to unify practice.

Simplicity

Because the whole subject could be very complex with wide application, AS 4343 was intended to be simple, clear and practical. It therefore is not claimed to be exact.

Logarithmic base and $10^{0.5}$

As $p \times V$ values range from less than 0.01 to over 10^8 MPa L, all basic thinking was in orders of magnitude. Half orders ($10^{0.5}$) were rounded from 3.1623 to 3. This resulted in inconsistency between tabular and calculated values and has been modified in this edition, by specifying the use of Table 1.

BASIS OF TECHNICAL REQUIREMENTS OF AS 4343

Experience

This new edition is based on scientific principles applied practically and tempered by wide Australian, New Zealand and global experience.

Various elements of the Standard are amplified below in the order of Table 1 and Equation B1.

Pressure equipment types

AS 4343 applies only to pressure equipment, i.e. boilers, pressure vessels (including vacuum vessels, hot water heaters etc.), pressure piping and pressure safety devices.

Hazard levels (and value)

Hazard levels represent a range of 'effective or equivalent energy (in 100 J)' available in the first few seconds after rupture and immediate release of contents. It also assumes people are in average working conditions, e.g. some metres distant, protected by appropriate clothing and there is normal safe-guarding and emergency provision.

Number and limits of hazard levels

The number and limits of hazard levels were determined by review of current Australian and overseas laws and practice (Standards) requiring different levels of control i.e conformity assessment, registration etc. AS 3920.1 shows this relationship and Clause 2.1 of AS 4343 shows the large range of pressure equipment which required 5 levels.

The limits for HL reflect the level of controls needed as follows:

(A) High hazard—highest level of control for a few critical PE.

(B) Average hazard—normal or average level of control for most PE.

(C) Low hazard—a lower level of controls as apply to smaller equipment, gas cylinders etc.

(D) Extra low hazard—the lowest level of control for low hazard small low pressure PE requiring registration of design, but not of the equipment itself.

(E) Negligible hazard—no specific regulatory controls as applies to great majority of equipment (e.g name of maker required, and general safety and trade laws apply).

In the 1995 amendment to AS 3920.1, Hazard Level C limits were fine tuned as a result of initial experience, and to ensure C and D levels were compatible with Australian laws.

It should be noted that even with extra low or negligible hazard PE, serious injury or serious damage can result, like with any equipment, if reasonable care normally adopted by society is not taken at various stages.

Pressure (*p*)

Design pressure, not working pressure, has been selected as the only readily identifiable pressure value particularly at the construction stage.

Minimum pressure is based on wide Australian practice where pressures below 35 kPa are exempt from special requirements. This value was initially proposed but when the draft European Standards came to light, this was changed at the last minute to align as far as practicable with those 18 countries. Hence, the 50 kPa lower limit was adopted, except for very large vessels.

Vacuum vessels raised a problem as some thin-walled vessels had collapsed in a manner to seriously harm persons in the immediate vicinity, particularly those working at heights. The initial AS 3920.1 adopted height as a criteria but this raised other problems. This is now simplified to allow for contents and be consistent with the using a factor 1/3 to cover height and diameter appropriately.

Volume (*V*)

As explained in the text, this is the net volume of fluid contents, i.e. gas, liquid or both. It excludes solids e.g. fittings and refractory.

Compressibility and Mass (Factor F_C)

Gas under pressure contains far greater pressure energy than water with the same pressure and volume. This is why hydro-tests are preferred to pneumatic testing as a method of risk control during fabrication. See AS 1210 and AS/NZS 3788.

Hence, the two main forms of fluid were separated and a factor of 10 was generally used for gas. This also recognized that in a failure, liquids usually contained much more mass, thermal and chemical energy and toxicity than gas. This is a simplification adequate for this classification.

Fluid contents (F_f)

Materials were identified and included in Table 2, which follows a trial listing carried out by Tubemakers Australia in 1989, which was then distributed to industry where they were found to be very useful. This Standard is based on the fluid groups in the Australian Code for Transport of Dangerous Goods, which in turn adopted the United Nations classification.

The text's notes to Table 1, Section 3, Table 2 and Appendix B cover the basis, classification and use of various contents, i.e. fluids are in four types.

Lethal fluids were primarily identified because special controls are needed to ensure safety e.g. 100% RT or UT for vessel fabrication, and care in operation.

Non-harmful contents were intended to cover water, air and non-toxic non-flammable, non-combustible fluids where hazards are reduced. However, it should be noted these fluids can cause serious injury under special conditions e.g. when released at high pressure very close to persons (e.g. less than 1 m) or they exclude adequate oxygen for breathing, e.g. drowning or asphyxiation in high nitrogen confined space.

The other two types of contents are similar to EU-PED (Ref 1).

Fluid temperature raised difficulties, particularly with 'steam' and 'hot water', which have not been classified by UN, ADG or NOHSC but are known to kill in rare cases. It is assumed that persons are appropriately clothed and operate reasonably when near such fluids. Hence steam and water above 90°C is classified as 'harmful' while air and non-toxic non-flammable gases at any temperature are classified as non-harmful.

Service and site (Factor F_S)

The following factors apply:

(a) *Importance* Service and site conditions greatly influence the harm and consequence of any failure. This was recognized in the USA (Ref 2) where significant relaxations were permitted by law for remote sites, but not in EU-PED (Ref 1).

    Hence the factor F_S was introduced – again as simple as practicable to cover these conditions.

(b) *Fired equipment* The factor of 3 is introduced to cover extra hazards associated with fire and similar high temperature heating sources. These can include highly focused solar energy but excludes heating by steam or hot water or air. Waste hot gases and electric heating are classified as fired.

The extra hazards are due mainly to furnace explosions, which have resulted in serious injuries and further damage to PE or plant. Such equipment also has greater probability of failure due to thermal fatigue, creep and overheating due to loss of control. Often equipment such as boilers are located close to operating personnel.

The values for boilers are now the same as for pressure vessels, but with the factor of 3 for fired equipment introduced to simplify use, i.e. incorporates the factor in Note 4 (a)(i) of Table 1.

(c) *Quick-actuating closures* The factor of 3 allows for the projection effect of the door and vessel in a sudden failure (release and separation) of the door. It is partly influenced by the relatively high frequency of these failures and injury to nearby persons.

(d) *Knock-on or domino effect* At sites where large amounts of pressure equipment are relatively closely located, the failure of a single piece of equipment may cause failure of adjacent equipment. A factor of 3 is used to allow for the increased hazard. Such sites usually involve more than five co-located pieces of equipment and also the Major Hazard Facilities as defined in the NOHSC and relevant state legislation.

(e) *Transportable vessels* The factor of 3 applicable here covers the extra hazards when such vessels get out of control or are impacted by other vehicles. These hazards result from the greater exposure to people, usually the public where involuntary risk must be kept at a very low level.

(f) *Very high pressure* Escaping fluid at such pressure poses extra hazards due to penetration effect on nearby persons and the projectile effect of dislodged plugs, fittings or parts.

(g) *Remote locations* The factor of 1/3 is introduced to allow for reduced hazard in remote sites similar to that done in Ref 2. and due to the greatly reduced exposure to people or sensitive property or environment. As a guide in determining 'remote', persons should not be near enough to be hurt in any way if the PE failed violently, for more than 1% of the time while the equipment is pressurized, e.g. approximately 7 hours per month for safety-trained maintainers to service equipment.

AS/NZS 3788 gives information on protection distance for air (as in pneumatic tests) but this should be increased for flammable and toxic fluids.

(h) *Buried and similar equipment* Bunkers, blast protection or properly installed underground or bunded vessels and piping could be considered as remote, and a factor of 1/3 applies.

(i) *Very low stress PE* Hazards with this equipment are usually reduced and warrant the factor of 1/3 because slight leakage usually occurs well before violent rupture. Low stress, compared with that normally allowed, also greatly reduces the likelihood of failure and thus risk. Such factor should not normally apply if there is a real feasibility of gross over-pressure due to lack of control on pressure.

(j) *Large low pressure vessels (tanks other than atmospheric)* These pose much greater hazards due to the loss of containment of contents than due to pressure. Often they are designed for less than 50 kPa. Hence to reduce the influence of pressure, the factor of 1/3 has been introduced.

(k) *Human occupancy* Hyperbaric chambers and other equipment containing people are increasing in numbers. Almost certainly if there is a sudden loss of pressure or over-pressure, hazards are higher. Hence the factor of 3 has been added.

This approach is recommended also for situations where more than 10 or 20 persons are severely exposed for lengthy periods.

Piping

Pressure piping is hazardous and, for simplicity, diameter is used in place of volume. The hazard level is made the same as for a pressure vessel with volume equal to that of a pipe length of 10 diameters.

Initial comment suggested the total volume of the piping should be used because this could influence the maximum damage that might occur. This can be the case but diameter was retained because:

(a) Most serious damage to people and consequence of a failure, usually occurred in the first two or three seconds of rupture and the resulting blast wave and immediate distribution of the contents.

(b) Piping in refineries, industrial plant and similar installations vary extensively in length and diameter between valves, and use of volume would complicate calculations.

(c) It would not be simple to allow for automatic shut-off devices to limit discharge or for various safe-guarding and emergency response provisions.

A recent gas explosion in Belgium, from a leaking major pipeline, indicates that blast and fire consequence some 30 minutes after a leak failure is a major factor depending on actions after the initial failure.

Components and fittings (subject to pressure)

These can be critical and to control hazards they are required to have at least the same hazard level as the pressure equipment to which they are attached.

APPLICATION

It is recommended that the hazard levels be used as follows:

(a) In accordance with the applicable regulations and Standards, e.g. AS 3920.1 AS/NZS 3788, AS 1210 etc.

(b) With care and for generic assessment of the consequences of failure for design, conformity assessment, and prioritising of in-service inspection and maintenance. For pressure equipment with highly hazardous contents in special circumstances, a more rigorous assessment of hazards and consequences of failure may be desirable.

(c) For general simplified risk management or risk-based asset management or inspection.

(d) Where the service conditions (pressure, temperature, contents and site etc.) are changed. Then the owner/user and in-service inspection body together should reclassify the Hazard Level appropriately and as required by the regulatory authority. If the hazard level is increased then the requirements for re-rating in AS/NZS 3788 should apply.

EXPECTED IMPACT OF NEW EDITION OF AS 4343

As suggested in the Preface, this edition should have a positive cost/benefit impact by improving safety and efficiency.

It is expected that there should be little or no change needed for existing equipment, but any changes desired should be in accordance with the edition referenced in the appropriate regulation.

CONCLUSION

AS 4343 provides a rational yet simple system for determining hazard levels, which are the basis for various controls used to ensure the probability of failure is sufficient to achieve a nationally acceptable very low level of risk for all pressure equipment.

The Standard effectively bridges the important and sensitive interface between law and Standards, and so is being adopted for regulatory controls in Australia.

It provides essential support to AS 3920.1. The two Standards have resulted in reduced costs, unified basis for controls whilst simultaneously improving safety.

The development over 25 years of this Standard illustrates:

(a) The great value, in making progress, of building on good ideas, continued improvement (particularly when shortcomings are identified), co-operation, trust, integrity and focus on optimum and practical solutions in the national interest.

(b) The importance of an environment or culture that encourages these ideas [AWRA as part of this technical infrastructure provided 3 key initiators of AS 3920.1].

(c) The success of a dedicated Standards Australia committee of industry users, makers, regulators and others working together to reach a transparent, equitable consensus, firstly in 1927 with title 'Unification of boiler regulations' and currently as ME-001, Pressure Equipment.

REFERENCES (SEE ALSO APPENDIX A)

[1] European Union. 'Pressure Equipment Directive' 97/23/EC – 29 May 1997.

[2] OSHA. Regulation 'Process Plant Safety Management' CFR 1901. February 1992. USA.

STANDARDS AUSTRALIA

Australian Standard
Pressure equipment—Hazard levels

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies criteria for determining the hazard levels of various types of pressure equipment to AS/NZS 1200, but not including gas cylinders. It also classifies fluids for use with pressure equipment.

1.2 OBJECTIVE

This Standard is intended to provide a uniform, practical, generic system for assessing the level of hazard associated with various pressure equipment, i.e. the potential to harm people, or damage property and the environment as a consequence of pressure equipment loss of containment by rupture, serious leakage or collapse.

These hazard levels may be used for a number of purposes including—

(a) selecting the appropriate levels of control for safety purposes and risk management;

(b) providing a basis for registration or notification of boilers and pressure vessels and their design with authorities; and

(c) providing a basis for in-service inspection of pressure equipment.

1.3 APPLICATION

This Standard is intended to be used in the design, manufacture, inspection, conformity assessment, use and ultimate disposal of pressure equipment.

The hazard levels determined by this Standard are minimum values and may need in certain cases to be increased.

NOTE: The National Standard for Plant, NOHSC:1010 (1994), and subsequent State and Territory regulations usually reference this Standard (or AS 3920.1) and require design registration or notification for boilers and pressure vessels of hazard levels A, B, C and D and registration of such equipment with hazard levels A, B or C.

1.4 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix A.

1.5 DEFINITIONS

For the purposes of this Standard, the definitions given in AS 4942 and the following apply.

1.5.1 Hazard level

The level to which pressure equipment has the potential to cause injury or illness to persons or damage to property or environment.

1.5.2 Pressure equipment

Boilers, pressure vessels and pressure piping.

SECTION 2 HAZARD LEVELS OF PRESSURE EQUIPMENT

2.1 HAZARD LEVELS

2.1.1 Method of calculation

The hazard levels A, B, C, D and E of various types of pressure equipment types shall be determined from Table 1 and the associated notes using the following procedure or equivalent:

(a) Identify the type of pressure equipment (boiler, vessel, piping, etc.) according to the 'Equipment' column of Table 1. See Note 9 to Table 1.

(b) Identify the values of:

  (i) p the design pressure in megapascals. If p is below the minimum value in Table 1, the Hazard Level is E except for Notes 4 (a)(v), 10 and 11 to Table 1.

  (ii) V (for all equipment except piping) the volume, in litres. See Note 3 to Table 1 If V is below the minimum value in Table 1 the Hazard Level is E.

  (iii) D (for piping only) the nominal pipe diameter, in millimetres. If D is below the minimum value in Table 1 the Hazard Level is E except for Note 12.

(c) Determine the initial value of the product:

  (i) pV in megapascal litres, for all equipment except piping; or

  (ii) pD in megapascal millimetres, for piping

(d) Determine the final value of pV or pD by multiplying the initial pV or pD value by the appropriate factor(s) in Note 4 to Table 1 where required.

(e) Identify the contents of the equipment, and whether they will be gas or liquid. See Notes 1 and 2 to Table 1, and Clause 3.2.

(f) Determine the fluid type of the contents using Section 3 and Table 2.

(g) Determine the hazard level (A, B, C, D or E) using the combination of identified equipment type, fluid type and final value of pV (or pD for piping), in the appropriate area of Table 1.

(h) Revise the Hazard Level to comply with Notes 5, 6, 7, 8, 11, 12 and 13 to Table 1.

2.1.2 Typical hazard levels

Typical examples of hazard levels A, B, C, D and E are as follows:

(a) *Hazard Level A (high hazard)*—applies to large vessels, e.g. 4000 tonne ethane vessels, 7000 tonne butane or propane vessels, 12 000 tonne ammonia vessels and 200 tonne chlorine vessels.

(b) *Hazard Level B (medium hazard)*—applies to most shop fabricated boilers and pressure vessels.

(c) *Hazard Levels C and D (low and extra low hazards, respectively)*—apply to small pressure equipment or equipment with low hazard contents.

(d) *Hazard Level E (negligible hazard)*—covers all negligible-hazard pressure equipment not classified in hazard levels A, B, C and D. It also includes unclassified pressure equipment, i.e. equipment below the pressure, volume and diameter limits given in Table 1. This equipment is usually exempt from special regulatory control but is covered by general plant safety regulations.

2.2 BASIS OF HAZARD LEVELS

2.2.1 Main principle

The need for independent controls, involving conformity assessment (quality systems, design verification, fabrication inspection), in-service inspection, or other controls used for the design, manufacture, and use of pressure equipment should increase with increased hazard to persons, property and the environment. This is aimed at reducing the probability of failure and hence at providing a low level of risk.

Pressure equipment Standards for design, manufacture and use have been developed to provide a low probability of failure.

2.2.2 Hazard level

The potential for harm arising from deficiencies in the design, manufacture and use of pressure equipment is primarily related to the consequences of equipment failure. These consequences depend on the level of hazard which increases with the following:

(a) Increased pressure (p) or volume (V) of contained fluid, or both.

(b) Increased compressibility of the contained fluid, which together with pressure and volume determines approximately the expansive energy in the equipment. To provide for this and the increased hazard due to mass effect of liquids, a multiplying factor of 10 has been used for gases and a factor of 1 for liquids in the determination of hazard level in Table 1.

(c) Increased harmful effect of contents on humans and the environment, e.g. a contents factor of 1000 for lethal contents, 10 for very harmful contents, $10^{0.5}$ for harmful contents, 1 for non-harmful gas, and $10^{-0.5}$ for non-harmful liquid to provide a wider margin for this gas and liquid in the determination of hazard level in Table 1. Refer to Clause 3.3 for basis of fluid types.

(d) Increased exposure of people, property or environment, e.g. transportable vessels or vessels in refineries where 'domino' effects can occur or human occupancy vessels.

(e) Increased hazard, e.g. fired vessels due to furnace explosions, vessels with quick-actuating doors, transportable vessels or vessels in exceptionally hazardous locations.

For boilers, a similar basis is adopted, except that Items (b), (c) and (d), above have been grouped to simplify Table 1.

For piping, the same basis is adopted as that for pressure vessels using the volume of piping length equal to 10 times the inside pipe diameter rounded to the units in Table 1.

With a pressure vessel, the entire contents have the potential to be released instantaneously but with piping it is only the volume close to the ends (at the pressure point) of a completely ruptured pipe which influences the immediate damage. In most cases, pressure would reduce and often the flow would be stopped through isolation being provided after the failure.

NOTE: The method of determining the Hazard Level in Table 1 is based on the numerical method shown in the informative Appendix B, but instead of using $10^{-0.5}$, $10^{0.5}$ etc for adjustment factors and division between Hazard Levels, Table 1 rounds these values to 1 significant figure for simplicity of calculation. Appendix B is not to be used to determine Hazard Levels and is included for information only.

TABLE 1

HAZARD LEVELS OF PRESSURE EQUIPMENT

Equipment – Type and conditions (see Notes 6 & 9)	Hazard level (see Notes 5, 7 & 8)

1 PRESSURE VESSELS (except vacuum vessels and boilers) – includes unfired, fired, static & transportable vessels

Value of *pV*, (as modified by Notes 4 & 10) MPa.L (see Note 3)

	Fluid Type of Contents (see Notes 1 & 2)		Volume (*V*) L	Pressure (*p*) MPa (see Notes 10 & 4(a)(v))	0.1	0.3	1	3	10	30	10^2	3×10^2	10^3	3×10^3	10^4	3×10^4	10^5	3×10^5	10^6	3×10^6	10^7	3×10^7	10^8
1.1	Lethal (see Note 11)	Gas	>0.05	>0.05		C							B							A			
		Liquid	>0.2		E	D		C					B							A			
1.2	Very harmful	Gas	>0.2				E	D		C			B							A			
		Liquid	>1.0				E			D	C		B									A	
1.3	Harmful	Gas	>0.2				E		D		C		B									A	
		Liquid	>1.0				E				D		C			B							A
1.4	Non-harmful (see Note 5)	Gas	>0.2				E			D	C					B						A	
		Liquid	>10				E						D	C		B							

2 VACUUM VESSELS (including vacuum furnaces)

		Pressure	Hazard level
2.1	Vacuum jackets	<-0.05 gauge i.e. <0.05 abs. or > 0.05 vacuum	E
2.2	All other types of vacuum vessels		Same as for pressure vessels in 1 above but use a value of 0.1 *pV*

3 BOILERS

Value of *pV*, (as modified by Notes 4 & 10) MPa.L (see Note 3)

	Type	Volume (*V*) L	Pressure (*p*) MPa	0.1	0.3	1	3	10	35	10^2	3×10^2	10^3	3×10^3	10^4	3×10^4	10^5	3×10^5	10^6	3×10^6	10^7	3×10^7	10^8
3.1	All types except below	>2	>0.05 ≤3.2			E	D		C					B						A		
		>0	>3.2											B						A		
3.2	Miniature boilers complying with AMBSC Code	≤50	≤0.7			D										Not applicable						

4 HOT WATER HEATERS, FIRED HEATERS AND STERILIZERS Same as pressure vessels, including Note 4(a)(i), except a hot water heater with a large open vent is Hazard Level E

5 PRESSURE PIPING (except vacuum) (see Notes 12 & 13)

Value of *pD*, (as modified by Notes 4 & 12) MPa.mm

	Fluid Type of Contents (see Notes 1 & 2)		Nom. Size (*D*) mm	Pressure (*p*) MPa	10	15	25	50	75	100	150	250	350	500	750	1000	1500	2500	3500	10000
5.1	Lethal	Gas	>25	>0.05	D		C							B					A	
		Liquid	>25		E		D		C					B					A	
5.2	Very Harmful	Gas	>25				E		D	C				B					A	
		Liquid	>32				E				D	C		B						A
5.3	Harmful	Gas	>32				E			D		C		B						A
		Liquid	>100				E					D		C					B	
5.4	Non-Harmful (See Note 5)	Gas	>32				E				D	C							B	
		Liquid	>200				E							D	C				B	

6 PRESSURE SAFETY DEVICES Pressure safety devices shall be considered the same hazard level as the equipment to which they are attached.

LEGEND TO TABLE 1:

D = nominal size (diameter) of piping, in millimetres (mm)

p = design pressure of equipment (gauge unless noted), in megapascals (MPa)

V = volume of contained pressurized fluid in the single item of equipment, in litres (L)
The volume of piping is not included in the volume of the pressure vessel

pV = product of p and V, in megapascal litres (MPa.L)

pD = product of p and D, in megapascal millimetres (MPa.mm)

NOTES TO TABLE 1 (To be used with discretion and where applicable):

1 **Terms relating to contents** The classification of contents into the four groups in this Note 1 applies specifically for this Standard and is based on the ADG Code (for dangerous goods), NOHSC:1005 and NOHSC:1008. Terms used by these references are shown in italics. The expected concentrations referenced as follows are for the contents of the pressure equipment:

Lethal contents—containing *a very toxic substance or highly radioactive substance* which, under the expected concentration and operating conditions, is capable, on leakage, of producing death or serious irreversible harm to persons from a single short-term exposure to a very small amount of the substance by inhalation or contact, even when prompt restorative measures are taken. Examples of such substances are acrolein, chloropicrin and other substances with an exposure limit usually ≤0.1 ppm by volume (or equivalent) to NOHSC:1003 or other relevant Standard.

Very harmful contents—containing a substance which, under expected concentration and operating conditions, is classified as *extremely* or *highly flammable, very toxic, toxic, harmful, oxidizing, explosive, self-reactive, corrosive,* or *harmful to human tissue*, but excluding *lethal contents*.

Harmful contents—containing a substance, which under the expected concentration and operating conditions, is classified as a *combustible liquid* or *fluid irritant* to humans, or is harmful to the environment, above 90°C, or below −30°C, but excluding *lethal* or *very harmful fluids*. Steam at any temperature is a harmful gas.

Non-harmful contents—containing substances which are not covered by *lethal, very harmful* or *harmful*, i.e. normally not *harmful*, except for pressure effects and concentration effects, e.g. oxygen depletion. Air at any temperature is a non-harmful gas.

For mixed contents, the harmfulness of the mixture may be determined from the criteria specified in NOHSC:1008, e.g. a mixture of 5% cyanide in water would not be classified as *lethal*.

2 **Terms relating to substances** Where a substance meets more than one of the following descriptions it shall be treated as that resulting in the most severe requirement:

Substance—includes gas, liquid, solid or mixture. A fluid is a gas, liquid or mixture; it may contain entrained solids e.g. slurries.

Harmful to human tissue—describes a substance which is capable of harming the skin, eyes or exposed mucous membrane so that irreversible damage may be done unless prompt restorative measures are taken, including flushing with water, use of antidotes or medicines. It includes oxidizing, radioactive and corrosive fluids.

Flammable gas—dangerous goods of Class 2.1 of the ADG Code; i.e. a gas capable of being ignited and burned in air at atmospheric pressure.

Flammable liquid—dangerous goods of Class 3 of the ADG Code; i.e. generally with a flashpoint not greater than 61°C, or a liquid at a service temperature at or above its flashpoint.

Combustible liquid—a liquid capable of burning but with a flashpoint above 61°C or at a service temperature below its flashpoint.

Gas—See Clause 3.2.4.

Liquid—See Clause 3.2.5.

Oxidizing substance—dangerous goods of Class 5 of the ADG Code.

Toxic (or poisonous) substance—dangerous goods of Class 2.3 or 6 of the ADG Code, e.g. chlorine, anhydrous ammonia or infectious substance. Also includes some carcinogenic, mutagenic and teratogenic substances in accordance with NOHSC:1008.

Very toxic substance—a toxic substance classified by NOHSC:1008 as *very toxic*.

Radioactive substance—dangerous goods of Class 7 of the ADG Code.

Corrosive substance—dangerous goods of Class 8 of the ADG Code.

3 **Volume to be used in pV calculations** The volume (V) to be used in calculating pV values shall be net internal volume in litres as follows:

(a) General vessels—use volume of vessel, i.e. volume which can be filled with fluid under pressure.

(b) Multichamber vessels—

(i) chambers normally open to each other, treat as one vessel, i.e. use total volume; or

(ii) chambers normally isolated, treat as separate vessels.

(c) Vessel containing fluid in more than one phases (e.g. gas and liquid): assume vessel full of gas if liquid is above its atmospheric pressure boiling point, otherwise select greater hazard based on maximum volume of liquid or gas.

(d) Open vessel with jacket, use volume of jacket.

(e) Coil or similar type heater/cooler, use the total volume or, if desired, the tubular portion may be regarded as a pipe with diameter equal to the tube diameter.

(f) Boilers—use total volume of pressurized fluids contained in the boiler.

4 **Modifications to values of pV or pD for special conditions** For use in Table 1, the calculated value of pV or pD shall be multiplied as follows:

(a) By a factor of 3 when one of the following conditions apply, or by a factor of 10 when two or more of the conditions apply (for piping the factors are 1.5 and 2, respectively):

(i) Fired equipment (e.g. fired oil heater) but not boilers.

(ii) Equipment fitted with quick-actuating closures or doors.

(iii) Equipment sited in a facility which comes under the control of the Major Hazard Facility Legislation, except where a risk assessment establishes that a different hazard level should be adopted for the equipment.

(iv) Road tankers and transportable vessels with volumes greater than 200 L. The lower volume limit listed in Table 1 is also to be reduced to 0.05 L for all contents except non-harmful. Conditions (a)(i) to (iii) are not intended to additionally supply.

(v) For pressure vessels intended for human occupancy and with an design pressure in excess of 0.01 MPa, and non-harmful gas.

Conditions (a)(i) to (iii) are not intended to apply additionally.

(b) By a factor of 30 for pressure vessels (5 for piping) with design pressure exceeding 50 MPa.

(c) By a factor of 1/3 when one of the following conditions (i) to (iii) apply, or by a factor of 1/10 when two or more items apply (these factors do not apply to fired boilers) and for piping the factors are 1/1.5 and 1/2 respectively):

(i) Equipment is located in an area where employees are not permanently stationed but may periodically visit for servicing and the like, and which is remote from other buildings, processes or persons.

(ii) Piping is buried or is covered in trenches or similarly safeguarded.

(iii) Maximum membrane stress for vessels and piping based on corroded thickness does not exceed 50 MPa, 20% of specified minimum yield stress at temperature, or 50% of permissible design strength (f), whichever is less.

5 Pressure equipment with a pV <100000 MPa.L or pD < 2300 MPa.mm (before multiplying factors are applied) with non-harmful liquid at a temperature above 0°C but not exceeding 65°C is classified as hazard level E.

6 **Combined conditions** All three conditions of volume or diameter, pressure and the product pV or pD are to be met before a hazard level is determined except for the conditions given in Notes 10, 11 and 12.

7 **Hazard level pV and pD limits** If the product $p \times V$ or $p \times D$ equals the value of boundary between two categories, then the higher category shall apply.

8 Where pressure equipment can be classified into more than one hazard level, the higher hazard level shall be selected.

9 For details on the type of equipment covered by pressure vessels, boilers, and pressure piping, refer to the particular product Standard.

10 All pressure vessels which fall above the application curves in AS 1210 (Figures 1.3.1 and 1.3.2), shall be classified in accordance with this Standard. The hazard level for pressure vessels having a design pressure not exceeding 0.05 MPa (or 0.05 MPa vacuum for vacuum vessels) but which have a pressure-diameter relationship above the application curves in AS 1210 shall be determined using a pV value equal to 0.3 times (0.1 times for vacuum vessels) the actual pV of the vessel).

11 For pressure vessels with lethal gas (Item 1.1) hazard level D shall apply where $pV \leq 0.1$ MPa.L.

12 For pressure piping, where $D \leq$ the nominal size in column 3 of Table 1, Items 5.1 to 5.4 and $p > 10$ MPa, then the hazard level is to be selected for the appropriate contents and value of pD.

13 Piping from pressure equipment up to their first point of isolation shall take the most severe hazard level of the pressure equipment or the piping.

SECTION 3 FLUID TYPES AND CLASSES

3.1 GENERAL

Table 2 lists the fluid types from this Standard and the fluid class from the ADG Code, for various fluids conveyed or contained in pressure piping or other pressure equipment.

This information is intended to assist designers, manufacturers, users and others in applying Table 1 and the following documents:

(a) AS 1210, AS 4041, AS 4458, AS/NZS 3788 and AS 3920.1, which specify design, fabrication and test requirements for different fluid types.

(b) NOHSC:1010 which is being used as a basis for State and Territory regulations and requires hazards to be identified, risks assessed and controlled, and compliance with Australian Pressure Equipment Standards; adopts hazard levels of this Standard.

(c) ADG Code which specifies requirements for land transport of dangerous goods and classifies these goods.

(d) NOHSC:1005 and NOHSC:2007.

(e) NOHSC:1014 and NOHSC:2016.

3.2 USE OF TABLE 2

3.2.1 Column 1

Column 1 identifies the fluid by the United Nation number (UN) listed in the ADG Code.

3.2.2 Column 2

Column 2 alphabetically lists the name of gases and liquids as in the ADG Code and also some substances piped as solutions or fluidized substances, e.g. slurries in liquids or powder in air or other gases.

3.2.3 Columns 3, 4 and 5

Columns 3, 4 and 5 identify type and class. (See Table 3 for basis).

3.2.4 Gas

Gas is any dangerous good Class 2 of the ADG Code, i.e. completely gaseous at 20°C and 101.3 kPa absolute or at 50°C has a vapour pressure greater than 300 kPa absolute. For this Standard, gas includes:

(a) Compressed gas which is entirely gaseous at 20°C and 101.3 kPa absolute.

(b) Liquefied gas which is partially liquid at 20°C.

(c) Refrigerated liquefied gas which is partially liquid because of its low temperature.

(d) Gas in solution which is a compressed gas dissolved in a solvent.

(e) Any liquid when it is above its atmospheric pressure boiling point, e.g. pressurized high-temperature water which flashes to steam on release of pressure.

(f) Fluidized solids in compressed air or other gas.

3.2.5 Liquid

For this Standard and AS 4041, liquid is any substance at a temperature below its atmospheric pressure boiling point, e.g. water <100°C. Liquid also includes solids fluidized in liquids, e.g. slurries. For the ADG Code, liquid is any substance with melting point ≤20°C at 101.3 kPa absolute and which is not a gas.

3.2.6 Change of fluid type for operation temperature

For this Standard the fluid type changes depending on the operating temperature as follows:

(a) Above 90°C or below −30°C, the fluid type listed in Table 2 is changed from non-harmful gas to harmful gas, non-harmful liquid to harmful liquid and Type 4 to Type 3.

(b) Above their atmospheric pressure boiling point, liquids are regarded as gas.

(c) Above their flashpoint, liquids are treated as flammable gas for this Standard and AS 4041.

3.2.7 Change of fluid type for mixture and different concentrations

For change of fluid type for mixture and different concentrations at the time and location of release from pipe or equipment, see ADG Code or NOHSC:10005.

3.2.8 Change of fluid type for pressure

For non-toxic, non-flammable gas (ADG Code Class 2.2) at pressure ≤300 kPa treat as Type 3 fluid or non-harmful gas.

3.3 BASIS OF FLUID TYPES

Fluids in Table 2 have been allocated a 'fluid type' number or letters on the following basis:

(a) Assumes 100% concentration unless noted otherwise.

(b) Compliance with this Standard and AS 4041 (using most severe criterion in each) see Table 3.

(c) Alignment with the class system of the ADG Code, except where temperature, concentration, or pressure necessitate modification. (See Clauses 3.2.6, 3.2.7 and 3.2.8.)

(d) Alignment with NOHSC:1003, NOHSC:1008 and NOHSC:10005.

This classification is intended to assist in determining hazards affecting—

(i) health and safety of persons by inhalation, ingestion, skin or eye contact, primarily with short-term exposure; and

(ii) property and environment by blast, flammability, corrosion, contamination and the like.

NOTE: Corrosion effect on pressure equipment material is assumed minor, as design is required to cater for these effects.

3.4 ACCURACY OF DATA

Where a fluid is not listed, or where users have doubt, they should determine fluid types from references such as Material Safety Data Sheets, tests, calculations, experience or supplier data.

TABLE 2

FLUID—NAME, TYPE AND CLASS (see Clauses 3.2.6, 3.2.7 and 3.2.8 for change of fluid type)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1088	Acetal		VHL	2	3
1089	Acetaldehyde		VHL	2	3
2789	Acetic Acid, glacial or Acetic acid solution 80%		VHL	2	8
2790	Acetic Acid solution 10%–80%		VHL	2	8
1715	Acetic Anhydride		VHL	2	8
1090	Acetone	BP 57°C	VHL	2	3
1541	Acetone Cyanohydrin, stabilized		VHL	2	6.1(a)
1091	Acetone oils		VHL	2	3
1716	Acetyl Bromide	BP 81°C	VHL	2	8
1717	Acetyl Chloride	BP 51°C	VHL	2	3-8
1001	Acetylene, dissolved	D 0.91	VHG	2	2.1
1898	Acetyl Iodide		VHL	2	8
2621	Acetyl Methyl Carbinol		VHL	2	3
2607	Acrolein Dimer, stabilized		VHL	2	3
1092	Acrolein, inhibited	BP 52°C	LL	1	6.1(a)-3
2218	Acrylic Acid inhibited		VHL	2	8
1093	Acrylonitrile, inhibited		VHL	2	3-6.1(a)
1133	Adhesives containing flammable liquid		VHL	2	3
2205	Adiponitrile	BP 93°C	VHL	2	6.1(b)
1002	Air, compressed		NHG	4	2.2
1003	Air, refrigerated liquid		VHG	2	2.2-5.1
3065	Alcoholic Beverages >24% alcohol		VHL	2	3
	Alcoholic Beverages ≤24% alcohol		NHL	4	
1987	Alcohols +		VHL	2	3
1986	Alcohols, toxic +		VHL	2	3-6.1(a) or (b)
1421	Alkali Metal Alloys, liquid +		VHL	2	4.3
3140	Alkaloids liquid +		VHL	2	6.1
2735	Alkylamines + or Polyalkylamines +, corrosive		VHL	2	8
2734	Alkylamines + or Polyalkylamines +, corrosive, flammable		VHL	2	8-3
3145	Alkyl Phenols, liquid+		VHL	2	6.1(b)
2333	Allyl Acetate		VHL	2	3-6.1(a)
1098	Allyl Alcohol		VHL	2	6.1(a)-3
2334	Allylamine	BP 55°C	VHL	2	6.1(a)-3
1100	Allyl Chloride	BP 44°C	VHL	2	3-6.1(a)
1722	Allyl Chloroformate		VHL	2	8
2335	Allyl Ethyl Ether		VHL	2	3-6.1(a)
2336	Allyl Formate		VHL	2	3-6.1(a)
2219	Allyl Glycidyl Ether		VHL	2	3-6.1(b)

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name	Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1723	Allyl Iodide	VHL	2	3-8
1545	Allyl Isothiocyanate, inhibited	VHL	2	6.1(a)
1724	Allyl Trichlorosilane, stabilized	VHL	2	8
3052	Aluminium Alkyl Halides	VHL	2	4.2
3076	Aluminium Alkyl Hydrides	VHL	2	4.2
3051	Aluminium Alkyls	VHL	2	4.2
2580	Aluminium Bromide solution	VHL	2	8
2581	Aluminium Chloride solution	VHL	2	8
2946	2-Amino-5-Diethylamino Pentane	VHL	2	6.1(b)
1005	Ammonia, Anhydrous, liquefied or Ammonia solutions >50%	VHG	2	2.3-8
2073	Ammonia solutions 35–50%	VHG	3	2.2
2817	Ammonium Hydrogen Fluoride solution	VHL	2	8-6.1
2426	Ammonium Nitrate liquid (hot concentrated solution)	VHL	2	5.1
2818	Ammonium Polysulfide solution	VHL	2	8-6.1
2683	Ammonium Sulphide solution	VHL	2	8-3-6.1
1104	Amyl Acetates	VHL	2	3
2819	Amyl Acid Phosphate	VHL	2	8
1105	Amyl Alcohols	VHL	2	3
1106	Amylamine	VHL	2	3
2620	Amyl Butyrates	VHL	2	3
1107	Amyl Chloride	VHL	2	3
1108	n-Amylene	VHL	2	3
1109	Amyl Formates	VHL	2	3
1111	Amyl Mercaptan	VHL	2	3
1110	Amyl Methyl Ketone	VHL	2	3
1112	Amyl Nitrate	VHL	2	3
1728	Amyl Trichlorosilane	VHL	2	8
1547	Aniline (Anifine oil)	VHL	2	6.1(a)
1548	Aniline Hydrochloride	VHL	2	6.1(b)
2222	Anisole	VHL	2	3
1730	Antimony Pentachloride, liquid	VHL	2	8
1731	Antimony Penthachloride, solution	VHL	2	8
1732	Antimony Pentafluoride	VHL	2	8-6.1(a)
1006	Argon, compressed	NHG	4	2.2
1951	Argon, refrigerated liquid	HG	3	2.2
1553	Arsenic Acid, liquid	VHL	2	6.1(a)
1556	Arsenic Compounds, liquid+	VHL	2	6.1(a) or (b)
1560	Arsenic Trichloride	VHL	2	6.1(a)
2188	Arsine	LG	1	2.3-2.1
2796	Battery Fluid, acid	VHL	2	8

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name	Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2797	Battery Fluid, alkali	VHL	2	8
1114	Benzene	VHL	2	3
2225	Benzene Sulfonyl Chloride	VHL	2	8
2224	Benzonitrile	VHL	2	6.1(a)
2226	Benzothrichloride	VHL	2	8
2338	Benzotrifluoride	VHL	2	3
1736	Benzoyl Chloride	VHL	2	8
1737	Benzyl Bromide	VHL	2	6.1(a)-8
1738	Benzyl Chloride	VHL	2	6.1(a)-8
1739	Benzyl Chloroformate	VHL	2	8
2619	Benzyl Dimethylamine	VHL	2	8
1886	Benzylidene Chloride	VHL	2	6.1(a)
2653	Benzyl Iodide	VHL	2	6.1(a)
. . .	Beverages (excluding alcoholic beverages with >24% alcohol)	NHL	4	—
2693	Bisulfites, inorganic, aqueous solns+	VHL	2	8
2692	Boron Tribromide	VHL	2	8
1741	Boron Trichloride D>1	VHG	2	2.3-8
1008	Boron Triflouride D2.35	VHG	2	2.3
2604	Boron Trifluoride Diethyletherate	VHL	2	8-3
2851	Boron Trifluoride Dihydrate	VHL	2	8
2965	Boron Trifluoride Dimethyl Etherate	VHL	2	4.3-3-8
1118	Brake Fluid, hydraulic	VHL	2	3
1744	Bromine or Bromine solutions BP 59°C	VHL	2	8-6.1(a)
2901	Bromine Chloride	VHG	2	2.3-5.1-8
1745	Bromine Pentafluoride BP 40°C	VHL	2	5.1-6.1(a)-8
1938	Bromoacetic Acid	VHL	2	8
1569	Bromoacetone	VHL	2	6.1(a)
2513	Bromoacetyl Bromide BP 150°C	VHL	2	8
2514	Bromobenzene	VHL	2	3
2339	2-Bromobutane	VHL	2	3
1887	Bromochloromethane BP 58°C	VHL	2	6.1(b)
2688	1-Bromo-3-Chloropropane	VHL	2	6.1(b)
2340	2-Bromoethyl Ethyl Ether	VHL	2	3
2341	1-Bromo-3-Methyl Butane	VHL	2	3
2342	Bromoethyl Propanes	VHL	2	3
2343	2-Bromopentane	VHL	2	3
2344	Bromopropanes	VHL	2	3
2345	3-Bromopropyne	VHL	2	3
2419	Bromotrifluoro Ethylene D 5.60	VHG	2	2.1
1009	Bromotrifluoro Methane D 5.20	HG	3	2.2

See end of Table for Legend. *(continued)*

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1010	Butadienes, inhibited	D 1.85	VHG	2	2.1
1011	Butane or Butane mixtures		VHG	2	2.1
2346	Butanedione		VHL	2	3
1120	Butanols		VHL	2	3
2708	Butoxyl		VHL	2	3
1123	Buty Acetates		VHL	2	3
1718	Butyl Acid Phosphate		VHL	2	8
2348	Butyl Acrylate		VHL	2	3
1125	n-Butylamine		VHL	2	3
2738	N-Butylaniline		VHL	2	6.1(a)
1126	n-Butyl Bromide		VHL	2	3
2747	tert-Butyl Cyclohexyl Chloroformate		VHL	2	6.1(b)
1012	Butylene		VHG	2	2.1
3022	1,2-Butylene Oxide, stabilized		VHL	2	3
1128	n-Butyl Formate		VHL	2	3
2485	n-Butyl Isocyanate		VHL	2	3-6.1(a)
2347	Butyl Mercaptan		VHL	2	3
2227	n-Butyl Methacrylate		VHL	2	3
2350	Butyl Methyl Ether	BP 70°C	VHL	2	3
2351	Butyl Nitrites		VHL	2	3
2228	Butylphenols, liquid		VHL	2	6.1(b)
1914	Butyl Propionate		VHL	2	3
2667	Butyltoluenes		VHL	2	6.1(b)
1747	Butyl Trichlorosiline		VHL	2	8
2352	Butyl Vinyl Ether, inhibited		VHL	2	3
1129	Butyraldehyde		VHL	2	3
2840	Butyraldoxime		VHL	2	3
2820	Butyric Acid		VHL	2	8
2739	Butyric Anhydride		VHL	2	8
2411	Butyrontrile		VHL	2	3-6.1(a)
2353	Butyryl Chloride		VHL	2	3-8
2570	Cadmium Compounds (dust or oxide)		LL	1	6.1
2681	Caesium Hydroxide solution		VHL	2	8
2429	Calcium Chlorate, Aqueous solution		VHL	2	5.1
1130	Camphor Oil		VHL	2	3
2829	Caproic Acid		VHL	2	8
1013	Carbon Dioxide	D 1.50	NHG	3	2.2
1041	Carbon Dioxide with >6% ethylene oxide		VHG	2	2.3-2.1
1015	Carbon Dioxide with Nitrous Oxide	D 1.50	NHG	4	2.2
1014	Carbon Dioxide and Oxygen Mixtures		NHG	4	2.2

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2187	Carbon Dioxide, Refrigerated liquid		HG	3	2.2
1845	Carbon Dioxide, Solid (Dry Ice)		HG	3	9
1131	Carbon Disulfide	BP 46°C	VHL	2	3-6.1(a)
1016	Carbon Monoxide	D 0.97	VHG	2	2.3-2.1
2600	Carbon Monoxide with Hydrogen	D 0.50	VHG	2	2.3-2.1
1846	Carbon Tetrachloride		VHL	2	6.1(a)
2417	Carbonyl Fluoride	D 2.30	VHG	2	2.3
2204	Carbonyl Sulfide	D 2.10	VHG	2	2.3-2.1
1719	Caustic Alkali liquid+		VHL	2	8
1017	Chlorine	D 2.40	VHG	2	2.3-5.1
2548	Chlorine Pentafluoride		VHG	2	2.3-5.1-8
1749	Chlorine Trifluoride	D 3.20	VHG	2	2.3-5.1-8
2232	Chloroacetaldehyde		VHL	2	6.1(a)
3250	Chloroacetic Acid, molten		VHL	2	6.1(a)-8
1750	Chloroacetic Acid, solution		VHL	2	6.1(a)-8
1695	Chloroacetone, Stabilized (Tear Gas)		VHL	2	6.1(a)
2668	Chloroacetonitrile		VHL	2	6.1(a)
1697	Chloroacetophenone		VHL	2	6.1(a)
1752	Chloroacetyl Chloride		VHL	2	8
2019	Chloroanilines, liquid		VHL	2	6.1(a)
1134	Chlorobenzene		VHL	2	3
2234	Chlorobenzo Trifluorides		VHL	2	3
1127	Chlorobutanes		VHL	2	3
1888	Chloroform	BP 61°C	VHL	2	6.1(a)
2745	Chloromethyl Chloroformate		VHL	2	6.1(a)-8
2354	Chloromethylethyl Ether		VHL	2	3-6.1(a)
2904	Chlorophenates, liquid		VHL	2	8
2021	Chlorophenols, liquid		VHL	2	6.1(b)
1753	Chlorophenyl Trichlorosilane		VHL	2	8
1580	Chloropicrin		LL	1	6.1(a)
1581	Chloropicrin and Methyl Bromide mixtures		VHL	2	2.3
1582	Chloropicrin and Methyl Chloride mixtures		VHL	2	2.3
1583	Chloropicrin mixtures+		VHL	2	6.1(a) or (b)
1991	Chloroprene, inhibited	BP 59°C	VHL	2	3-6.1(a)
2356	2-Chloropropane	BP 35°C	VHL	2	3
2849	3-Chloropropanol-1		VHL	2	6.1(b)
2456	2-Chloropropene	BP 23°C	VHL	2	3
2511	a-Chloropropionic Acid		VHL	2	8
2822	2-Chloropyridine		VHL	2	6.1(a)
2987	Chlorosilanes+		VHL	2	8

See end of Table for Legend. (*continued*)

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2985	Chlorosilanes+	FP<23°C	VHL	2	3-8
2986	Chlorosilanes+ and corrosive	FP≥23°C	VHL	2	8.3
2988	Chlorosilanes+ with water emit flammable gas		VHL	2	4.3-3-8
1754	Chlorosulfonic Acid		VHL	2	8
2238	Chlorotoluenes		VHL	2	3
1983	1-Chloro-2,2,2-Trifluoroethane	D 4.10	NHG	4	2.2
1755	Chromic Acid solution		VHL	2	8
1757	Chromic Fluoride solution		VHL	2	8
1758	Chromium Oxychloride		VHL	2	8
2240	Chromosulfuric Acid		VHL	2	8
1023	Coal Gas	D 0.4-0.6	VHG	2	2.3-2.1
1136	Coal Tar Distillates, flammable		VHL	2	3
1956	Compressed Gas+ (Non-flammable, non-toxic)		NHG	4	2.2
1954	Compressed Gas, flammable+		VHG	2	2.1
3156	Compressed Gas, oxidizing+		VHG	2	2.2-5.1
1955	Compressed Gas, toxic+		VHG	2	2.3
1760	Corrosive liquid+ (Non-flammable/toxic/ oxidizing)		VHG	2	8
2076	Cresols		VHL	2	6.1(a)
2022	Cresylic Acid		VHL	2	6.1(a)
1143	Crotonaldehyde, stabilized		VHL	2	3
1144	Crotonylene	BP 28°C	VHL	2	3
1761	Cupriethylene Diamine, solution		VHL	2	8-6.1
1935	Cyanide solutions (see Note 1 to Table 1)		VHL	2	6.1(a) or (b)
1589	Cyanogen Chloride, inhibited	D 2.10	VHG	2	2.3
1026	Cyanogen, liquefied		VHG	2	2.3-2.1
2601	Cyclobutane		VHG	2	2.1
2744	Cyclobutyl Chloroformate		VHL	2	6.1(a)-8
2518	1,5,9-Cyclo Dodecatriene		VHL	2	6.1(b)
2241	Cycloheptane		VHL	2	3
2603	Cycloheptatriene		VHL	2	3-6.1(a)
2242	Cycloheptene		VHL	2	3
1915	Cyclohexanone		VHL	2	3
2256	Cyclohexene		VHL	2	3
1762	Cyclohexenyl Trichlorosilane		VHL	2	8
2243	Cyclohexyl Acetate		VHL	2	3
2357	Cyclohexylamine		VHL	2	8-3
2488	Cyclohexyl Iscyanate		VHL	2	6.1(a)
3054	Cyclohexyl Mercaptan		VHL	2	3
1763	Cyclohexyl Trichlorosilane		VHL	2	8
2520	Cyclooctadienes		VHL	2	3

See end of Table for Legend. *(continued)*

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2358	Cycloctatetraene		VHL	2	3
2244	Cyclopentanol		VHL	2	3
2245	Cyclopentanone		VHL	2	3
2246	Cyclopentene	BP 44°C	VHL	2	3
1027	Cyclopropane, liquefied		VHG	2	2.1
2046	Cymenes		VHL	2	3
1868	Decaborane	MP 100°C	LL	1	4.1-6.1(a)
1147	Decahydro Naphthalene		VHL	2	3
2247	n-Decane		VHL	2	3
1957	Deuterium	D 0.14	VHL	2	2.1
1148	Diacetone Alcohol		VHL	2	3
2359	Diallylamine		VHL	2	3
2360	Diallyl Ether		VHL	2	3-6.1(a)
2841	Di-n-Amylamine		VHL	2	6.1(b)
2434	Dibenzyldichloro Silane		VHL	2	8
1911	Diborane	D 0.95	LG	1	2.3-2.1
2711	Dibromobenzene		VHL	2	3
2648	1,2-Dibromobutan-3-one		VHL	2	6.1(a)
1941	Dibromodifluoro Methane	BP 24°C	HL	3	9
2664	Dibromomethane		VHL	2	6.1(b)
2248	Di-n-Butylamine		VHL	2	8-3
2873	Dibutylaminoethanol		VHL	2	6.1(b)
1149	Dibutyl Ethers		VHL	2	3
1764	Dichloroacetic Acid		VHL	2	8
1765	Dichloroacetyl Chloride		VHL	2	8
1591	o-Dichlorobenzene		VHL	2	6.1(b)
1916	2,2'-Dichlorodiethyl Ether		VHL	2	6.1(a)
2249	Dichloro Dimethyl Ether, Symmetrical		LL	1	6.1(a)
2362	1,1-Dichloroethane	BP 57°C	VHL	2	3
1150	Dichloroethylene		VHL	2	3
2490	Dichloroisopropyl Ether		VHL	2	6.1(a)
1593	Dichloromethane	BP 40°C	VHL	2	6.1(b)
2650	1,1-Dichloro-1-Nitro Ethane		VHL	2	6.1(a)
1152	Dichloropentanes		VHL	2	3
1766	Dichlorophenyl Trichlorosilane		VHL	2	8
2750	1,3-Dichloro Propanol-2		VHL	2	6.1(a)
2047	Dichloropropenes		VHL	2	3
2189	Dichlorosilane		VHG	2	2.3-2.1
1958	Dichlorotetra Fluoroethane	D 5.90	NHG	4	2.2
2565	Dicyclohexylamine		VHL	2	8

See end of Table for Legend. *(continued)*

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2372	1,2-DI-(Dimethylamino) Ethane		VHL	2	3
—	Diesel oil	FP>61°C	HL	3	—
2373	Diethoxymethane		VHL	2	3
2374	3,3-Diethoxypropene		VHL	2	3
1154	Diethylamine	BP 55°C	VHL	2	3
2686	Diethylaminoethanol		VHL	2	3
2684	Diethylamino Propylamine		VHL	2	8-3
2432	N,N-Diethylaniline		VHL	2	6.1(b)
2049	Diethylbenzene		VHL	2	3
2366	Diethyl Carbonate		VHL	2	3
1767	Diethyl Dichlorosilane		VHL	2	8-3
2079	Diethylenetriamine		VHL	2	8
1155	Diethyl Ether (Ethyl Ether)	BP 34°C	VHL	2	3
2685	N,N-Diethylethtlene Diamine		VHL	2	8-3
1156	Diethyl Ketone		VHL	2	3
1594	Diethyl Sulfate		VHL	2	6.1(a)
2375	Diethyl Sulfide		VHL	2	3
2751	Diethyl Thiophosphoryl Chloride		VHL	2	8
1366	Diethylzinc		VHL	2	4.2
1768	Difluorophophoric Acid, Anhydrous		VHL	2	8
2376	2,3-Dihydropyran		VHL	2	3
2361	Diisobutylamine		VHL	2	3
2050	Diisobutylene, Isomeric compounds	BP 101°C to 105°C	VHL	2	3
1157	Diisobutyl Ketone		VHL	2	3
1902	Diisooctyl Acid Phosphate		VHL	2	8
1158	Diisopropylamine		VHL	2	3
1159	Diisopropyl Ether		VHL	2	3
2521	Diketene, inhibited		VHL	2	3
2377	1,1-Dimethoxyethane	BP 62°C	VHL	2	3
2252	1,2-Dimethoxyethane		VHL	2	3
1032	Dimethylamine, Anydrous	D 1.60	VHG	2	2.1
1160	Dimethylamine solution		VHL	2	3
2378	2-Dimethylamino Acetonitrile		VHL	2	3-6.1(a)
2522	Dimethylaminoethyl Methacrylate		VHL	2	6.1(a)
2253	N,N-Dimethylaniline		VHL	2	6.1(a)
2379	1,3-Dimethyl Butylamine		VHL	2	3
2262	Dimethyl Carbamoyl Chloride		VHL	2	8
1161	Dimethyl Carbonate		VHL	2	3
2263	Dimethylcyclo Hexanes		VHL	2	3

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2264	N,N-Dimethylcyclo Hexylamine		VHL	2	8
1162	Dimethyldichloro Silane	B 70°C	VHL	2	3-8
2380	Dimethyldiethoxy Silane		VHL	2	3
2707	Dimethyldioxanes		VHL	2	3
2381	Dimethyl Disulfide		VHL	2	3
2051	Dimethylethanol Amine		VHL	2	3
1033	Dimethyl Ether	D 1.60	VHG	2	2.1
2265	N,N-Dimethyl Formamide		VHL	2	3
2382	Dimethylhydrazine, Symmetrical		VHL	2	3-6.1(a)
1163	Dimethylhydrazine, Unsymmetrical		VHL	2	6.1(a)-3-8
2044	2,2-Dimethylpropane other than pentane and isopentane		VHG	2	2.1
2266	Dimethyl-N-Propylamine		VHL	2	3-8
1595	Dimethyl Sulfate		LL	1	6.1(a)-8
1164	Dimethyl Sulfide	BP 37°C	VHL	2	3
2267	Dimethyl Thiophosphoryl Chloride		VHL	2	8
1370	Dimethyl Zinc	BP 46°C	VHL	2	4.2
1067	Dinitrogen Tetroxide (Nitrogen Dioxide), liquefied	D 1.60	VHG	2	2.3-5.1
1599	Dinitrophenol solutions		VHL	2	6.1(a) or (b)
1165	Dioxane		VHL	2	3
1166	Dioxolane		VHL	2	3
2052	Dipentene		VHL	2	3
1769	Diphenyldichloro Silane		VHL	2	8
2383	Diprophylamine		VHL	2	3
2384	Dipropyl Ether		VHL	2	3
2710	Dipropylketone		VHL	2	3
1903	Disinfectants, corrosive liquid+		VHL	2	8
3142	Disinfectants, liquid+, poisonous		VHL	2	6.1
—	Distillate	FP>61°C	HL	3	—
1167	Divinyl Ether, inhibited	BP 30°C	VHL	2	3
1771	Dodecyl Trichlorosilane		VHL	2	8
2801	Dyes, liquid, corrosive+		VHL	2	8
1602	Dyes, liquid, poisonous+		VHL	2	6.1(a) or (b)
1960	Engine starting fluid with flammable gas		VHG	2	2.1
3082	Environmentally hazardous substances, liquid+		HL	3	9
2558	Epibromohydrin	BP 135°C	VHL	2	6.1(a)
2023	Ephichlorohydrin		VHL	2	6.1(a)
1035	Ethane, compressed	D 1.05	VHG	2	2.1
1961	Ethane, refrigerated liquid		VHG	2	2.1

See end of Table for Legend.

(continued)

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1170	Ethanol (Ethyl Alcohol) or Ethanol solutions (Ethyl Alcohol solutions)		VHL	2	3
2491	Ethanolamine or Ethanolamine solutions		VHL	2	8
1173	Ethyl Acetate		VHL	2	3
2452	Ethyl Acetylene, inhibited		VHG	2	2.1
1917	Ethyl Acrylate, inhibited	BP 98°C	VHL	2	3
1036	Ethylamine	D 1.60	VHG	2	2.1
2270	Ethylamine, aqueous solutions (50–70% ethylamine)		VHL	2	3
2271	Ethyl Amyl Ketone		VHL	2	3
2273	2-Ethylaniline		VHL	2	6.1(b)
2272	N-Ethylaniline		VHL	2	6.1(b)
1175	Ethylbenzene		VHL	2	3
2274	N-Ethyl-N-Benzylaniline		VHL	2	6.1(b)
2753	N-Ethylbenzyl Toluidines		VHL	2	6.1(b)
1176	Ethyl Borate		VHL	2	3
1891	Ethyl Bromide	BP 38°C	VHL	2	6.1(a)
1603	Ethyl Bromoacetate		VHL	2	6.1(a)
2275	2-Ethylbutanol		VHL	2	3
1177	Ethylbutyl Acetate		VHL	2	3
1179	Ethyl Butyl Ether		VHL	2	3
1178	2-Ethyl Butyraldehyde		VHL	2	3
1180	Ethyl Butryate		VHL	2	3
1037	Ethyl Chloride	D 2.20	VHG	2	2.1
1181	Ethyl Chloroacetate		VHL	2	6.1(a)
1182	Ethyl Chloroformate		VHL	2	6.1(a)-3-8
2935	Ethyl 2-Chloropropionate		VHL	2	3
2826	Ethyl Chlorothioformate		VHL	2	8
1862	Ethyl Crotonate		VHL	2	3
2666	Ethyl Cyanoacetate		VHL	2	6.1(b)
1892	Ethyl Dichloroarsine		VHL	2	6.1(a)
1183	Ethyl Dichlorosilane	BP 98°C	VHL	2	4.3-3-8
3138	Ethylene, Acetylene < = 22% and Propylene <= 6% of mixtures, refrigerated liquid		VHG	2	2.1
1135	Ethylene Chlorohydrin		VHL	2	6.1(a)
1962	Ethylene, compressed	D 0.98	VHG	2	2.1
1604	Ethylenediamine		VHL	2	8-3
1605	Ethylene Dibromide		VHL	2	6.1(a)
1184	Ethylene Dichloride		VHL	2	3-6.1(a)
1153	Ethylene Glycol Diethyl Ether		VHL	2	3
2369	Ethylene Glycol Monobutyl Ether		VHL	2	6.1(b)

See end of Table for Legend. *(continued)*

TABLE 2 *(continued)*

UN No.	Fluid name	Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1171	Ethylene Glycol Monoethyl Ether	VHL	2	3
1172	Ethylene Glycol Monoethyl Ether Acetate	VHL	2	3
1188	Ethylene Glycol Monoethyl Ether	VHL	2	3
1189	Ethylene Glycol Monomethyl Ether Acetate	VHL	2	3
1185	Ethyleneimine, inhibited	VHL	2	6.1(a)-3
1040	Ethylene Oxide pure or with nitrogen D 1.50	VHG	2	2.3-2.1
2983	Ethylene Oxide and Propylene Oxide Mixtures, not more than 30% ethylene oxide	VHL	2	3-6.1(a)
1038	Ethylene, refrigerated liquid	VHG	2	2.1
2453	Ethyl Fluoride	VHG	2	2.1
1190	Ethyl Formate BP 54°C	VHL	2	3
2276	2-Ethylhexylamine	VHL	2	8
2748	2-Ethylhexyl Chloroformate	VHL	2	6.1(a)-8
2385	Ethyl Isobutyrate	VHL	2	3
2481	Ethyl Isocyanate BP 60°C	VHL	2	3-6.1(a)
1192	Ethyl Lactate	VHL	2	3
2363	Ethyl Mercaptan BP 35°C	VHL	2	3
2277	Ethyl Methacrylate	VHL	2	3
1039	Ethyl Methyl Ether D 2.10	VHG	2	2.1
1193	Ethyl Methyl Ketone	VHL	2	3
1194	Ethyl Nitrite solutions	VHL	2	3-6.1(a)
2524	Ethyl Orthoformate	VHL	2	3
2525	Ethyl Oxalate	VHL	2	6.1(b)
2435	Ethyl Phenyl Dichlorosilane BP 61°C	VHL	2	8
2386	1-Ethylpiperidine	VHL	2	3
1195	Ethyl Propionate	VHL	2	3
2615	Ethyl Propyl Ether BP ≤61°C	VHL	2	3
2571	Ethyl Sulfuric Acid	VHL	2	8
2754	N-Ethyltoluidines	VHL	2	6.1(a)
1196	Ethylthricloro Silane	VHL	2	3-8
1169	Extracts, Aromatic, liquid	VHL	2	3
1197	Extracts, Flavouring, liquid	VHL	2	3
2582	Ferric Chloride solution	VHL	2	8
1043	Fertilizer Ammoniating solution with free ammonia	HG	3	2.2
1993	Flammable liquid+	VHL	2	3
2924	Flammable liquid, corrosive	VHL	2	3
1992	Flammable liquid, poisonous	VHL	2	3-6.1(a) or (b)
1045	Fluorine, compressed D 1.30	VHG	2	2.3-5.1
2941	Fluoroanilines	VHL	2	6.1(b)
2387	Fluorobenzene	VHL	2	3

See end of Table for Legend.

(continued)

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1775	Fluoroboric Acid		VHL	2	3
1776	Fluorophosphoric Acid, Anyhydrous		VHL	2	8
1777	Fluorosulfonic Acid		VHL	2	8
2388	Fluorotoluenes		VHL	2	3
1778	Fluosilicic Acid		VHL	2	8
2209	Formaldehyde solutions with not less than 25% formaldehyde		VHL	2	8
1780	Fumaryl Chloride		VHL	2	8
2389	Furan	BP 31°C	VHL	2	3
1199	Furfural		VHL	2	3
2874	Furfuryl Alcohol		VHL	2	6.1(b)
1201	Fusel Oil		VHL	2	3
1864	Gas Drips, hydrocarbon		VHL	2	3
2192	Germane	D 2.60	VHG	2	2.3-2.1
2689	Glycerol-a-Monochlorohydrin		VHL	2	6.1(b)
2622	Glycidaldehyde		VHL	2	3-6.1(b)
1610	Halogenated irritating liquid+		VHL	2	6.1(a) or (b)
1046	Helium compressed	D 0.14	NHG	4	2.2
1963	Helium, refrigerated liquid		HG	3	2.2
2278	n-Heptene		VHL	2	3
2661	Hexachloroacetone		VHL	2	6.1(b)
2279	Hexachloro Butadiene		VHL	2	6.1(b)
2646	Hexachloro Cyclopentadiene		LL	1	6.1(a)
2875	Hexachlorophene		VHL	2	6.1(b)
1781	Hexadecyltrichloro Silane		VHL	2	8
2458	Hexadiene	BP 59-82°C	VHL	2	3
1611	Hexaethyl Tetraphosphate		VHL	2	6.1(a) or (b)
1612	Hexaethyl Tetraphosphate and compressed gas mixtures		VHG	2	2.3
2420	Hexafluoroacetone	D 5.70	LL	1	2.3
2552	Hexafluoroacetone Hydrate		VHL	2	6.1(a)
2193	Hexafluoroethane Refrigerant Gas R116	D 4.80	NHG	4	2.2
1782	Hexafluoro phosphoric acid		VHL	2	8
1858	Hexafluoro Propylene	D 5.20	NHG	4	2.2
1207	Hexaldehyde		VHL	2	3
1783	Hexamethylene Diamine solution		VHL	2	6.1(a)
2281	Hexamethylene Diisocyanate		VHL	2	6.1(a)
2493	Hexamethyleneimine		VHL	2	3-8
2282	Hexanols		VHL	2	3
2370	1-Hexene	BP 64°C	VHL	2	3
1784	Hexyl Trichlorosilane		VHL	2	8
2029	Hydrazine, Anhydrous, or Aqueous >64%		LL	1	3-6.1(a)-8

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2030	Hydrazine Hydrate or Aqueous ≤64%		VHL	2	8-6.1(a)
1787	Hydriodic Acid solution		VHL	2	8
1788	Hydrobromic Acid solution		VHL	2	8
1964	Hydrocarbon Gas or Mixtures—compressed+		VHG	2	2.1
1965	Hydrocarbon Gas/Mixtures, liquefied+		VHG	2	2.1
1789	Hydrochloric Acid solution		VHL	2	8
1613	Hydrocyanic Acid, Aqueous solutions with not more than 20% hydrocyanic acid		VHL	2	6.1(a)
1790	Hydrofluoric Acid solution >50%		VHL	2	8-6.1(a)
1786	Hydrofluoric Acid and Sulfuric Acid mixtures		VHL	2	8-6.1(a)
1048	Hydrogen Bromide, Anyhydrous	D >1	VHG	2	2.3-8
1050	Hydrogen Chloride, Anyhydrous	D 1.30	VHG	2	2.3-8
2186	Hydrogen Chloride, refrigerated liquid		VHG	2	2.3-8
1049	Hydrogen, compressed	D 0.07	VHG	2	2.1
1051	Hydrogen Cyanide, Anydrous stabilized	BP 26°C	VHL	2	6.1(a)-3
1052	Hydrogen fluoride, Anhydrous	BP 20°C	VHL	2	8-6.1(a)
2197	Hydrogen Iodide, Anhydrous	D 4.40	VHG	2	2.3-8
2034	Hydrogen and Methane mixtures, compressed		VHG	2	2.1
2015	Hydrogen Peroxide stabilized, or Hydrogen Peroxide aqueous solutions, stabilized, with more than 60% Hydrogen Peroxide		VHL	2	5.1-8
2014	Hydrogen Peroxide, aqueous solutions, 20%–60%		VHL	2	5.1-8
2984	Hydrogen Peroxide, aqueous solutions 8%–20%		VHL	2	5.1
1966	Hydrogen, refrigerated liquid		VHG	2	2.1
2202	Hydrogen Selenide, Anhydrous	D 2.80	LG	1	2.3-2.1
1053	Hydrogen Sulfide, Liquefied	D 1.20	VHG	2	2.3-2.1
1791	Hypochlorite solutions with more than 5% available chlorine		VHL	2	8
2269	3,3′-Iminodi Propylamine		VHL	2	8
2814	Infectious substances, affecting humans		VHL	2	6.2
1968	Insecticide gas+		HG	3	2.2
1967	Insecticide gas, toxic+		VHG	2	2.3
1792	Iodine Monochloride		VHL	2	8
2495	Iodine Pentafluoride	BP 98°C	VHL	2	5.1-6.1(a)-8
2390	2-Iodobutane		VHL	2	3
2391	Iodomethyl Propanes		VHL	2	3
2392	Iodopropanes		VHL	2	3
1994	Iron Pentacarbonyl	BP 103°C	VHL	2	6.1(a)-3
1969	Isobutane or Isobutane mixtures		VHG	2	2.1
1212	Isobutanol (Isobutyl Alcohol)		VHL	2	3
1213	Isobutyl Acetate		VHL	2	3
2527	Isobutyl Acrylate	BP 61-63°C	VHL	2	3

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1214	Isobutylamine		VHL	2	3
1055	Isobutylene		VHG	2	2.1
2393	Isobutyl Formate		VHL	2	3
2528	Isobutyl Isobutyrate		VHL	2	3
2486	Isobutyl Isocyanate	BP 60°C	VHL	2	3-6.1(a)
2283	Ishutyl Methacrylate		VHL	2	3
2394	Isobutyl Propionate		VHL	2	3
2045	Isobutyraldehyde	BP 64°C	VHL	2	3
2529	Isobuturic Acid		VHL	2	3
2530	Isobutyric Anydride		VHL	2	3
2284	Isobutyronitrile		VHL	2	3-6.1(a)
2395	Isobutyryl Chloride		VHL	2	3-8
2478	Isocyanates, solutions+	FP <23°C	VHL	2	3
3080	Isocyanates, solutions+	FP 23-60	VHL	2	6.1(a)
2206	Isocynates, solutions+	FP >60°C	VHL	2	6.1(a)
2285	Isocyanatobenzo Trifluorides		VHL	2	6.1(a)
2287	Isoheptene		VHL	2	3
2288	Isohexane	BP 64-68°C	VHL	2	3
2371	Isopentenes		VHL	2	3
2289	Isophoronediamine		VHL	2	8
2290	Isophorone Diisocyanate		VHL	2	6.1(a)
1218	Isoprene, inhibited	BP 34°C	VHL	2	3
1219	Isopropanol (Isopropyl Alcohol)		VHL	2	3
2403	Isopropenyl Acetate		VHL	2	3
2303	Isopropenylbenzene		VHL	2	3
1220	Isopropyl Acetate		VHL	2	3
1793	Isoprophyl Acid Phosphate		VHL	2	8
1221	Isopropylamine	BP 32°C	VHL	2	3
1918	Isoprophylbenzene		VHL	2	3
2405	Isopropyl Butyrate		VHL	2	3
2947	Isopropyl Chloroacetate		VHL	2	3
2407	Isopropyl Chloroformate		VHL	2	3-8
2934	Isopropyl 2-Chloro Propionate		VHL	2	3
2406	Isopropyl Isobutyrate		VHL	2	3
2483	Isopropyl Isocyanate		VHL	2	3-6.1(a)
1222	Isopropyl Nitrate		VHL	2	3
2409	Isopropyl Propionate		VHL	2	3
1224	Keystones, liquid+		VHL	2	3
1056	Krypton, compressed		NHG	3	2.2
1970	Krypton, refrigerated liquid	D 2.90	HG	3	2.2

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
3163	Liquefied Gas+		NHG	4	2.2
3163	Liquefied Gas, flammable+		VHG	2	3
1058	Liquefied Gases, non-flammable, charged with nitrogen, carbon dioxide or air		NHG	4	2.2
3157	Liquefied Gas, oxidizing+		VHG	2	2.2-5.1
3162	Liquefied Gas, toxic+		VHG	2	2.3
3160	Liquefied Gas, toxic, flammable+		VHG	2	2.3-2.1
—	Liquefied Petroleum Gas		VHG	2	2.1
2445	Lithium Alkyls		VHL	2	4.2
1411	Lithium Aluminium Hydride, Ethereal		VHL	2	4.3-3
2679	Lithium Hydroxide solution		VHL	2	8
—	Lithium Bromide & water (Refrigerant +)		NHG	4	—
3053	Magnesium alkyls		VHL	2	4.2
3248	Medicines, liquid, flammable, poisonous+		VHL	2	3-6.1
1228	Mercaptans, liquid or mixtures+	FP <23°C	VHL	2	3-6.1(a)
3071	Mercaptans, liquid, or mixtures	FP≥23°C	VHL	2	6.1(a)
2809	Mercury		VHL	2	8
2024	Mercury compounds, liquid+		VHL	3	6.1(a) or (b)
1229	Mesityl oxide		VHL	2	3
2396	Methacrylaldehyde		VHL	2	3-6.1(a)
1971	Methane, or Natural Gas, compressed, CNG	D 0.55	VHG	2	2.1
1972	Methane or Natural Gas, refrigerated liquid, LNG		VHG	2	2.1
1230	Methanol (Methyl Alcohol)		VHL	2	3-6.1(b)
2605	Methoxymethyl Isocyanate		VHL	2	3-6.1(a)
2293	4-Methoxy-4-Methyl Pentan-2-One		VHL	2	3
3092	1-Methoxy-2-Propanol		VHL	2	3
1231	Methyl Acetate		VHL	2	3
1993	Methyl Acetone		VHL	2	3
1060	Methyl Acetylene and Propadiene, mixtures, stabilized	D 1.40	VHG	2	2.1
1919	Methyl Acrylate, inhibited	BP 80°C	VHL	2	3
1234	Methylal		VHL	2	3
2554	Methylallyl Chloride	BP 68°C	VHL	2	3
1061	Methylamine, Anhydrous	D 1.09	VHG	2	2.1
1235	Methylamine, Aqueous solution		VHL	2	3
1233	Methylmyl Acetate		VHL	2	3
2294	N-Methylaniline		VHL	2	6.1(b)
2938	Methyl Benzoate		VHL	2	6.1(b)
2937	a-Methylbenzyl Alcohol		VHL	2	6.1(b)
1062	Methyl Bromide	D 3.30	VHG	2	2.3
1647	Methyl Bromide and Ethylene Dibromide mixtures, liquid		VHL	2	6.1(a)

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2643	Methyl Bromoacetate		VHL	2	6.1(a)
2397	3-Methylbutan-2-one		VHL	2	3
2459	2-Methyl-1-Butene	BP 31°C	VHL	2	3
2460	2-Methyl-2-Butene	BP 39°C	VHL	2	3
2561	3-Methyl-1-Butene	BP 31°C	VHL	2	3
2945	N-Methylbutylamine		VHL	2	3
2398	Methyl tert-Butyl Ether		VHL	2	3
1237	Methyl Butyrate		VHL	2	3
1063	Methyl Chloride = R40	D 1.80	VHG	2	2.1
1912	Methyl Chloride and Methylene Chloride mixture		VHG	2	2.2
2295	Methyl Chloroacetate		VHL	2	6.1(a)
1238	Methyl Chloroformate		VHL	2	6.1(a)-3-8
1239	Methyl Chloromethyl Ether	BP 60°C	LL	1	6.1(a)-3
2933	Methyl-2-Chloro Propionate		VHL	2	3
2534	MethyChlorosilane	D >1	VHG	2	2.3-2.1-8
1648	Methyl Cyanide	BP 82°C	VHL	2	3-6.1(b)
2617	Methyl Cyclohexanols	FP ≤61°C	VHL	2	3
2297	Methylcyclo Hexanone		VHL	2	3
2299	Methyldichloro Acetate		VHL	2	6.1(b)
1242	Methyldichloro Silane	BP 41°C	VHL	2	4.3-3-8
2300	2-Methyl-5-Ethyl Pyridine		VHL	2	6.1(b)
2454	Methyl Fluoride		VHG	2	2.1
1243	Methyl Formate	BP 31°C	VHL	2	3
2301	2-Methylfuran	BP 63°C	VHL	2	3
2302	5-Methylhexan-2-one		VHL	2	3
1244	Methylhydrazine		VHL	2	6.1(a)-3-8
2644	Methyl Iodide		VHL	2	6.1(a)
2053	Methyl Isobutyl Carbinol		VHL	2	3
1245	Methyl Isobutyl Ketone		VHL	2	3
2480	Methyl Isocyanate	BP 38°C	VHL	2	6.1(a)-3
1246	Methyl Isopropenyl Ketone, inhibited		VHL	2	3
2477	Methyl Isothiocyanate		VHL	2	3-6.1(a)
2400	Methyl Isovalerate		VHL	2	3
1064	Methyl Mercaptan	D 1.70	VHG	2	2.3-2.1
1247	Methyl Methacrylate Monomer inhibited	BP 101°C	VHL	2	3
2535	Methylmorpholine		VHL	2	3
2455	Methyl Nitrate		VHG	2	2.2
2606	Methyl Orthosilicate		VHL	2	3-6.1(a)
2461	Methyl Pentadiene		VHL	2	3
2560	2-Methylpentan-2-OL		VHL	2	3

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2437	Methylphenyl Dichlorosilane		VHL	2	8
2399	1-Methylpiperidine		VHL	2	3
1248	Methyl Propionate		VHL	2	3
2612	Methyl Propyl Ether	BP 39°C	VHL	2	3
1249	Methyl Propyl Ketone		VHL	2	3
2536	Methyltetrahydro Furan		VHL	2	3
2533	Methyltrichloro Acetate		VHL	2	6.1(b)
1250	Methyltrichloro Silane	BP 66°C	VHL	2	3-8
2367	a-Methylvaler Aldehyde		VHL	2	3
1251	Methyl Vynyl Ketone		VHL	2	3
1796	Mixed Acid		VHL	2	8
2054	Morpholine	BP 129°C	VHL	2	3
1649	Motor Fuel Anti-knock mixtures		VHL	2	6.1(a)
2553	Naphtha		VHL	2	3
1256	Naphtha, solvent		VHL	2	3
2304	Naphthalene, molten		VHL	2	4.1
	Natural Gas, see Methane				
1065	Neon, compressed		NHG	4	2.2
1913	Neon, refrigerated liquid		HG	3	2.2
1259	Nickel Carbonyl		LL	1	6.1(a)-3
1654	Nicotine		VHL	2	6.1(a)
1796	Nitrating Acid mixtures		VHL	2	8
1826	Nitrating Acid mixtures, spent		VHL	2	8
2031	Nitric Acid, other than red fuming		VHL	2	8
2032	Nitric Acid, red fuming		VHL	2	8-5.1-6.1(a)
1660	Nitric Oxide	D 1.40	VHG	2	2.3
1975	Nitric Oxide with Dinitrogen Tetroxide		VHG	2	2.3
2730	Nitroanisole		VHL	2	6.1(b)
1662	Nitrobenzene		VHL	2	6.1(a)
2306	Nitrobenzo Trifluorides		VHL	2	6.1(a)
2059	Nitrocellulose solutions, flammable with more than 12.6% nitrogen, by mass, and not more than 55% nitrocellulose		VHL	2	3
2307	3-Nitro-4-Chlorobenzo Trifluoride		VHL	2	6.1(a)
1066	Nitrogen, compressed	D 0.97	NHG	4	2.2
1977	Nitrogen, refrigerated liquid		HG	3	2.2
2451	Nitrogen Trifluoride	D 2.40	VHG	2	2.3-5.1
2421	Nitrogen Trioxide	D 2.60	VHG	2	2.3-5.1
3064	Nitroglycerin (1–5%) solution in alcohol		VHL	2	3
1798	Nitrohydrochloric Acid		VHL	2	8

See end of Table for Legend. (*continued*)

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1261	Nitromethane		VHL	2	3
2608	Nitropropanes		VHL	2	3
1069	Nitrosyl Chloride	D 2.30	VHG	2	2.3-8
1070	Nitrous Oxide, compressed	D 1.50	VHG	2	2.2-5.1
2201	Nitrous Oxide, refrigerated liquid		VHG	2	2.2-5.1
1799	Nonyl trichlorosilane		VHL	2	8
2251	2,5-Norbornadiene (Dicycloheptadiene)		VHL	2	3
1800	Octadecyl Trichlorsilane		VHL	2	8
2309	Octadiene		VHL	2	3
2422	Octafluorobut-2-ENE	D 7.00	NHG	4	2.2
1976	Octafluorocyclo Butane	D 7.00	NHG	4	2.2
2424	Octafluoropropane		NHG	4	2.2
1191	Octyl Aldehydes, flammable		VHL	2	3
3023	tert-Octyl Mercaptan		VHL	2	6.1(a)-3
1801	Octyl Trichlorosilane		VHL	2	8
1071	Oil gas		VHG	2	2.1
—	Oils, Combustible, e.g. bunker, furnace, heat-transfer, lubricating, transformer and vegetable	<BP	HL	3	—
		≥BP	VHG	2	—
3101	Organic Peroxide Type B, Liquid+ also 3111, 3103, 3113, 3105, 3107, 3109, 3119		VHL	2	5.2
2471	Osmium Tetroxide		LL	1	6.1(a)
1072	Oxygen, compressed	D 1.10	VHG	2	2.2-5.1
1073	Oxygen, refrigerated liquid		VHG	2	2.2-5.1
2190	Oxygen difluoride	D 1.90	LG	1	2.3-5.1
—	Ozone gas		VHG	2	—
3066	Paint (including lacquer, stain, liguid filler, etc)—Corrosive		HL	3	8
1263	Paint (including lacquer, stain, liquid filler, etc)—Flammable		HL	3	3
1264	Paraldehyde		VHL	2	3
1380	Pentaborane	BP 48-63°C	VHL	2	4.2-6.1(a)
1669	Pentachloroethane		VHL	2	6.1(a)
2286	Pentamethylheptane		VHL	2	3
2310	Pentan-2,4-Dione		VHL	2	3
1265	n-Pentane (or Isopentane)		VHL	2	3
2750	1-Pentol		VHL	2	8
1873	Perchloric Acid, 50–72% acid by mass		VHL	2	5.1-8
1670	Perchloromethyl Mercaptan		VHL	2	6.1(a)
3083	Perchloryl Fluoride	D 3.50	VHG	2	2.3
1266	Perfumery Products, with flammable solvent		VHL	2	3
—	Pesticides, almost all are		VHL	2	3 and/or 6.1
1075	Petroleum Gases, liquefied		VHG	2	2.1

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
—	Petroleum products, includes:	FP ≤61°C	VHL	2	3
1145	Cyclohexane				
1146	Cyclopentane				
2457	2,3-Dimethylbutane				
1863	Fuel, aviation, turbine engine				
1202	Gas Oil				
1206	Heptanes				
1208	Hexanes				
1216	Isooctene				
1223	Kerosene				
2296	Methylcyclohexane				
2298	Methylcyclopentane				
1203	Motor spirit, includes gasoline or petrol				
1255	Naphtha, petroleum				
1257	Natural gasoline				
1920	Nonanes				
1262	Octanes				
1267	Petroleum crude oil				
1268	Petroleum distillates+				
1270	Petroleum fuel				
1271	Petroleum spirit				
1288	Shale Oil				
1294	Toluene				
1300	Turpentine substitute (Mineral Terpentine)				
2311	Phenetidines		VHL	2	6.1(b)
2312	Phenol, molten		VHL	2	6.1(a)
2821	Phenol, solutions		VHL	2	6.1
1803	Phenolsulfonic Acid, liquid		VHL	2	8
2470	Phenyl Acetonitrile, liquid		VHL	2	6.1(b)
2577	Phenylacetyl Chloride		VHL	2	8
1672	Phenylcarbyamine Chloride		VHL	2	6.1(a)
2746	Phenyl Chloroformate		VHL	2	6.1(a)
2487	Phenyl Isocyanate		VHL	2	6.1(a)
2337	Phenyl Mercaptan		VHL	2	6.1(a)
2798	Phenyl Phosphorus Dichloride		VHL	2	8
2799	Phenyl Phosphorus Thiodichloride		VHL	2	8
1804	Phenyltrichloro Silane		VHL	2	8
1076	Phosgene (i.e. Carbonyl Chloride)	D 3.50	LL	1	2.3
2199	Phosphine	D 1.20	VHL	2	2.3
1805	Phosphoric Acid		VHL	2	8

See end of Table for Legend. *(continued)*

TABLE 2 *(continued)*

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1810	Phosphorus Oxychloride		VHL	2	8
2198	Phosphorus Pentafluoride	D 4.30	VHG	2	2.3
1808	Phosphorus Tribromide		VHL	2	8
1809	Phosphorus Trichloride		VHL	2	8
2447	Phosphorus, White, molten		VHL	2	4.2-6.1(a)
2313	Picolines		VHL	2	3
2368	a-Pinene		VHL	2	3
1272	Pine Oil		VHL	2	3
2401	Peperidine		VHL	2	3
2315	Polychlorinated Biphenols		VHL	2	9
2427	Potassium Chlorate Aqueous solution		VHL	2	5.1
1814	Potassium Hydroxide solution		VHL	2	8
2200	Propadiene, inhibited		VHG	2	2.1
1978	Propane		VHG	2	2.1
1274	n-Propanol		VHL	2	3
1275	Propionaldehyde		VHL	2	3
1848	Propionic Acid		VHL	2	8
2496	Propionic Anhydride		VHL	2	8
2404	Propionitrile		VHL	2	3-6.1(a)
1815	Propionyl Chloride	BP 80°C	VHL	2	3-8
1276	n-Propyl acetate		VHL	2	3
1277	Propylamine	BP 49°C	VHL	2	3
2364	n-Propylbenzene		VHL	2	3
1278	Propyl Chloride	BP 47°C	VHL	2	3
2740	n-Propyl Chloroformate		VHL	2	6.1(a)-3-8
1077	Propylene		VHG	2	2.1
2611	Propylene Chlorohydrin		VHL	2	6.1(a)
2258	1,2-Propylenediamine		VHL	2	8
1279	Prophylene Dichloride		VHL	2	3
1921	Propyleneimine, inhibited		VHL	2	3
1280	Propylene Oxide	BP 35°C	VHL	2	3
2850	Propylene Tetramer		VHL	2	3
1281	Propyl Formates	BP 68°C	VHL	2	3
2482	n-Propyl Isocyanate		VHL	2	3
1865	n-Propyl Nitrate		VHL	2	3
1816	Propyl Trichlorosilane		VHL	2	8
1282	Pyridine		VHL	2	3
3194	Pyrophoric Liquid, inorganic+		VHL	2	4.2
2845	Pyrophoric Liquid, organic+		VHL	2	4.2
1817	Pyrosulfuryl Chloride		VHL	2	8

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1922	Pyrrolidine		VHL	2	3
2656	Quinoline		VHL	2	6.1(b)
1979	Rare Gas Mixtures (He, Ne, Xe, Ar, Kr)		NHG	4	2.2
—	Refrigerant Gases, non-toxic or non-flammable (refer to AS/NZS 1677.1)		NHG	4	2.2
—	Refrigerant Gases, toxic or flammable (refer to AS/NZS 1677.1)		VHG	2	2.3, 2.1
1286	Rosin oil		VHL	2	3
1287	Rubber solution		VHL	2	3
2677	Rubidium Hydroxide		VHL	2	8
—	Sarin		LG	1	
2203	Silane		VHG	2	2.1
1818	Silicon Tetrachloride	D 1.10	VHL	2	8
1859	Silicon Tetrafluoride	D 3.60	VHG	2	2.3
1819	Sodium Aluminate solution		VHL	2	8
1686	Sodium Arsenite solutions		VHL	2	6.1(a)
2428	Sodium Chlorate, Aqueous solution		VHL	2	5.1
1908	Sodium Chlorite solution		VHL	2	8
2317	Sodium Cuprocyanide solution		VHL	2	6.1(a)
1824	Sodium Hydroxide solution		VHL	2	8
1827	Stannic Chloride, Anhydrous		VHL	2	8
—	Steam		HG	3	—
2676	Stibine	D 4.30	VHG	2	2.3-2.1
2055	Styrene Monomer, inhibited		VHL	2	3
1828	Sulfur Chlorides		VHL	2	8
1079	Sulfur Dioxide, Liquefied	D 2.30	VHG	2	2.3
1080	Sulfur Hexafluoride	D 5.10	NHG	4	2.2
1830	Sulfuric Acid		VHL	2	8
2448	Sulfur, molten		VHL	2	4.1
1833	Sulfurous Acid		VHL	2	8
2418	Sulfur Tetrafluoride	D 3.70	VHG	2	2.3
1834	Sulfuryl Chloride	BP 69°C	VHL	2	8
2191	Sulfuryl Fluoride	D 3.50	VHG	2	2.3
1999	Tars, Liquid including bitumen		VHL	2	3
1693	Tear Gas Substances, liquid/solid+		VHL	2	6.1(a)
2195	Tellurium Hexafluoride	D 7.20	VHG	2	2.3
2319	Terpine Hydrocarbons+		VHL	2	3
2541	Terpinolene		VHL	2	3
2504	Tetrabromoethane		VHL	2	6.1(b)
1702	Tetrachloroethane		VHL	2	6.1(a)
1897	Tetrachloroethylene		VHL	2	6.1(b)
1704	Tetraethyl Dithiopyrophosphate		VHL	2	6.1(a) or (b)

See end of Table for Legend. (*continued*)

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2320	Tetraethylene Pentamine		VHL	2	8
1705	Tetraethyl Pyrophosphate & compressed gas		LG	1	2.3
1292	Tetraethyl Silicate		VHL	2	3
1081	Tetrafluoroethylene, inhibited	D 3.50	VHG	2	2.1
2498	1, 2, 3, 6-Tetrahydrobenzaldehyde		VHL	2	3
2056	Tetrahydrofuran	BP 66°C	VHL	2	3
2943	Tetrahydrofurfurylamine		VHL	2	3
2410	1, 2, 3, 6-Tetrahydropyridine		VHL	2	3
2412	Tetrahydrothiophene		VHL	2	3
2749	Tetramethylsilane	BP 27°C	VHL	2	3
1510	Tetranitromethane		VHL	2	5.1-6.1(b)
2413	Tetrapropylorthotitanate		VHL	2	3
2785	Thia-4-Pentanal		VHL	2	6.1(b)
2436	Thioacetic Acid		VHL	2	3
2966	Thioglycol		VHL	2	6.1(a)
1940	Thioglycolic Acid		VHL	2	8
2936	Thiolactic Acid		VHL	2	6.1(a)
1836	Thionyl Chloride	BP 79°C	VHL	2	8
2414	Thiophene		VHL	2	3
2474	Thiophosgene		VHL	2	6.1(a)
1837	Thiophosphoryl Chloride		VHL	2	8
1838	Titanium Tetrachloride		VHL	2	8
1294	Toluene		VHL	2	3
2078	Toluene Diisocyanate		VHL	2	6.1(a)
2610	Triallylamine		VHL	2	3
2609	Triallyl Borate		VHL	2	6.1(b)
2542	Tributylamine		VHL	2	8
2564	Trichloroacetic Acid, solution		VHL	2	8
2442	Trichloroacetyl Chloride		VHL	2	8
2321	Trichlorobenzenes		VHL	2	6.1(b)
2322	Trichorobutene		VHL	2	6.1(a)
2831	1, 1, 1-Trichloroethane		VHL	2	6.1(b)
1710	Trichloroethylene	BP 87°C	VHL	2	6.1(b)
1295	Trichlorosilane	BP 32°C	VHL	2	4.3
2574	Tricresyl Phosphate, with >3% or the isomer		VHL	2	6.1(a)
1296	Triethylamine		VHL	2	3
2259	Triethylene Tetramine		VHL	2	8
2323	Triethyl Phosphite		VHL	2	3
2699	Trifluoroacetic Acid		VHL	2	8
3057	Trifluoroacetyl Chloride		VHG	2	2.3

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
1082	Trifluorochloroethylene, inhibited	D 4.00	VHG	2	2.1
2324	Triisobutylene		VHG	2	3
2616	Triisopropyl Borate		VHL	2	3
2438	Trimethyl Acetyl Chloride	BP 108°C	VHL	2	8
1083	Trimethylamine, Anhydrous	D 2.10	VHG	2	2.1
2325	1, 3, 5-Trimethylbenzene		VHL	2	3
2416	Trimethyl Borate	BP 67/8°C	VHL	2	3
1298	Trimethyl Chlorosilane	BP 58°C	VHL	2	3
2326	Trimethylcyclohexylamine		VHL	2	8
2327	Trimethylhexamethylenediamines		VHL	2	8
2328	Trimethylhexamethylene Diisocyanate		VHL	2	6.1(b)
2329	Trimethyl Phosphite		VHL	2	3
2260	Tripropylamine		VHL	2	3
2196	Tungsten Hexafluoride	D 10.3 BP 19.5°C	VHG	2	2.3
1299	Turpentine		VHL	2	3
2330	Undecane		VHL	2	3
2058	Valeraldehyde	BP 103°C	VHL	2	3
2502	Valeryl Chloride		VHL	2	8
2443	Vandium Oxytrichloride		VHL	2	8
2444	Vandium Tetrachloride		VHL	2	8
1301	Vinyl Acetate, inhibited		VHL	2	3
1085	Vinyl Bromide, inhibited	D 3.7 BP 16°C	VHG	2	2.1
2838	Vinyl Butyrate, inhibited		VHL	2	3
1086	Vinyl Chloride, inhibited	D 2.20	VHG	2	2.1
2589	Vinyl Chloroacetate		VHL	2	6.1(a)
1302	Vinyl Ethyl Ether, inhivited	BP 36°C	VHL	2	3
1860	Vinyl Fluoride, inhibited	D 1.60	VHG	2	2.1
1303	Vinylidene Chloride, inhibited	BP 32°C	VHL	2	3
1304	Vinyl Isobutyl Ether, inhibited		VHL	2	3
1087	Vinyl Methyl Ether, inhibited	D 2.0 BP 6°C	VHG	2	2.1
2618	Vinyltoluene, inhibited		VHL	2	3
1305	Vinyltrichlorosilane	BP 92°C	VHL	2	3
—	Water, fresh and sea:	>100°C >90°C ≤100°C ≤90°C	HG HL NHL	3 3 4	— — —
—	Water based potable liquids, e.g. milk, soups, soft drinks	>100°C >90°C ≤100°C ≤90°C	HG HL NHL	3 3 4	— — —
1306	Wood preservatives, liquid		VHL	2	3

See end of Table for Legend. *(continued)*

TABLE 2 (*continued*)

UN No.	Fluid name		Fluid type to Table 1	Fluid type to AS 4041	ADG CODE Class and subrisk
2063	Xenon	D 4.50	NHG	4	2.2
1307	Xylenes		VHL	2	3
1711	Xylidines		VHL	2	6.1(a)
1701	Xylyl Bromide		VHL	2	6.1(a)
1840	Zinc Chloride solution		VHL	2	8

LEGEND TO TABLE 2:

+ = Not otherwise specified
BP = Boiling point at standard or atmospheric pressure
D = Vapour density at standard pressure relative to air (values are listed only for gases heavier than air except for some common gases)
FP = Flashpoint
HG = Harmful gas
HL = Harmful liquid
LG = Lethal gas
LL = Lethal liquid
MP = Melting point
NHG = Non harmful gas
NHL = Non harmful liquid
VHG = Very harmful gas
VHL Very harmful liquid

NOTE TO TABLE 2:

When selecting the fluid type, consideration should be given to the service temperature e.g. see water. Also refer to Clause 3.2 for the difference between liquid and gas, application at different temperatures, and other guidance in the use of this Table.

TABLE 3

TYPES AND CLASSES OF FLUIDS

Main property of fluid	Form of fluid (Note 1)	Fluid type to Table 1	Fluid type to AS 4041	ADG Code Class
LETHAL i.e. very toxic (Note 2) or highly radioactive	Gas Liquid	LG LL	1	2.3 6.1(a) or 7
EXPLOSIVE	Liquid	VHL	2	1.1-1.6
FLAMMABLE				
— Extremely flammable	Gas	VHG		2.1
— Flammable, i.e. flashpoint ≤61°C or the operating temperature (Note 3)	Liquid	VHL		3
— Flammable solid or self-reactive substances	Liquid	VHL		4.1
— Spontaneously combustible	Liquid	VHL		4.2
— Emits flammable gas when wet	Liquid	VHL		4.3
TOXIC (i.e. poisonous) (Note 4)				
— Toxic and very toxic gases (not in lethal)	Gas	VHG		2.3
— Very toxic (not in lethal)	Liquid	VHL		6.1 (PG I & II)
— Toxic	Liquid	VHL		6.1 (PG III)
— Infectious substances (bacteria, viruses, etc)	Liquid	VHL		6.2
HARMFUL (Note 4)	Gas or liquid	VHG or VHL		—
OXIDIZING				
— Oxidizing gas	Gas	VHG	HARMFUL TO HUMAN TISSUE	2.2 (Subrisk 5.1)
— Oxidizing agent	Liquid	VHL	HARMFUL TO HUMAN TISSUE	5.1
— Organic peroxides	Liquid	VHL	HARMFUL TO HUMAN TISSUE	5.2
RADIOACTIVE excluding highly radioactive	Gas or liquid	VHG or VHL	HARMFUL TO HUMAN TISSUE	7
CORROSIVE				
— Very corrosive to living tissue and metal	Liquid	VHL	HARMFUL TO HUMAN TISSUE	8 (PG I)
— Corrosive to living tissue and metal	Liquid	VHL		8(PG II & III)
COMBUSTIBLE **ENVIRONMENTALLY HAZARDOUS**	Liquid Liquid	HL HL	3	— 9
EXTREMELY HOT OR COLD (i.e. normal operating temperature over 90°C or below −30°C)	Liquid	HL		—
IRRITANT TO HUMANS (Note 5) **ENVIRONMENTALLY HAZARDOUS**	Gas other than type 1 or 2 to AS 4041	HG HG		2.2 (selected) 9
NOT IRRITANT TO HUMANS **NOT ENVIRONMENTALLY HAZARDOUS (NOTE 7)**	Gas other than type 1 or 2 to AS 4041	NHG NHG		2.2 (Note 6) 2.2
NON HARMFUL (NOTE 7)	Liquids other than types 1, 2 or 3 to AS 4041	NHL	4	—

LEGEND TO TABLE 3:

HG = Harmful gas
HL = Harmful liquid
LG = Lethal gas
LL = Lethal liquid
NHG = Non harmful gas
NHL = Non harmful liquid
VHG = Very harmful gas
VHL = Very harmful liquid

NOTES TO TABLE 3:

1 Solid substances are assumed to be 'liquids' when fluidized as slurries or to be 'gas' when fluidized as powder, fume, dust, and the like, in air or other gases.

2 Lethal material is 'very toxic' in NOHSC:10005 and has a time weighted average exposure standard (Acute Lethal Effect—NOHSC:1003) ≤0.1 ppm. Here ppm = part per million by volume, or equivalent concentration in mg/m^3 $\left(= \text{ppm} \times \frac{\text{molecular weight}}{24.4}\right)$ and, if applicable, ADG Code Packaging Group 1, or equivalent.

3 Operating temperature must exceed 61°C.

4 Includes some carcinogens, mutagens and teratogens and inhalation sensitisers. See Note 2 of Table 1.

5 This includes Class 2 or 6.1 substances at concentrations which are not hazardous to humans and also skin sensitizing substances.

6 Air, nitrogen, carbon dioxide, refrigerant gases are typical examples.

7 See Note 1 to Table 1 re: hazard with oxygen depletion.

APPENDIX A

LIST OF REFERENCED DOCUMENTS

(Normative)

AS	
1210	Pressure vessels
3920	Assurance of product quality
3920.1	Part 1: Pressure equipment manufacture
4041	Pressure piping
4458	Pressure equipment—Manufacture
4942	Pressure equipment—Glossary of terms
AS/NZS	
1200	Pressure equipment
1677	Refrigerating systems
1677.1	Part 1: Refrigerant classification
3788	Pressure equipment—In-service inspection
ADG Code	Australian Dangerous Goods Code
NOHSC	
1003	National Exposure Standards for Atmospheric Contaminants in the Occupational Environment
1005	National Standard for the Control of Workplace Hazardous Substances—Model Regulations
1008	National Standard for Approved Criteria for Classifying Hazardous Substances
1010	National Standard for Plant
1014	National Standard for the Control of Major Hazards Facilities
2007	National Standard for the Control of Workplace Hazardous Substances—Code of Practice
2016	National Code of Practice for the Control of Major Hazards Facilities
10005	List of Designated Hazardous Substances
AMBSC	(Australian Miniature Boiler Safety committee)
AMBSC Code	Part 1: Copper boilers
AMBSC Code	Part 2: Steel boilers, Briggs type

APPENDIX B

NUMERICAL METHOD OF DETERMINING HAZARD LEVELS FOR PRESSURE VESSELS

(Informative)

B1 GENERAL

The hazard levels of pressure vessels in Table 1 are based on the following numerical method (see Clause 2.2.3).

B2 METHOD

Determine hazard level value (H) from Equation B1.

$$H = p\,V\,F_c\,F_f\,F_s \qquad \ldots B1$$

where

H = hazard level value, in megapascal litres

p = design pressure, (see Legend to Table 1), in megapascals

V = volume (see Note 3 of Table 1), in litres

F_c = compressibility and mass factor (see Note 1 of Table 1)

= 1 for liquid

= 10 for gas

F_f = contents (fluid) factor (see Note 1 of Table 1)

= $10^{-0.5}$ for non-harmful liquids (except as provided in Table 1 note 5)

= 1.0 for non-harmful gas

= $10^{0.5}$ for harmful liquid or gas

= 10 for very harmful liquid or gas

= 1000 for lethal liquid or gas

F_s = location or service factor

= 1 unless one of the following conditions apply

= 3 for one of the conditions in Note 4(a) of Table 1

= 10 for more than one of the conditions in Note 4(a) of Table 1

= 30 for P >50 MPa (see Note 4(b) of Table 1)

= $\frac{1}{3}$ for one of the conditions in Note 4(c) of Table 1

= $\frac{1}{10}$ for more than one of the conditions in Note 4(c) Table 1

= 3 for human occupancy vessels (see Note 4(a) of Table 1)

Obtain the hazard level from the hazard level value as given below:

Hazard level value (*H*)	**Hazard Level**
$<10^{2.5}$	E
$\geq 10^{2.5}$ to $<10^{3}$	D
$\geq 10^{3}$ to $<10^{4}$	C
$\geq 10^{4}$ to $\leq 10^{8.5}$	B
$>10^{8.5}$	A

NOTES

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GPO Box 476 Sydney NSW 2001
Administration Phone (02) 8206 6000 Fax (02) 8206 6001 Email mail@standards.com.au
Customer Service Phone 1300 65 46 46 Fax 1300 65 49 49 Email sales@standards.com.au
Internet www.standards.org.au

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