AS 2971—2002

Australian Standard™

Serially produced pressure vessels

Standards Australia

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Australian Standard™

Serially produced pressure vessels

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee ME-001, Pressure Equipment to supersede AS 2971—1987, *Serially produced pressure vessels.* 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.

This Standard covers a wide range of small, usually low-hazard, pressure vessels whose design and construction are based on satisfactory burst and other performance tests of a significant number of representative samples. The main types of vessels falling into this group are small, serially produced refrigeration type vessels, air brake reservoirs, drink dispensers, and consumer items such as pressurized fire extinguisher bodies not covered by other Australian Standards, and beer kegs.

Almost invariably these types of vessels do not comply with AS 1210, *Pressure vessels,* which has been prepared primarily for one-off vessels where the design is based on proven formulas, and construction is based on proven materials, fabrication procedures, personnel, and tests which are predominantly non-destructive. AS 1210 does permit burst testing as a basis for acceptance of design of parts or vessels, but only when they cannot be calculated. Thus, there is a need to cover this alternative method of producing safe vessels where it is frequently equally sound and more economic to use burst and other performance tests to validate design, materials, and fabrication, all simultaneously.

The main changes in this revision include the following:

(a) An increase in limits on contained energy.

(b) The introduction of a two-tiered concept for vessels which distinguishes between vessels with a simple shape and design and those with a more complicated shape, higher design strength and incapable of simple analysis.

(c) A new appendix introducing the concept of an Integrated Pressure Equipment Test Station (IPETS).

(d) Alignment with Standardization Guide No. 17.1, *Drafting of Standards that may be referenced under occupational health and safety legislation*.

From 1995, there has been, and will continue to be, a phasing out of State and Territory regulatory authorities approving pressure vessel design and testing and a phasing in of competent bodies or persons to undertake this task. This Standard introduces a new concept of a pressure equipment test station, integral to the manufacturing process which will carry out these tasks.

The economy and proven safety record of this alternative approach, which essentially results in the specification of ‘performance’ type requirements was recognized during the revision of this Standard as was the need for consistency with the principles of AS 1210.

This Standard has been prepared to —

(i) avoid possible confusion between the various classes of AS 1210 vessels and the four classes of serially produced vessels; and

(ii) permit coverage of non-metallic vessels or pressure parts, e.g. plastic covers on cream dispensers or rubber protectors for thin bases of some vessels.

The adoption of various classes approximates to the principle established in AS 1210; the classification being based primarily on the minimum safety factor as in AS 1210. In this way, a variety of vessels can be covered in a systematic manner in one document. The basis of these classes is discussed in the Commentary (which follows the appendices to this Standard).

While the Standard primarily considers mass-produced or serially produced vessels, provision has been made for the production of vessels in very small numbers to meet the special needs of the refrigeration industry and the limited production runs in Australia.

Limits have been placed on volume, pressure and contained energy for these vessels to ensure reasonable harmonization with AS 1210 and to cover virtually all vessels currently produced to satisfactory standards by this approach.

It is envisaged that experience gained in the use of the Standard will highlight areas that need to be strengthened. The Standard will be regularly reviewed and revised as necessary to ensure it remains a useful document to all parties concerned and provides safe, reliable pressure plant.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

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.

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for the materials, design, manufacture, inspection and testing of serially produced metallic or non-metallic or combination unfired pressure vessels comprising:

(a) A maximum volume of 500 L.

(b) A design pressure exceeding 0.05 MPa.

(c) A product of the design pressure (in megapascals) and the total vapour space (in litres) that is greater than 1 but less than 3000. Where the vessel contents are classified as harmful or very harmful to AS 4343, the upper limit is 1500 MPa.L. This Standard excludes contents classified as lethal.

NOTE: The vapour space is the maximum volume which will contain compressed gas or vapour or liquefied gas or liquid above its atmospheric boiling point.

(d) A temperature range of –20°C to 150°C. Vessels designated outside the range of 0°C to 50°C require special tests. Refer to Appendices D, F and G where applicable.

Such vessels may be refillable or non-refillable.

NOTE: Users of this Standard are reminded that it has no legal authority in its own right, but may acquire legal standing if adopted by government or any other authority having jurisdiction, or if specified as part of a commercial contract.

1.2 OBJECTIVE

This Standard is intended to —

(a) establish minimum requirements for the materials, design, manufacture, inspection and testing for pressure vessels within the range of Clause 1.1; and

(b) provide a method of design based on destructive type testing and monitoring of manufacture by performance testing of representative samples from production. This method is an alternative to that given in AS 1210 to vessels within the range of Clause 1.1.

1.3 APPLICATION

This Standard is not intended to apply to —

(a) pressure vessels covered by other Australian Standards, e.g. portable fire extinguishers, LP Gas fuel vessels for automotive use and sterilizers;

(b) compressed gas cylinders covered by AS 2030 (series) and Supplement No. 1 to AS 2030;

(c) glass and plastics bottles; or

(d) vacuum vessels (i.e. vessels that operate only below atmospheric pressure).

1.4 REFERENCED DOCUMENTS

The following Standards are referred to in this Standard:

AS	
1056	Storage water heaters (series)
1210	Pressure vessels
1271	Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
1358	Bursting discs and bursting disc devices—Guide to application, selection, and installation
1826	Electrical equipment for explosive atmospheres—Special protection—Type of protections
2030	The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases (series)
Supp 1	Foreign gas cylinder specifications
2038	Methods for detecting the susceptibility of austenitic stainless steel to intergranular corrosion
2278	Non-refillable metal aerosol dispensers of capacity 50 mL to 1000 mL inclusive
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1841	Portable fire extinguishers (series)
3509	LP Gas fuel vessels for automotive use
3992	Pressure equipment—Welding and brazing qualification
AS/NZS ISO	
9001	Quality management systems—Requirements
ASTM	
B154	Test method for mercurous nitrate test for copper and copper alloys.
BS	
1746	Specification for domestic pressure cookers

SAE	
J10	Automotive and off-high highway air brake reservoir performance and identification requirements
ANSI/UL	
207	Refrigerant-containing components and accessories, non-electrical
DOT	
39	Non-reusable non-refillable cylinders

1.5 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 4942 and those below apply.

1.5.1 Batch

A group of serially produced vessels made with the same set-up in the same plant over a period not exceeding 3 months with a maximum interval of 5 days and subject to the same quality control measures.

NOTE: The ‘same set-up’ refers to the same diameter, nominal thickness, heat treatment process and welding control settings.

1.5.2 Certification body

A nationally recognized body that provides certification.

1.5.3 Customer

Organization or person that receives a product or service.

NOTES:

1 A customer may be internal or external to the organization.

2 A customer can be the ‘purchaser’.

1.5.4 Design minimum temperature

The lowest temperature at which the vessel part under consideration is intended to be operated. It is used to select material with suitable low temperature properties and as the basis for type and production tests.

1.5.5 Design pressure

The maximum gauge pressure, at a designated temperature, which is allowed at the top of the pressure vessel in its operating position.

1.5.6 Design temperature

The maximum temperature at the design pressure, used to determine the dimensions of the vessel part under consideration, and used as the basis for type and production tests.

1.5.7 Design verifier

A person who verifies the design of pressure equipment.

NOTE: In this Standard, the design verifier may also witness tests or interpret test results or a combination of these.

1.5.8 Integrated pressure equipment test station (IPETS)

A test station integral with the manufacturing process and operating as specified in Appendix A. It is responsible for the quality of all pressure equipment sold from the manufacturing plant from which it operates.

1.5.9 Serially produced vessels

Vessels of the same diameter, configuration, nominal thickness, materials, openings, attachments and manufacture which are produced in series in such manner and numbers as will permit the use of statistical methods to control quality.

NOTE: Such vessels are sometimes referred to as ‘multiple duplicate’ vessels.

1.5.10 Shall

Indicates that a statement is mandatory.

1.5.11 Should

Indicates a recommendation.

1.5.12 Type testing

A performance evaluation procedure (for the purpose of design verification) on a representative sample of production which ascertains that the product will fulfil the performance requirements of the design specification and the application Standard.

1.5.13 Unfired pressure vessel

A vessel subject to internal pressure or external pressure including inter-connecting parts and components up to the first point of connection to connected piping and fittings by bolting, screwing, welding, or by other means, but not including those vessels wherein steam or other vapour is or is intended to be generated, or water or other liquid is or is intended to be heated, by the application of fire or the products of combustion or by electrical means.

1.5.14 Verification

Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled (by the IPETS or an independent third party design verifier and independent third party inspector).

1.5.15 Verifying organization

An organization accredited by a recognized body to grant certificates to the integrated pressure equipment test stations.

1.6 CLASSIFICATION OF VESSELS

Vessels shall be classified according to their design, material, manufacture, and pressure performance as shown in Tables 1.1 and 1.2.

TABLE 1.1

CLASSES OF VESSELS

Class	Minimum burst pressure (times design pressure)	Minimum proof pressure (times design pressure)	Performance fatigue test	Other performance test
1H	2.35	1.25	Required if $N > 10$	see Section 5
1	3.5	1.5	Required if $N > 200$	
2	4.4	1.5 (Note 3)	Not required	
3	9	2	Not required	

NOTES:

1 N = the expected number of significant pressurizing cycles (i.e. cycles having a range of pressure greater than 20 percent of the design pressure) over the design life.

2 The manufacturer shall state in the data report the design life in cycles for Class 1H and Class 1 vessels or vessel parts.

3 Vessels less than 155 mm inside diameter and with harmful and non-harmful contents may be tested at design pressure.

TABLE 1.2

TYPICAL APPLICATIONS OF CLASSES OF VESSELS

Class	Material	Service (see Note)	Example of application
1H	Ductile	Static	Sparklet cylinders
1	Ductile	Static	Fire extinguishers
2	Ductile	Static or dynamic	Air brake reservoir, refrigeration vessels, or components, including ductile plastics vessels or components
3	Non-ductile	Static or dynamic	Cast iron, glass, or plastics vessels or components

NOTE: Static service is service where the vessel will not normally be subject to extra stresses due to external shock loads or due to pressure shocks, e.g. air brake reservoirs.

1.7 DESIGNATION

Vessels shall be designated by the number of this Standard and the class of vessel (e.g. AS 2971.1).

1.8 APPLICATION OF CLASSES AND TIERS OF VESSELS

The class and tier applicable to each vessel shall be nominated by the manufacturer and be in accordance with Table 1.1, Table 1.2 and Table 1.3 as appropriate. The class and tier nominated shall be reviewed by the person or body witnessing the type tests in accordance with Clause 5.2, applicable to the pressure envelope which is usually governed by the cylindrical shell.

Where non-ductile components are attached to ductile vessels, the non-ductile components shall be tested in accordance with Class 3 requirements. This may require different testing for the non-ductile components.

TABLE 1.3

TIERS OF VESSELS

Property	Tier 1 vessels	Tier 2 vessels
Shape	Simple (see Note 1)	All shapes
Class of vessel	1, 2 or 3	1, 2, 3, or 1H
Materials	Suitably ductile (see Note 2)	All acceptable materials
Service conditions	Fatigue tests not required except where required by Table 1.1 for Class 1	All conditions
Contents	Harmful and non-harmful (see Note 3)	All contents classifications except lethal (see Note 3)

NOTES:

1 Simply shaped: Those that are cylindrical or spherical in shape and have ends of conventional shape.

2 Suitably ductile: Those materials having a yield or 0.2% proof strength of less than 300 MPa and an elongation of more than 20%. Where the yield or 0.2% proof strength is >320 MPa but ≤360 MPa, the elongation may be reduced by 1% for each 10 MPa over 320 MPa but in no case be <16%.

3 Refer to AS 4343 for the classification of contents and hazard levels of pressure equipment.

SECTION 2 MATERIALS, DESIGN AND MANUFACTURE

2.1 MATERIALS

The material used in pressure parts of a vessel shall not be deleteriously affected by, nor have a deleterious effect on, the intended contents of the vessel, and shall be such that each vessel would be able to pass the relevant type tests specified in this Standard.

For the purpose of establishing the classification applicable to each vessel in accordance with Clause 1.8, ductile materials may be considered to be those materials which when tested by approved methods after manufacture of the vessel have not less than 8 percent elongation at rupture on a gauge length of $5.65\sqrt{S_o}$, where S_o is the original cross-section within the gauge length, or equivalent elongation when measured on other gauge lengths or in a bend test or burst test, and which do not fragment during burst tests (see Clause 3.3). The ductility shall be measured in the area or areas of the vessel, and at conditions, such as temperature, that represent the lowest ductility in the material of the vessel as manufactured. Where the manufacturing process does not significantly alter the properties of the material, test certificates for, or tests on, the original material may be accepted by the manufacturer.

2.2 DESIGN

2.2.1 General

The design shall be such that each vessel will consistently be able to pass the type tests specified in this Standard.

2.2.2 Design pressure

The design pressure shall not be less than one or more of the following:

(a) The maximum operating pressure specified in the appropriate application Standard, e.g. AS/NZS 1677 (series).

(b) The maximum pressure likely to be experienced in normal operation.

(c) The maximum developed pressure at 65°C where the vessel is likely to be exposed to the sun without insulation unless satisfactory evidence can be provided demonstrating that a lower temperature can be assumed.

(d) The start to discharge pressure of any pressure-relief device(s) in the system with which the vessel is to be used (see Note).

NOTE: To avoid premature operation of pressure-relief device(s), it is necessary for the design pressure to be higher than the normal operating pressure.

2.2.3 Crevices

Reverse curvature ends, joggled joints, joints with retained backing strips, and incomplete penetration welds are not permitted where serious crevice or local corrosion could occur.

2.2.4 Cleaning access

Suitable provision shall be made for cleaning purposes where cleaning is required in service. Access openings may be required for this purpose.

2.2.5 Inspection openings

Each vessel subject to corrosion and exceeding 155 mm inside diameter shall have at least two openings of at least 11 mm clear bore, or one opening of at least 20 mm clear bore, to permit inspection of representative areas of the vessel's inside surface. For a vessel 155 mm or less inside diameter, the size, number, and location of openings shall be appropriate for the principal dimensions of the vessel. Such openings may be provided by openings for piping, fittings, or drainage.

2.2.6 Closures

Closures shall comply with following requirements as appropriate:

(a) *Screwed cap or plug*

A screw-threaded cap or plug closure shall have provision to leak while there are still sufficient threads engaged to withstand the design pressure. Adequate allowance shall be provided for reduction of effective threads due to expected wear in operating the closure, and due to corrosion. It shall not be possible to release the closure at any dangerous pressure without a clear indication of leakage.

(b) *Studded connection*

The length of studs on a studded connection shall be such that the closure can leak while there are sufficient threads engaged to withstand the design pressure.

(c) *Bayonet closure*

For a quick-acting bayonet closure, it shall not be possible to dangerously pressurize the vessel unless the closure is fully or safely engaged (see Note 2).

(d) *Internally fitted bridge closure*

The forces on a bridge type internally fitted closure at any dangerous pressure shall be such that the closure cannot be opened by unassisted handpower (see Note 2).

(e) *Externally fitted bridge closure*

For a bridge type external closure, it shall not be possible to dangerously pressurize the vessel unless the bridge is fully or safely engaged (see Notes 1 and 2).

NOTES:

1 In Item (e), the operation of a screw on a bridge-type externally fitted closure should lift the lid slowly and cause obvious leakage before the bridge can be moved to an open position.

2 In Items (c), (d), and (e), dangerous pressure is any pressure sufficient to eject the vessel contents or any part of the closure in a manner that could result in injury to personnel.

2.2.7 Drains

Where waste liquid or deposits can accumulate in the vessel, drainage of the vessel in the operating position shall be possible. Openings provided for other purposes may be utilized for drainage.

2.3 MANUFACTURE

The manufacturing procedures shall be such that each vessel will be able to pass the relevant type tests specified in this Standard.

NOTE: See Appendix B for information to be supplied by the customer and manufacturer.

2.4 PROTECTIVE DEVICES AND FITTINGS

2.4.1 Fittings

Provision shall be made for each vessel to be equipped with valves or other pressure-retaining fittings including safety fittings necessary to ensure that, in service, the vessel will—

(a) be able to be used as intended;

(b) be protected against overpressure; and

(c) comply with the requirements of the appropriate application Standard.

2.4.2 Pressure-relief devices

Each vessel shall be fitted with a suitable pressure-relief device where either of the following conditions prevail:

(a) Where it is possible for the vessel to be pressurized in normal service from a source having a pressure greater than the design pressure of the vessel.

NOTE: Excessive pressure may be prevented by a suitable pressure-relief device in the filling system. A pressure-reducing valve or regulator is not adequate alone.

(b) Where the pressurized vessel may be subject to fire while not attached to a system having a suitable pressure-relief device, except that a pressure-relief device is not required where the gas or vapour space is not greater than 2 L and the contents are non-harmful.

Pressure-relief devices shall comply with the performance requirements of Clause 3.11.

2.5 CORROSION PROTECTION

Each vessel shall be suitably protected against corrosion, and where specified in Table 5.1 shall be capable of passing the appropriate corrosion test in Clause 3.10.

Air brake reservoirs shall be protectively treated against corrosion as follows:

(a) After satisfactory completion of hydrostatic testing, all reservoirs shall be suitably treated to remove scale and rust, dried internally, and protectively treated internally against corrosion, particular attention being paid to the open joint in the inserted end.

(b) The material used for protective treatment shall be resistant to oil, grease, water, and crankcase gases, and to temperatures up to 150°C, and when tested with an equivalent coating thickness as provided in the air reservoir, shall comply with Clause 3.10(b).

(c) An exterior paint finish providing the same salt spray protection as for the interior shall be applied to all reservoirs on completion.

SECTION 3 PERFORMANCE REQUIREMENTS

3.1 GENERAL

Each vessel shall be capable of complying with the relevant requirements specified in this Section (3) for the performance characteristics applicable to the type of vessel, as given in Table 5.1.

NOTE: Other methods of test at least equivalent to the method described in this Standard may be used subject to approval by the design verifier.

3.2 RESISTANCE TO INTERNAL PRESSURE

When proof tested in accordance with Appendix C, the vessel shall not leak nor show signs of weakness (i.e. cracking or excessive distortion).

3.3 RESISTANCE TO BURSTING AND FRAGMENTATION

When tested in accordance with Appendix D, the vessel shall not leak nor burst at, or below, the minimum burst pressure given in Table 1.1, and when the test is continued until the vessel bursts, any Class 1H, Class 1, or Class 2 vessel shall fracture in a ductile manner and shall not fragment.

3.4 RESISTANCE TO FATIGUE

When tested in accordance with Appendix E, the vessel shall not leak or show any sign of bulging, cracking, or other defects indicative of the onset of failure.

3.5 RESISTANCE TO DROPPING

When tested in accordance with Appendix F, the vessel shall not leak nor show signs of cracking except that for vessels which have non-harmful contents, leakage or penetration is permitted provided that the vessel complies with Clause 3.6(b).

3.6 RESISTANCE TO PENETRATION

When tested in accordance with Appendix G, the vessel—

(a) shall not be penetrated; or

(b) if penetrated—

  (i) shall fracture in a ductile manner;

  (ii) shall remain in one piece;

  (iii) shall not be projected in a dangerous manner (i.e. not more than 1 m in height); and

  (iv) shall not dangerously expel fluid through the penetration.

3.7 RESISTANCE TO IMPACT

When tested in accordance with Appendix H, the vessel shall not leak, and parts shall not be damaged to an extent that the vessel will not function safely. Small dents, chipping of paint work, and similar superficial damage shall be ignored.

3.8 RESISTANCE TO TORQUE

Connections for the attachment of pipe and fittings, bushings, terminal studs, and similar strength attachments to pressure parts which are subjected to torque when connections are made or removed shall not turn nor shall the vessel part be damaged when subjected to a torque of the lesser of 100 N.m and $D^2/4.5$ N.m, where D is the minimum outside diameter of the connection or the root diameter of the threaded part (in millimetres), whichever is the lesser.

There shall be no visible sign of damage to any pressure part.

3.9 CLOSURE

The closure of a vessel shall comply with the following requirements:

(a) When the closure is not completely fitted in the final operating position, the vessel shall obviously leak when pressurized and the maximum pressure which can be developed with normal filling shall not exceed a safe value for the closure.

(b) When the closure is fully shut, sealed, and at any pressure up to the design pressure, it shall not be possible by normal means (without tools) to remove the closure in a manner which could be dangerous to the operator.

(c) When the vessel is raised to the design temperature, parts of the closure to be handled shall not exceed 50°C, and when the vessel is reduced to the design minimum temperature, parts of the closure to be handled shall be not less than −20°C.

3.10 RESISTANCE TO CORROSION

Where corrosion tests of the vessel or vessel parts are required, the vessel shall comply with the following requirements as appropriate:

(a) *Welded stainless steel pressure parts*

When three test pieces from representative welds of each type of weld in a stainless steel vessel are tested in accordance with AS 2038, all test pieces shall pass the test.

(b) *Vessels subject to corrosion due to moisture*

When tested in accordance with Paragraph I3 of Appendix I, test pieces from the vessel shall not exhibit corrosion (see Notes).

NOTES:

1 Minor or scattered corrosion spots are permitted.

2 Corrosion on edges or areas damaged in preparation for the test or on purposely uncoated areas such as threads and laps is disregarded.

(c) *Parts of copper alloy containing more than 15 percent zinc*

When parts of copper alloy containing more than 15 percent zinc are tested in accordance with Paragraph I4 of Appendix I, the parts shall pass the tests.

(d) *Vessels subject to other types of corrosion*

Where vessels are subject to types of corrosion other than those covered in Items (a) to (c), approved test methods and acceptance criteria agreed by the parties nominated in Section 5 shall be used to assess the vessels.

3.11 PRESSURE RELIEF

3.11.1 Pressure-relief valves or similar devices

When a pressure-relief valve or similar device is tested in accordance with Paragraph J4.1 of Appendix J—

(a) the pressure at which the device commences to discharge shall not exceed the design pressure;

(b) the pressure at which the maximum discharge rate is achieved shall not exceed 110 percent of the design pressure; and

(c) the discharge capacity shall comply with Clause 3.11.4.

3.11.2 Rupture member

When the rupture member is tested in accordance with Paragraph J4.2 of Appendix J—

(a) the pressure at which the rupture member bursts shall not exceed the design pressure;

(b) the pressure at which the maximum discharge rate is achieved shall not exceed 110 percent of the design pressure; and

(c) the discharge capacity shall comply with Clause 3.11.4.

3.11.3 Fusible plug

When the fusible plug is tested in accordance with Paragraph J4.3 of Appendix J—

(a) the relief temperature shall be within ±6°C of the nominal relief temperature; and

(b) the discharge capacity shall comply with Clause 3.11.4.

3.11.4 Required discharge capacity

The discharge capacity mentioned in Clause 3.11.1(c), Clause 3.11.2(c), and Clause 3.11.3(b) shall be the capacity required to prevent the pressure in the vessel rising to more than 121 percent of the design pressure, under the worst conditions for which protection against excessive pressure is required. This discharge capacity may be determined from the relevant application Standard or from full scale type tests of the vessel under the worst conditions in which the vessel will be used.

3.12 MARKING PLATE ADHESION

When tested in accordance with Appendix K, the marking plate shall comply with the following requirements:

(a) Each sample shall demonstrate positive adhesion and the edges shall not be curled.

(b) The marking plate shall resist defacement or removal by scraping.

(c) The printing shall be legible and shall not be defaced by rubbing.

3.13 SURFACE QUALITY AND CONFORMANCE

When the vessel is visually examined, it shall conform to the design drawings, shall be free from sharp or pointed areas which could cause injury to personnel, and shall show no areas of non-compliance, e.g. rough, distorted, or creviced areas, incorrect shape, surface defects, coating defects, or omitted components.

3.14 OTHER PERFORMANCE CHARACTERISTICS

If compliance with performance requirements for characteristics other than those specified in this Standard is necessary to ensure the safe and reliable operation of vessels for particular uses, the manufacturer shall specify the characteristic(s) and performance requirements and shall ensure that the appropriate tests are carried out and the requirements complied with, e.g. fatigue due to externally applied cyclic loads, abrasion, erosion, and degradation of some plastics due to exposure to sunlight.

SECTION 4 MARKING AND INSTRUCTIONS

4.1 MARKING

4.1.1 Marks required

Each completed vessel shall have the following marks:

(a) Designation in accordance with Clause 1.7.

(b) Design pressure to at least two significant figures, e.g. ‘210 kPa’.

(c) Manufacturer’s name or symbol.

(d) Date of manufacture (month and year), e.g. ‘701’ meaning the seventh month (July) of 2001, or other approved coding.

(e) Where required, the design registration number allotted by the regulatory authority.

(f) Any necessary warning or advice for safe use, storage, maintenance, and disposal. Non-refillable types shall be clearly identified.

NOTE: Manufacturers who place the number of this Australian Standard on the vessels, on packaging or on literature related thereto should ensure that the products are manufactured to comply with the Standard.

4.1.2 Method of marking

Marks shall be applied so that the marks will be durable and distinctly visible during the design life of the vessel.

Marks shall be stamped, etched, moulded, or forged on the vessel or on a name plate permanently attached to the vessel. Name plates may be in the form of decals.

Where name plates or decals are used, the vessel body also shall be marked with at least the manufacturer’s mark and the date of manufacture.

4.1.3 Location of marks

Marks shall be located in a readily visible position.

4.1.4 Type of marks

Marks shall be at least 3 mm high and shall not involve sharp indentation into parts of the vessel subject to high stress unless shown to be safe by type tests.

4.2 INSTRUCTIONS

Where the manufacturer has specific requirements for installation, operation, inspection, or maintenance, or warnings to ensure safe reliable use, these shall be supplied to the purchaser in English.

SECTION 5 ASSESSMENT OF COMPLIANCE WITH THE REQUIREMENTS OF THIS STANDARD

5.1 GENERAL

Compliance with the requirements of this Standard shall be assessed by at least one of the following:

(a) An IPETS approved by a verifying organization.

(b) A quality management system certified to AS/NZS ISO 9001 implementing the requirements of this Standard.

(c) The regulatory authority, if applicable under State or Territory legislation.

Vessels shall be assessed for compliance with the performance requirements of this Standard in accordance with Table 5.1.

Tests listed in Table 5.1 shall be carried out.

NOTE: Other tests may be required by the manufacturer for quality control purposes, additional to those specified in Table 5.1.

5.2 WITNESSING OF TYPE TESTS

Type tests shall be witnessed by one of the following:

(a) The design verifier or the person nominated by the design verifier acceptable to the customer and the IPETS. (See Clause 5.1(a).)

(b) The person or body nominated by the AS/NZS ISO 9001 quality management system in Clause 5.1(b).

(c) The body nominated in Clause 5.1(c), if applicable.

5.3 REPORT OF TYPE TESTING

A report of all type tests carried out shall be compiled and be available upon request, as appropriate.

5.4 MANUFACTURER'S DATA REPORT

After the vessel has been completed and tested, the manufacturer shall complete a manufacturer's data report which contains the following:

(a) Manufacturer's name and address.

(b) Brief identification of the vessel, e.g. '2-litre refrigerant dryer—model L'.

(c) Design approval number (where applicable).

(d) Design pressure.

(e) Design temperature when above 50°C, and the design minimum temperature when below 0°C.

(f) Design life in cycles (where applicable).

(g) Main overall dimensions and thickness.

(h) Date of manufacture.

(i) Date of proof pressure testing.

(j) Certification that the vessel has been designed, manufactured, and tested in accordance with this Standard, and signed and dated by the manufacturer.

One report may cover more than one vessel.

A copy of this report and reports of all type and production tests shall be retained by the manufacturer for at least 5 years, and shall be available for examination by the regulatory authority if required.

5.5 AUDITING OF MANUFACTURER'S FACILITIES

The verifying organization or certification body and the regulatory authority, where appropriate, shall have access at all reasonable times to audit the manufacturer's facility.

5.6 RETESTS

5.6.1 Retest after failure of a type test

If a test vessel fails a type test, the cause of the failure shall be investigated, and if desired, two more vessels shall be subjected to the type test. If either of the retest vessels fail, the vessel type shall be rejected. Failures due to testing errors may be disregarded.

5.6.2 Retests after failure of a production test

If a test vessel fails a production test, the cause of the failure shall be investigated, and if desired, two more vessels from the same batch and produced as close as practicable to the failed vessel shall be subjected to the same production test.

If either of the retest vessels fails, the production batch represented by the test vessels shall be rejected or individually be subjected to approved tests. Action shall be taken to correct the cause of failure. Rejected vessels shall be repaired using a qualified procedure, e.g. for welding repairs, a qualified welding procedure according to the requirements of AS/NZS 3992.

5.6.3 Modification

After each modification including any change in material, design, or manufacturing method, those type tests which could possibly be affected by the modification shall be agreed by the parties nominated in Section 5 and repeated in full. These repeated tests shall comply with the relevant performance requirements of this Standard before production vessels can be accepted.

TABLE 5.1

SCHEDULE FOR ASSESSMENT OF PERFORMANCE CHARACTERISTICS

Performance characteristic	Reference clause	Test method reference	Applicability	Number of vessels for type testing (See Note 1)	Minimum number of vessels for production testing (See Note 12)
Resistance to proof pressure (internal pressure and leakage)	3.2	Appendix C	All types of vessels	All vessels used in other type tests	All vessels (See Note 2)
Resistance to bursting and fragmenting	3.3	Appendix D	All types of vessels	3 (See Notes 3 and 4)	1 per 500 or 1 per batch, whichever is the lesser (See Note 10)
Resistance to fatigue	3.4	Appendix E	Class 1 H vessels with more than 10 significant cycles Class 1 vessels with more than 200 significant cycles (See Note 1 to Table 1.1)	3	1 per 1000 or 1 per batch, whichever is the lesser (See Note 10)
Resistance to dropping	3.5	Appendix F	See Note 5	6 (See Note 6)	See Note to Clause 5.1
Resistance to penetration	3.6	Appendix G	See Note 5	2	
Resistance to impact	3.7	Appendix H	See Note 5	2	
Resistance to torque	3.8	Clause 3.8	Vessels with connections that may be subjected to torque	2	
Closure	3.9	Clause 3.9	Vessels with closures which can be operated by hand without tools	2	
Resistance to corrosion	3.10	Appendix I and AS 2038	Where the combination of materials and internal or external environment may cause serious corrosion (See Notes 7 and 8)	1	
Pressure relief	3.11	Appendix J	Vessels fitted with pressure-relief or temperature-relief devices	3 (See Note 9)	1 per 1000 or 1 per batch, whichever is the lesser (See Note 11)
Marking plate adhesion	3.12	Appendix K	Vessels which use a marking plate which is cemented to the vessel	3 (See Note 9)	1 per 1000 or 1 per batch, whichever is the lesser
Surface quality and conformance	3.13	Clause 3.13	All types of vessels	All vessels used in other type tests	All vessels (See Note 2)
Other	3.14	Clause 3.14	See Clause 3.14	—	—

NOTES TO TABLE 5.1:

1 Where appropriate, the same vessel may be used in more than one test.

2 All production vessels are to be proof pressure-tested and visually examined.

3 For vessels that are intended for use at temperatures both below 0°C and above 50°C, four burst tests are required (see Appendix D, Paragraph D4(b)).

4 For Class 1H, Class 1, and Class 2 vessels, the pressure in one or more of the test vessels (see Appendix D, Paragraph D6.1(c)) is to be increased until the vessel bursts, as specified in Appendix D.

5 Tests are required only for vessels that may be carried by a person or dropped near persons while pressurized and the following:

(a) Constructed of metals of thickness less than—

(i) for all castings..... 4 mm;

(ii) for all wrought steels and for nickel and titanium .....1.75 mm; or

(iii) for other wrought non-ferrous metals.....2.5 mm.

(b) Constructed of non-metallic materials of thickness less than..... 2.5 mm.

6 An additional six tests are required when vessels may operate below 0°C, and a further six tests if vessels may operate above 50°C. At the manufacturer's option one vessel may be used for more than one test. At least three separate vessels shall be tested in each test series.

7 Serious corrosion is corrosion which would make the vessel unsafe for its intended use. Approved satisfactory service under similar conditions is acceptable as an alternative to these tests.

8 Air brake reservoirs are an example (because control of internal corrosion is important).

9 Alternative and where appropriate, relief devices and marking plates may be tested separately from the vessel.

10 The number of vessels for the burst and fragmentation production tests and the fatigue production tests may be halved where at least 10 consecutive tests of a particular vessel design exceeds the requirement as follows:

(a) Burst and fragmentation test ..... 1.2 times the specified minimum burst pressure.

(b) Fatigue test ..... 2 times the specified number of cycles.

11 Production tests are required for the performance requirements specified in Item (a) only of each of Clause 3.11.1, Clause 3.11.2, and Clause 3.11.3.

12 Tier 1 vessels complying with the ductile requirements of Table 1.3 Note 2 are exempt from all production test requirements, except where Clauses 3.2, 3.13 and, where appropriate, Clause 3.14 apply.

APPENDIX A

INTEGRATED PRESSURE EQUIPMENT TEST STATIONS

(Normative)

A1 SCOPE

This Appendix sets out the requirements for an Integrated Pressure Equipment Test Station (IPETS).

A2 GENERAL REQUIREMENTS

The IPETS shall ensure that all new items of pressure equipment which are released from the plant —

(a) comply with the design;

(b) are manufactured by the manufacturing processes used to produce the type tested pressure equipment of that design;

(c) have passed the 'new pressure equipment' inspection requirements of AS 2971 prior to the delivery of any pressure equipment to a customer; and

(d) have been stamped with the IPETS stamp to indicate that the pressure equipment has passed all the required quality control measures specified in the design.

A3 SPECIFIC REQUIREMENTS

To achieve the requirements of Paragraph A2, the IPETS shall ensure that —

(a) all requirements of the appropriate product Standard are met;

(b) all type tests are conducted by a competent design verifier acceptable to the customer and the IPETS;

(c) traceability of materials of construction conforms with the requirements of the appropriate product Standard;

(d) the components of construction comply with the shape requirements of the design and any tolerances specified in the product Standard and associated Standards;

(e) all welding procedures are implemented within the allowable tolerances;

(f) all non-destructive examination is carried out by personnel acceptable to the signatory of the responsible NDE organization;

(g) heat treatment processes are properly controlled and recorded;

(h) destructive testing is carried out by personnel acceptable to the signatory of the testing organization;

(i) proof testing is carried out in accordance with AS 2971, or other equivalent product Standard;

(j) all inspection and test results are recorded and all records are traceable;

(k) surface treatment complies with the design requirements, AS 2971 and the product specification;

(l) all inspections required by AS 2971, or other equivalent product Standard, for new pressure equipment have been passed;

(m) all markings are correct, including the test station mark of the IPETS; and

(n) at least one audit of the facility is carried out annually by a verifying organization in conjunction with, where appropriate under legislation, the regulatory authority (having responsibility for pressure equipment in the jurisdiction in which the container manufacturing plant is located). Such audits shall verify that the IPETS is implementing Items (a) to (m) of Paragraph A3 at a satisfactory level of competence and that the management of the IPETS is competent to continue to operate the IPETS for at least an additional twelve months.

NOTE: It is also understood that informal audits by representatives of the original auditors may occur from time to time as the opportunity arises.

APPENDIX B

INFORMATION TO BE SUPPLIED BY THE CUSTOMER AND THE MANUFACTURER

(Informative)

B1 INFORMATION TO BE SUPPLIED BY THE CUSTOMER

To assist in ensuring that each completed vessel will comply with this Standard, the applicable information listed below should be provided by the customer to the manufacturer not later than the time of placement of the order.

The customer should include such additional requirements, which in the customer's view, are necessary to enable the vessel to carry out its intended function in a satisfactory manner.

(a) Size and overall dimensions.

(b) Number, size, location, and type of connections and openings.

(c) Type and mode of support.

(d) Whether vessel is covered by any other Standard (e.g. AS 1677 series).

(e) Design pressure and design temperature.

(f) For vessels to operate below 0°C, the design minimum temperature and coincident pressure.

(g) Number of operating cycles expected from the intended service of the vessel (see Clause 1.6).

(h) Material to be used and corrosion allowance.

(i) Classification of vessel (see Clause 1.6).

(j) Contents of vessel (i.e. contained fluid).

(k) Any excessive loads or torques (see Clause 3.8) to be applied to nozzles or other parts of the vessel.

(l) Whether vessel is to be carried by, or is likely to be dropped near, persons while pressurized.

(m) Type of closure (see Clause 2.2.6).

(n) Specific details on flanges and connections including tolerances on locations and machined surfaces.

(o) Surface treatment and finishes, internal and external.

(p) Insulation—hot or cold, as required.

(q) Whether pressure-relief devices are required and type of device (see Clause 2.4).

(r) Whether vessel is to be used as a transport vessel.

(s) Whether vessel is to be supplied complete with valves and fittings.

(t) Any other tests required (e.g. leakage tests in completed condition) (see Clause 3.14).

NOTE: Where the manufacturer is producing a standard vessel to serve multiple purposes, the customer should be provided with the information, requested in the applicable items listed above, that is used as the basis for manufacture of the vessel.

B2 INFORMATION TO BE SUPPLIED TO THE DESIGN VERIFIER TO OBTAIN DESIGN APPROVAL

The following information is to be prepared, and if requested supplied to the design verifier to obtain design approval:

(a) Prior to commencing manufacture —

(i) design data which includes Items (a) to (t) of Paragraph B1;

(ii) details of any welding procedures, heat treatments, or specific inspection techniques to be used (e.g. ultrasonic or magnetic particle examinations);

(iii) brief description of manufacturing methods for major components (e.g. deep drawn, hot pressed, cold formed, extruded);

(iv) notification of timing of the type tests;

(v) report of type test results; and

(vi) application Standards and any additional documentation reasonably requested by the design verifier.

(b) On completion of manufacture —

(i) records of results of production tests;

(ii) records of material identification;

(iii) records of any heat treatment; and

(iv) reports on any non-destructive examination.

NOTE: The information required in Item (b) above need not be submitted to the design verifier, but should be maintained in-house for random audit from time to time.

APPENDIX C

PROOF PRESSURE TESTS

(Normative)

C1 SCOPE

This Appendix sets out a method for the proof pressure testing of pressure vessels.

Vessels designed with contents which are classified as harmful, very harmful or lethal to AS 4343 shall be subject to a leakage test in addition to the proof pressure test.

C2 PRESSURIZING MEDIUM

Where the test vessel is not contained in a test chamber, the pressurizing medium shall be water or a non-harmful liquid which is not harmful to the vessel. However, air or non-harmful gas may be used as the pressurizing medium where the test vessel is contained in a test chamber which will prevent injury to the test operator in the event of a failure.

NOTE: The proof test of vessels is traditionally by hydrostatic means, but it is not intended that this Standard prohibit pneumatic testing. Pneumatic testing has particular hazards which must be guarded against and may require specific approval of the equipment and procedure by the relevant regulatory authority.

C3 STATE OF VESSEL

The vessel shall be completely fabricated except that any painting, coatings, or insulation shall not be present.

C4 PROCEDURE

The procedure shall be as follows:

(a) Where air or gas is the pressurizing medium, the vessel shall be immersed in water, or seams and other places on the vessel where leakage could occur shall be covered with a soap solution, heavy oil or other suitable liquid.

(b) The vessel shall be pressurized internally to the minimum test pressure given in Table 1.1 as appropriate for the class of vessel.

(c) The test pressure shall be maintained for at least 15 s for vessels up to and including 5 L water capacity, and at least 30 s for vessels exceeding 5 L water capacity.

(d) The whole of the external surface of the vessel at test pressure shall be examined visually for leaks of liquids or bubbles from seams and other possible leakage places and for signs of weakness.

(e) The leakage test shall be conducted at a pressure equal to at least 90%, but no greater than, the design pressure, using a test medium at least as searching as the intended contents of the vessel in service.

NOTE: Where the vessel manufacturer is requested to supply the vessel with fittings, the leakage test may be conducted on the vessel complete with fittings.

C5 REPORT

The reported results shall be that the vessel(s) has passed the proof pressure tests.

APPENDIX D

BURST AND FRAGMENTATION TEST

(Normative)

D1 SCOPE

This Appendix sets out a method for the burst and fragmentation testing of pressure vessels.

D2 PRESSURIZING MEDIUM

The pressurizing medium shall be water or a non-harmful liquid which is not harmful to the vessel and will not freeze in low temperature tests (anti-freeze may be added).

D3 TEST SAMPLES

The vessels shall be typical of production and be completely fabricated, including any painting or coating, and stampings, but excluding any applied thermal insulation.

D4 TEST TEMPERATURE

The temperature at which the test(s) shall be carried out shall be as follows:

(a) For vessels that are intended for use in the temperature range of 0°C to 50°C, the test shall be carried out at ambient temperature.

(b) For vessels that are intended for use at temperatures both below and above the temperature range 0°C to 50°C, two (type) tests shall be carried out at each of the following temperatures:

  (i) Design minimum temperature.

  (ii) Design temperature.

(c) For vessels that are intended for use either below 0°C or above 50°C, one (type) test shall be carried out at ambient temperature and two tests at design minimum temperature or design temperature as appropriate.

(d) For production tests on vessels requiring type tests in accordance with Item (b) or (c), the production tests shall be carried out at each of the required temperatures in sequence.

D5 PREPARATION FOR THE TEST

Where gaskets or mechanical seals prevent the required burst pressure being attained, the gaskets and seals shall be nullified to enable the burst test to be carried out (type test only).

NOTE: It may be necessary to carry out the burst test with components such as covers, fittings, or bridge beams removed and replaced by parts specially made for the tests or specially welded or other appropriate means.

D6 PROCEDURE

D6.1 General

The procedure shall be as follows:

(a) The internal pressure in the vessel shall be raised gradually (over at least 1 min) to the minimum burst pressure given in Table 1.1 as appropriate for the class of vessel.

(b) The pressure shall be maintained for at least the following period:

(i) For type tests ..... 30 min.

(ii) For production tests ..... 1 min.

(c) For Class 1H, Class 1, and Class 2 vessels, the pressure in one or more of the test vessels shall be increased until the vessel bursts, as follows:

(i) Where the test is being carried out in accordance with Paragraph D4(a), one test vessel.

(ii) Where the test is being carried out in accordance with Paragraph D4(b) or Paragraph D4(c)—

(A) one test vessel at the highest required test temperature; and

(B) one test vessel at the lowest required test temperature.

NOTE: If gaskets or mechanical seals (e.g. mating machined surfaces other than simple threaded joints) are employed in components designed for use in systems containing any of the refrigerants 11, 12, 13, 112, 113, 114, 115, 500, and 502, leakage at the gaskets or seals will not be considered a failure provided that the leakage occurs at a pressure greater than twice the design pressure.

D6.2 Safety precautions

Care shall be taken to exclude all air and to provide suitable protection from ruptured parts and the discharged test medium.

D7 REPORT

The following shall be reported:

(a) For procedures of Paragraphs D6.1(a) and D6.1(b)—

(i) maximum test pressure; and

(ii) any sign of leakage or bursting.

(b) For procedures of Paragraph D6.1(c), the burst pressure and the location and type of failure.

APPENDIX E

FATIGUE TEST

(Normative)

E1 SCOPE

This Appendix sets out a method for the fatigue testing of pressure vessels.

E2 PRESSURIZING MEDIUM

The pressurizing medium shall be water or a non-harmful liquid which is not harmful to the vessel.

E3 TEST SAMPLE

The vessels shall be typical of production and be completely fabricated, including any painting or coating, and stampings, but excluding any applied thermal insulation.

E4 PROCEDURE

The procedure shall be as follows:

(a) The vessel shall be pressurized internally and the pressure cycled from not more than 5 percent of the design pressure to not less than 100 percent of the design pressure.

(b) Cycling preferably should be at less than 0.25 Hz and such that the temperature of the vessel does not exceed the design temperature of the vessel.

(c) The number of cycles applied shall be not less than —

  (i) for Tier 1 vessels 10 000;

  (ii) for all other vessels..... 10 times the expected number of significant cycles in the life of the vessel (see Note 1 to Table 1.1).

E5 REPORT

The following shall be reported:

(a) The number and frequency of cycles.

(b) The maximum and minimum pressures.

(c) Any sign of leakage and its location.

(d) Any sign of bulging, cracking, or other defects indicative of the onset of failure.

APPENDIX F

DROP TEST

(Normative)

F1 SCOPE

This Appendix sets out a method for the drop testing of pressure vessels.

F2 APPARATUS

The following apparatus is required:

(a) Target consisting of a 100 mm × 100 mm steel angle of sufficient length to avoid penetration of the vessel by the ends of the angle. The toes of the angle shall be securely fixed to a target base. The edges and corner of the cut ends of the angle may be radiused to not more than 1 mm.

(b) Target base having a horizontal and flat surface and which is massive enough to be immovable and rigid enough to be non-deformable under test conditions while complying with the following requirements:

(i) It shall be in one piece with a mass at least 50 times the gross mass of the heaviest vessel to be tested.

(ii) It shall be flat to the extent that no two points on the surface differ in level by more than 2 mm.

(iii) It shall be rigid to the extent that it will not be deformed by more than 0.1 mm when an area of 100 mm^2 is loaded statically with 10 kg anywhere on the surface.

(iv) It shall have an area sufficient to ensure that the test vessel falls entirely upon the surface.

NOTE: An impact plane in accordance with AS 2582.4 complies with this requirement.

F3 TEST SAMPLES

The vessels shall be typical of production and be completely fabricated, including any painting or coating, and stamping but excluding any applied thermal insulation unless otherwise approved.

Six vessels shall be used in each drop test (see also Note 6 to Table 5.1).

F4 TEST TEMPERATURE

The temperature of the vessels and contents during the test shall be as follows:

(a) Where the vessels are intended to be used in the temperature range 0°C to 50°C..... .....in the range 7°C to 50°C.

(b) Where the vessels may be used below 0°C..... as in Item (a) and also at the design minimum temperature.

(c) Where the vessels may be used above 50°C and it is feasible for pressure parts of the vessel to be weakened or embrittled..... as in Item (a) and also at the design temperature.

F5 PREPARATION FOR THE TEST

The preparation of each vessel used for the test is as follows:

(a) The vessel shall be pressurized to the design pressure and, if it is to be used with liquid or solids, also filled to the maximum rated liquid or solid level. The liquid and solids should preferably be the same as those to be contained but where this would be dangerous, alternative contents (e.g. water) may be used provided that the level is at least 90 percent of the rated level, the mass is at least 90 percent of the rated mass, and the water does not freeze in low temperature tests (anti-freeze may be added). Where the vessel is pressurized by air or gas, the relevant requirements in Paragraph C2 of Appendix C shall apply.

(b) Where plastics pressure-retaining parts are used, the plastics shall be conditioned to represent the degradation expected to occur over the designed life of the part.

F6 PROCEDURE

F6.1 General

The six sample vessels used in each drop test shall be dropped 1.5 m onto the target described in Paragraph F2 in a range of positions which will assess the impact resistance of all critical parts of the vessel. For example, for a welded cylindrical vessel, the positions adopted in the assessment may include dropping of the vessel—

(a) flat on the central part of the longitudinal seam, with the axis of the vessel approximately perpendicular to the length of the angle;

(b) diagonally on the circumferential seam between the ends and the cylinder;

(c) diagonally on the base ring, valve guard and any exposed fittings; and

(d) on any closure or pressure part not tested by Steps (a), (b), or (c) above.

F6.2 Safety precautions

Safety precautions shall be taken to ensure no danger exists to persons as a result of the drop and impact, such as shattering of the vessel.

F7 REPORT

Any sign of leakage or cracking and its location shall be reported.

APPENDIX G

PENETRATION TEST

(Normative)

G1 SCOPE

This Appendix sets out a method for the penetration testing of pressure vessels.

G2 APPARATUS

The apparatus for the test shall comprise a hardened steel target which has a conical point with a 60 degree included angle and a radius not greater than 0.5 mm on the end of a 30 mm diameter rod securely fixed to, and projecting 50 mm above the target base described in Paragraph F2(b) of Appendix F.

Alternatively, the target may be attached to the test samples, at the positions specified in Paragraph G6.1 in sequence, instead of the base.

G3 TEST SAMPLES

The vessel shall be typical of production and be completely fabricated, including any painting or coating, and stamping, but excluding any applied thermal insulation.

One vessel may be used for both penetration tests. After the first penetration test in Paragraph G6.2(a), the vessel may be repaired to hold pressure for the second penetration test in Paragraph G6.2(b), on another point of the pressure envelope. If the vessel cannot be repaired, another identical vessel may be used.

G4 TEST TEMPERATURE

The test(s) shall be carried out at the temperature(s) specified in Paragraph F4 of Appendix F as appropriate.

G5 PREPARATION FOR THE TEST

Each vessel used in the test shall be prepared as described in Paragraph F5 of Appendix F.

G6 PROCEDURE

G6.1 General

The test procedure shall be either of the following:

(a) Dropping the vessel 1.5 m onto the target as described in Paragraph G2.

(b) Dropping the target as described in Paragraph G2 onto the vessel from a height which achieves the equivalent energy as in Item (a).

The procedure should be nominated by the manufacturer, unless specified by the customer and should approximate service conditions.

G6.2 Orientation

The orientation of the vessel for the procedure described in Paragraph G6.1(a) shall be as follows:

(a) For the first test, the vessel shall be dropped so that the centre of the longitudinal side first hits the target. Where the vessel has a longitudinal weld or a central circumferential weld, the point of impact shall be the weld or its heat-affected zone.

(b) For the second test, the vessel shall be dropped so that the end hits the target and is normal to the target when it hits.

The orientation of the vessel for the procedure described in Paragraph G6.1(b) shall be the same as that in Items (a) and (b), except that the target shall be dropped onto the vessel.

G6.3 Safety precautions

Safety precautions shall be taken to ensure that no danger exists to persons as a result of the drop and impact, such as shattering of the vessel.

G7 REPORT

The following shall be reported:

(a) Whether the vessel was penetrated.

(b) If penetrated, whether the vessel—

(i) fractured in a ductile manner;

(ii) remained in one piece;

(iii) was not projected in a dangerous manner, i.e. not more than 1 m in height; and

(iv) did not dangerously expel fluid through the penetration.

APPENDIX H

IMPACT TEST

(Normative)

H1 SCOPE

This Appendix sets out a method for the impact testing of pressure vessels.

H2 APPARATUS

The following apparatus is required:

(a) A rigid test block having a mass of 1 kg fitted with a toughened steel impact head in the form of a 25 mm diameter hemisphere with a smooth surface.

(b) A rigid base having a mass of at least 20 kg.

H3 TEST SAMPLES

The vessels shall be typical of production and be completely fabricated, including any painting or coating, and stamping, but excluding any applied thermal insulation.

H4 TEST TEMPERATURE

Except where the vessel or vessel parts are made of plastics materials, the test shall be carried out at a temperature in the range 7°C to 30°C.

For plastics materials, the test temperature shall be as follows:

(a) Where the vessel may be used below 0°C ..... the design minimum temperature.

(b) Where the vessel may be used at or above 0°C.....the design temperature.

H5 PREPARATION FOR THE TEST

The vessel shall be pressurized to the design pressure. The part of the vessel to be impacted should have a pressurizing medium of air on the inside if that part will have gas or vapour backing in service; otherwise the test medium should be water, with provision to prevent freezing during any low temperature test (anti-freeze may be added).

H6 PROCEDURE

H6.1 General

The test procedure shall be either of the following:

(a) Dropping the test block described in Paragraph H2(a) from a height of 2 m onto the vessel mounted on the rigid base as described in Paragraph H2(b) so that the direction of impact is normal to the surface being tested.

(b) Dropping the vessel onto the test block as described in Paragraph H2(a) from a height which achieves an equivalent energy as H6.1(a) so that the direction of impact is normal to the surface being tested.

The point of impact shall be at the place(s) considered by the design verifier to be the weakest.

The test procedure used should be nominated by the manufacturer, unless specified by the customer and should approximate service conditions.

H6.2 Safety precautions

Safety precautions shall be taken to ensure no danger exists to persons as a result of the drop or impact, such as shattering of the vessel. Where gas backing is required, the volume of gas should be reduced by part filling of the test vessel with water.

H7 REPORT

Any sign of leakage or damage to parts shall be reported.

APPENDIX I

CORROSION TESTS

(Normative)

I1 SCOPE

This Appendix sets out two methods for the corrosion testing of pressure vessels, viz. the salt spray test and the brass-cracking test.

I2 APPLICATION

I2.1 Salt spray test

The salt spray test is appropriate where the internal surfaces of air brake reservoirs and similar vessels may be subject to corrosion due to moisture or have protection coatings.

I2.2 Brass-cracking test

The brass-cracking test is appropriate where components are made of copper alloy containing more than 15 percent of zinc.

I3 SALT SPRAY TEST

The procedure shall be as follows:

(a) A vessel typical of production, completely fabricated including any painting or coating, and stampings, shall be cut into quarters so that each section includes 50 percent of one end and 25 percent of the shell, or equivalent sections for non-cylindrical vessels.

(b) After 72 h exposure to air, the sectioned vessel shall be placed in a spray booth in a position which will ensure that thorough drainage occurs.

(c) The vessel sections shall be tested in accordance with AS 2331.3.1 for a period of 40 h.

I4 BRASS-CRACKING TEST

The procedure shall be as follows:

(a) The brass parts shall be subjected to the physical stresses normally imposed on or within a part as a result of assembly. Such stresses shall be applied to and be effective during the test. (See Table I1 for required torque.)

(b) The parts shall be immersed in an aqueous mercurous nitrate solution containing 10 g of mercurous nitrate and 10 mL of nitric acid (ϱ_{20} 1420 kg/m^3) per litre of solution.

Instructions and precautions for the preparation of solutions and procedures for replenishment, together with descriptions for cleaning and degreasing of samples, shall be as set out in ASTM B 154.

WARNING: TESTING WITH MERCURY IS A DEFINITE HEALTH HAZARD BOTH IN THE FORM OF MERCUROUS NITRATE CRYSTALS AND IN THE FORM OF VAPOUR PRODUCED BY VOLATILIZATION. EQUIPMENT FOR THE DETECTION AND REMOVAL OF MERCURY VAPOUR IS ALWAYS TO BE PROVIDED. RUBBER GLOVES ARE ALWAYS TO BE USED IN HANDLING CRYSTALS AND DURING ALL OTHER PHASES OF TESTING.

TABLE I1

TEST TORQUE FOR FEMALE THREADED CONNECTIONS

Connection size (nominal copper tube size)	Torque N.m
3	17
6	28
10	51
15	91
20	113
25	136
32	164
40	175
50	186
65	198
80	204
100	215

NOTE: Other threaded components for test are to be tightened to the degree normally found acceptable to produce a leak-tight assembly.

APPENDIX J

PRESSURE-RELIEF DEVICE TESTS

(Normative)

J1 SCOPE

This Appendix sets out methods for testing three types of safety devices designed to operate when the pressure or temperature in a vessel exceeds a predetermined value. These safety devices are as follows:

(a) Pressure-relief valve or equivalent device.

(b) Rupture disc or similar device.

(c) Fusible plug.

NOTE: Devices complying with AS 1271, AS 2613 or AS 1358 are not required to be tested.

J2 PRESSURIZING MEDIUM

Where the devices are to be used on vessels which will contain liquid only, the pressurizing medium shall be water or a non-flammable, non-toxic liquid which is not harmful to humans.

Where the device is to be used on vessels which will contain gas or vapour, the pressurizing medium shall be air or a non-flammable, non-toxic gas which is not harmful to humans.

J3 TEST SAMPLES

The samples shall be typical of the devices to be installed on the vessel.

Three samples shall be tested.

The tests may be carried out with the device fitted to the vessel or separately.

J4 PROCEDURE

J4.1 Pressure-relief valves or similar devices

The procedure shall be as follows:

(a) The sample devices shall be connected individually or together to a suitable pressure source (see Paragraph J2).

(b) The pressure on the device shall be increased gradually to 90 percent of design pressure and thereafter at a rate not greater than 5 percent of the nominal set pressure of the device per minute until the required discharge capacity is reached.

J4.2 Rupture discs or similar devices

The procedure shall be as follows:

(a) The sample devices shall be connected individually or together to a suitable pressure source (see Paragraph J2).

(b) The pressure on the device shall be increased gradually to 90 percent of design pressure and thereafter at a rate not greater than 5 percent of the nominal rupture pressure per minute until the device ruptures.

J4.3 Fusible plug

The procedure shall be as follows:

(a) Each sample plug shall be connected to a 3 m length of coiled copper tubing and pressurized to at least 50 percent of design pressure or 0.3 MPa, whichever is the lesser.

(b) The pressurized sample and coil shall be immersed in fluid with a temperature 10°C below the nominal relief temperature of the plug and soaked for at least 5 min.

(c) The temperature of the fluid shall then be increased at a rate not greater than 0.5 K/min until the complete blowout of the plug has occurred.

NOTE: Blowout is complete if the area of the relief opening is such that the resulting discharge capacity equals or exceeds that required.

J5 REPORT

The following shall be recorded:

(a) For procedure of Paragraph J4.1 —

(i) pressure at which the device commenced to discharge; and

(ii) maximum discharge rate and associated pressure.

(b) For procedure of Paragraph J4.2—

(i) pressure at which the rupture member bursts; and

(ii) maximum discharge rate and associated pressure.

(c) For procedure of Paragraph J4.3—

(i) temperature at which complete blowout occurs; and

(ii) maximum discharge rate and associated pressure.

APPENDIX K

MARKING PLATE ADHESION TEST

(Normative)

K1 SCOPE

This Appendix sets out a method for testing the adhesive used to secure marking plates to vessels.

K2 PROCEDURE

The procedure shall be as follows:

(a) Six samples of the marking plate as received by the vessel manufacturer shall be secured to a surface equivalent to that of the vessel by the cement or adhesive to be tested.

NOTE: The tests may be carried out with the marking plate fitted to the vessel or separately.

(b) Not less than 24 h after the marking plates have been cemented to the surface—

(i) three of the test samples shall be immersed in water at a temperature of 23 ±2°C for not less than 48 h; and

(ii) three of the test samples shall be placed in an air oven maintained at the appropriate temperature specified in Table K1 for 240 h.

TABLE K1
AIR OVEN TEMPERATURES

degrees Celsius

Maximum normal operating temperature of surface of applied label ($T_{max.}$)	Minimum air oven temperature ($T_{min.}$)
$T_{max.} \leq 60$	87
$60 < T_{max.} \leq 80$	105
$80 < T_{max.} \leq 100$	121
$100 < T_{max.} \leq 125$	150
$125 < T_{max.} \leq 150$	180

(c) Each test shall be examined immediately after removal from the test medium and also after exposure to ambient air, and then—

(i) a flat metal blade 1.6 mm thick held at right angles to the test sample shall be scraped across the surface; and

(ii) the printing on the test sample shall be rubbed with the thumb or forefinger.

K3 REPORT

The following shall be reported:

(a) Any lack of adhesion or curling of edges.

(b) Any defacement of the marking plate.

(c) Any lack of legibility of the printing.

COMMENTARY

This commentary briefly outlines some matters taken into account in the development of this Standard and is complementary to the Preface in which some such matters are also covered.

The main purpose of the Standard is to provide a consistent set of requirements for a large range of small pressure vessels which are produced in Australia and overseas to a variety of specifications, some national, others industry or in-house. In such specifications, the integrity and performance of the vessel is assessed by suitable destructive tests on completed vessels during their development and continued production. The Standard is intended to consolidate current practice, complement AS 1210 and the AS 2030 (series), limit the proliferation of similar Standards and assist users, manufacturers, importers, and statutory authorities by providing a sound basis for the manufacture of such vessels.

In this edition of the Standard, the new concept of an Integrated Pressure Equipment Test Station (IPETS) has been introduced to provide a more efficient and economical route of producing the final product directly to the customer. The test station operates as an integral part of the manufacturing process and is responsible for the quality of pressure equipment released from the facility.

The accompanying table, 'Summary of Requirements in Miscellaneous Standards', was compiled to enable ready comparison of current practice in various existing specifications. However, it should be noted that the Standard is *not* intended to cover all the vessel types in the table (e.g. those already covered by other Australian Standards).

In the following commentary, headings are related to headings in the Standard, and, where appropriate, the number of the clause or section is shown in brackets.

Scope (Clause 1.1)

The maximum volume of the type of pressure vessels that this Standard is intended to cover is specified, but not the maximum pressure. However, limits specified for the product of the volume and pressure impose limits on the total energy permitted in any vessel.

Attention is drawn to the Note in the Scope clause and the Preface of this Standard to the need for manufacturers, importers, and users to comply with the appropriate statutory requirements in each of the States or Territories of Australia in which the vessel is used. While these requirements may still vary from State to State or Territory, it is understood that the authorities are continuing to review this situation with the aim of further unifying requirements.

Classification of vessels (Clause 1.6)

The safety factors (minimum burst pressure divided by design or equivalent pressure) were determined after a review of Australian and overseas Standards that have been used successfully for a wide range of similar type pressure vessels such as those in the accompanying table and in AS 1210. The safety levels required for other performance characteristics are comparable with those in the burst test.

It was recognized that where a factor of safety less than 4 is specified for the burst test, the test does not necessarily ensure that the vessel has an adequate margin of safety against failure due to fatigue. Hence a fatigue performance test has been included as a requirement where the vessel may be subjected to cyclic loading.

Performance requirements (Section 3) and their assessment (Section 5)

Design and construction type Standards such as AS 1210 require pressure parts to be subject to detailed design, non-destructive testing, destructive tests on production test plates, and to be constructed by approved welding procedures and qualified welders. In this Standard, for serially produced vessels of relatively small size, the integrity of the vessel is established and assessed on the basis of specified performance requirements. These performance requirements are assessed by type tests, usually destructive, on samples of complete vessels or parts of finished vessels, and by production tests, to establish that the vessels are consistently capable of complying with the performance requirements in the Standard. Minimum testing rates are specified for production tests for some performance requirements.

The appropriate values for minimum thickness of pressure vessels depends on variable factors such as materials, size of vessel, contents, and expected service conditions. This subject has caused difficulties for over 30 years in the preparation of Standards for pressure vessels. In this Standard, where the vessel wall thickness is below specified values and the vessel may be exposed to mechanical damage, suitable tests for resistance to dropping, penetration, impact, and other performance requirements have been incorporated to establish that the thickness selected by the manufacturer is adequate for safe service. While taking account of any protection provided by shielding, such as insulated or double-wall vessels, such tests should establish whether any resulting release of pressure energy will be safe (e.g. leakage rather than a sudden violent separation of pressure parts).

In preparing the Standard, the Committee could not take into account all possible combinations of materials, contents, and service conditions that may be applicable to the wide range of vessels that the Standard is intended to cover. It is therefore a principal requirement of the Standard (Clause 3.14) that the manufacturer must identify any performance characteristics additional to those already covered in the Standard, that may be necessary to establish the overall safety and integrity of the vessels for their intended service. The manufacturer must specify appropriate requirements and methods of testing for such additional characteristics and ensure that adequate testing is carried out.

The following comments give information on the source of the various test methods and related matters:

- *Proof pressure test*

  The proof pressure test is a standard hydrostatic test.

- *Burst test*

  The burst test is a standard burst test directly related to the specified factor of safety against bursting. As a means of checking the ductility of the material, the test is required to be continued to bursting for at least some of the vessels in the test sample.

- *Fatigue test*

  The fatigue test is similar to those in the gas cylinder Standards, e.g. AS 2470 and AS/NZS 3509, the Standard for LP Gas fuel vessels for automotive use, but is related to the number of cycles expected in service.

- *Drop test*

  The drop test is based on the standard drop tests for petrol drums except that a very severe indentor is added to ensure reasonable serviceability. This should prevent frequent severe damage leading to rupture.

- *Penetration test*

  The penetration test is aimed at proving that the vessel will not shatter or be projected dangerously if locally penetrated owing to a feasible fall.

- *Impact test*

  The impact test is a serviceability test for glass, brittle, or other fragile parts, and is based on tests in AS 1826 and AS 2380.1 for flameproof electrical enclosures.

- *Torque test*

  The torque test is aimed at ensuring the adequacy of threaded attachments, and is based on tests in AS 1826 and AS 2380.1 for flameproof electrical enclosures.

- *Closure test*

  The closure test is intended to assess the safety of the closure against pressurizing while the closure is in a dangerous position or against inadvertent opening while the vessel is pressurized.

- *Corrosion test*

  Various corrosion tests relating to specific materials and contents are included, and are based on standard tests. The test for air brake reservoirs is similar to that in SAE J10.

- *Fire test*

  A fire test is expected to be rarely required and would then be covered by Clause 3.14.

- *Pressure relief test*

  The pressure-relief tests are based on the tests for similar devices in pressure vessel and gas cylinder codes.

- *Marking plate adhesion test*

  This test is based on similar tests in the ANSI Standard for small refrigeration vessels.

- *Tests for other performance requirements*

  Clause 3.14 requires that the manufacturer specify and test any additional performance characteristics that may be necessary to ensure the safe and reliable operation of the vessels for their intended service.

Integrated Pressure Equipment Test Station (IPETS) (Appendix A)

The IPETS operates with the manufacturing facility and ensures that all product released from the plant complies with the design, the manufacturing process used to produce type tested vessels of that design. The IPETS also performs ‘new equipment’ inspections required by this Standard prior to delivery of any pressure equipment to the customer and provide records of the inspections as required.

The new pressure equipment that has passed all the quality control requirements of IPETS will be stamped with the IPETS stamp.

SUMMARY OF REQUIREMENTS IN MISCELLANEOUS STANDARDS

This Table was prepared for comparison purposes only. The vessel types in the Table are *not necessarily covered* in this Standard.

Vessel type	Standard	Approximate maximum *P* and *PV* (Note 1)	Contents (Note 2)	Fatigue loading	Minimum thickness mm	Test pressure	Minimum burst pressure (Note 1)	Expected corrosion
Non-electrical refrigerant containing components and accessories	ANSI/UL 207	7.290 100	Non-flammable Flammable Non-harmful Harmful	Yes	Nil	1*P*	5*P*	Negligible
Air brake reservoirs	SAE J10	1 100	Air (i.e. non-flammable non-harmful)	Yes	Nil	2*P*	5*P* and 1% max. deformation	Negligible (inside protected)
Portable fire extinguisher	AS/NZS 1841 (series)	2 30	Non-flammable Non-harmful	Nil	0.6	1.5*P* and >2.5 MPa	3.75*P* or 4.13*P*	Negligible (inside protected)
Beer kegs	Brewers code of practice (UK)	0.4 14	Non-flammable Non-harmful	Yes	1.3 to 1.6	1.5*P*	4*P* or 5*P*	Negligible (stainless steel)
Drink dispensers	NSDA (USA)	0.7 20	Non-flammable Non-harmful	Yes	0.67	1.5*P*	4*P*	Negligible (stainless steel)
Metal aerosol containers	AS 2278	1.24 (at 55°C) 1.5	Non-flammable Flammable	No	Nil	—	1.5*P* (at 55°C)	Negligible (coated and short life)
Drink bottle	—	0.8 0.8	Non-flammable Non-toxic	No	Approximately 3	—	1.2 MPa to 2.1 MPa	Negligible (glass)
LP Gas fuel vessels for automotive use	AS/NZS 3509	2.55 1275	Flammable	Yes	Approximately 1.9 to 4	1.3*P*	2.35*P*	Negligible
Non-reusable cylinders	DOT 39	7 85	Non-flammable Flammable	No	Approximately 0.7 at 200 mm diameter (ID)	1.25*P*	2.5*P*	Negligible (short life)
Storage water heaters (mains)	AS 1056 (series)	1.4 900	Non-flammable Harmful	Yes	0.5	1.5*P* to 2*P*	2.5*P*	Minor, low hazard
Domestic pressure cooker	BS 1746	0.14 (at 120°C) 1.4	Harmful Steam	Yes	Approximately 1	2*P*	6*P*	Negligible (stainless steel or aluminium)

NOTES:

1 *P* = design pressure (MPa) *PV* = design pressure × maximum volume of gas, vapour, or liquefied gas (MPa.L).

2 See AS 4343 for contents classifications.

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