

Australian/New Zealand Standard™

LP Gas fuel vessels for automotive use



AS/NZS 3509:2009

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Australian/New Zealand Standard™

LP Gas fuel vessels for automotive use

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committees ME-001, Pressure Equipment and ME-002, Gas Cylinders, to supersede AS/NZS 3509:2003, *LP Gas fuel vessels for automotive use*.

The Standard is for vessels with welded attachments intended to be used as parts of installations complying with AS/NZS 1425, *LP Gas fuel systems for vehicle engines*. Certain features, e.g. attachments, require reference to AS/NZS 1425 and so manufacturers need to be familiar with that Standard.

The design and manufacture of fuel vessels has strong links with both the gas cylinder industry and the pressure vessels industry, and the Standard has adopted successful practices from both these fields.

The main changes from the 2003 edition are the following:

- (a) Revised frequencies for radiographic examination (Clause 2.4.1).
- (b) Revised testing requirements for carbon steel vessels that are not intended to undergo heat treatment (Clause 2.4.3.2).
- (c) Clarification of requirements for elliptical pads.

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

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

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Australian/New Zealand Standard LP Gas fuel vessels for automotive use

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for welded carbon steel LP Gas fuel vessels of total internal volume not greater than 500 L, and for welded stainless steel LP Gas fuel vessels of total internal volume not greater than 200 L, intended for automotive and marine installations.

Appendix A specifies additional requirements to allow the supply of subassemblies, consisting of the container shell and the components listed in AS/NZS 1425, for use by an installer without pre-installation tests.

NOTES:

- 1 AS/NZS 1425 specifies requirements for the installation of LP Gas fuel vessels for vehicles.
- 2 Users of this Standard are reminded that it has no legal authority in its own right, but acquires legal standing when adopted by government or an authority having jurisdiction, or if specified as part of a commercial contract.

1.2 OBJECTIVE

This Standard is intended to—

- (a) specify requirements for the design, manufacture, inspection and testing of LP Gas fuel vessels within the limits of Clause 1.1; and
- (b) facilitate the supply of LP Gas fuel vessels to meet current customer and regulatory requirements.

1.3 APPLICATION

The LP Gas fuel vessels shall comply with the general requirements of Section 2, and with the specific requirements of Section 3 or Section 4 according to the material of construction as follows:

- (a) Carbon steel Section 3.
- (b) Stainless steel..... Section 4.

NOTES:

- 1 Vessels of thickness less than 2.2 mm and vessels of stainless steel material grade 304 are suitable only for installation within a compartment of a vehicle (see also AS/NZS 1425).
- 2 For New Zealand, which is deemed to be a marine environment, specific material requirements are set out in Clauses 3.4 and 4.1.1.

Type tests shall be performed in accordance with Section 5.

This Standard has been written for vessels for use with LP Gas having an effective vapour pressure of 2.55 MPa at 65°C.

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1210	Pressure vessels
1391	Metallic materials—Tensile testing at ambient temperature
1627	Metal finishing—Preparation and pretreatment of surfaces
1627.4	Part 4: Abrasive blast cleaning of steel
1796	Certification of welders and welding supervisors
2177	Non-destructive testing—Radiography of welded butt joints in metal
2205	Methods of destructive testing of welds in metal
2205.2.1	Part 2.1: Transverse butt tensile test
2205.2.3	Part 2.3: Transverse joggle-butt tensile test
2205.3.1	Part 3.1: Transverse guided bend test
2314	Radiography of metals—Image quality indicators (IQI) and recommendations for their use
2337	Gas cylinder test stations
2337.1	Part 1: General requirements, inspections and tests—Gas cylinders
2337.2	Part 2: LP Gas fuel vessels for automotive use
2812	Welding, brazing and cutting of metals—Glossary of terms
4037	Pressure equipment—Examination and testing
4833	Pressure-sensitive labels for stock-paper, stock-plastic and general purpose use
4942	Pressure equipment—Glossary of terms
AS/NZS	
1200	Pressure equipment
1425	LP Gas fuel systems for vehicle engines
1594	Hot-rolled steel flat products
3992	Pressure equipment—Welding and brazing qualification
AS/NZS ISO	
9001	Quality management systems—Requirements
ANSI/CGA	
V-1	Compressed gas cylinder valve outlet and inlet connections
ASTM	
A240M	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications
A262	Standard practices for detecting susceptibility to intergranular attack in austenitic stainless steels
A484	Standard specification for general requirements for stainless steel bars, billets and forgings
EN	
287	Qualification test of welders—Fusion welding (series)
288	Specification and approval of welding procedures for metallic materials

1.5 DEFINITIONS

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

1.5.1 Capacity (of a fuel vessel)

The designated water capacity (total volume) of the space within the fuel vessel.

1.5.2 Inspection body

A body that has acquired through training, qualification or practical experience, or a combination of these, an understanding of the equipment and processes enabling that body to verify compliance with this Standard.

For the purposes of this Standard, an inspection body is one or more of the following:

- (a) An integrated gas cylinder test station.
- (b) The manufacturer, where the manufacturer has 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.
- (d) An independent third party inspection body acceptable to the statutory authority where relevant and the customer.

1.5.3 Integrated gas cylinder test station (IGCTS)

A gas cylinder test station that is integral with the manufacturing process of LP Gas fuel vessels. It is responsible for the quality of LP Gas fuel vessels from the manufacturing plant from which it operates. (See AS 2337.2.)

1.5.4 Main longitudinal joint

A longitudinal joint in the vessel shell other than any longitudinal joint associated with the attachment of an inserted non-circular pad for openings.

1.5.5 May

Indicates the existence of an option.

1.5.6 Shall

Indicates that a statement is mandatory.

1.5.7 Should

Indicates a recommendation.

1.5.8 Vessel

A 'cylinder', 'tank', 'container' or 'bottle' capable of being safely filled with LP Gas.

1.5.9 Welding procedure specification

A documented qualified welding procedure prepared to provide direction for making production welds to the requirements of this Standard.

1.5.10 Welding procedure test

The making and testing of a welded joint, representative of that to be used in production, in order to prove the weldment is capable of providing the required properties for its intended application.

1.5.11 Yield strength

1.5.11.1 For carbon steel

0.2% proof stress (non-proportional), or 0.5% proof stress (total elongation), or lower yield stress.

1.5.11.2 *For stainless steel*

0.2% proof stress.

1.6 DESIGNATION

Fuel vessels for LP Gas shall be designated according to this Standard and the materials of construction as follows:

- (a) For welded carbon steel AN 3509/C.
- (b) For welded stainless steel AN 3509/316S.*
- (c) For marine environment AN 3509/CM†.

NOTE: 'AN' is a shortened version of 'AS/NZS' to limit the amount of stamping required.

1.7 NEW DESIGNS, MATERIALS AND MANUFACTURING METHODS

New designs, materials and methods of manufacturing are not prohibited by this Standard. However it is advisable that no major variations are attempted without a thorough design verification by an inspection body. Refer to AS/NZS 1200 for the use of new materials.

* Designation shown for type 316 stainless steel.

† Letter 'M' added to signify vessel is constructed for a marine environment.

SECTION 2 GENERAL REQUIREMENTS

2.1 DESIGN AND CONSTRUCTION

2.1.1 Thickness of cylindrical section

The thickness of the cylindrical section after forming shall be not less than the greater of those calculated from the following equations, but in no case less than the value given in Table 2.1:

$$t = 2.5 \left(\frac{D_i}{R_m} \right)^{1/2} \quad \dots 2.1$$

$$t = \frac{2.55 D_o}{2f\eta + 2.55} \quad \dots 2.2$$

where

- t = minimum calculated thickness, in millimetres
- D_i = inside diameter of cylindrical section, in millimetres
- D_o = outside diameter of cylindrical section, in millimetres
- R_m = tensile strength for the steel in the finished condition. This shall be taken as the least value of the following:
 - (a) The tensile strength of the parent metal (see Clause 2.4.3.3).
 - (b) The transverse tensile strength of the main longitudinal joint (see Clause 2.4.3.4).
 - (c) The tensile strength of the circumferential joint determined in accordance with Clause 2.4.3.5.
 - (d) 700 MPa.
- f = maximum permissible design strength is the lower of $\frac{R_e}{1.5}$ and $\frac{R_m}{C}$, in megapascals, where
 - R_e = yield strength from the tensile test of the parent metal (see Clause 2.4.3.3). The yield strength may be any one of the yield parameters assessed by the tensile test of the parent metal, in megapascals
 - R_m = the value defined above, in megapascals
 - C = a factor
 - = 2.35 for carbon steel
 - = 2.5 for stainless steel
- η = efficiency of the welded joint is 0.9 or 1.0, as substantiated in accordance with Clause 2.4.1.2.

TABLE 2.1
MINIMUM THICKNESS

Material	Minimum thickness, mm	
	Protected location	Unprotected location
Carbon steel	1.75	2.2
Stainless steel	1.5	2.2

2.1.2 Thickness of ends

The minimum thickness of ends after forming shall be as follows:

- (a) *In the cylindrical portion* (see Figure 2.1(A)) The greater of the thicknesses given in Items (i) and (ii) below:

- (i) The greater of the values calculated from the following equations:

$$t = 2.5 \left(\frac{D_i}{R_m} \right)^{1/2} \quad \dots 2.3$$

$$t = \frac{2.55 D_o}{2f\eta + 2.55} \quad \dots 2.4$$

where t , D_i , D_o , R_m , f , and η have the meanings given in Clause 2.1.1.

- (ii) In accordance with Table 2.1.

- (b) *In the spherical or ellipsoidal portion* The minimum thickness at any thinned section shall be not less than the greater of the thicknesses given in Items (i) and (ii) below:

- (i) 90% of the thickness established in Item (a) above.

- (ii) In accordance with Table 2.1.

NOTE: Parts described as 'ends' may include portions of the 'shell', e.g. where a shell has one or more knuckles formed into it to extend into the end(s).

- (c) *Torispherical ends* (see Figure 2.1(B)) The minimum calculated thickness of torispherical ends, with or without openings, shall be determined by the following equation:

$$t = \frac{2.55 D_o M}{2f\eta + 2.55} \quad \dots 2.5$$

where t , D_o , f , η have the meanings given in Clause 2.1.1, and

M = A factor in the equation for torispherical ends depending on the end proportion $\frac{R_i}{r}$ (see Table 2.2)

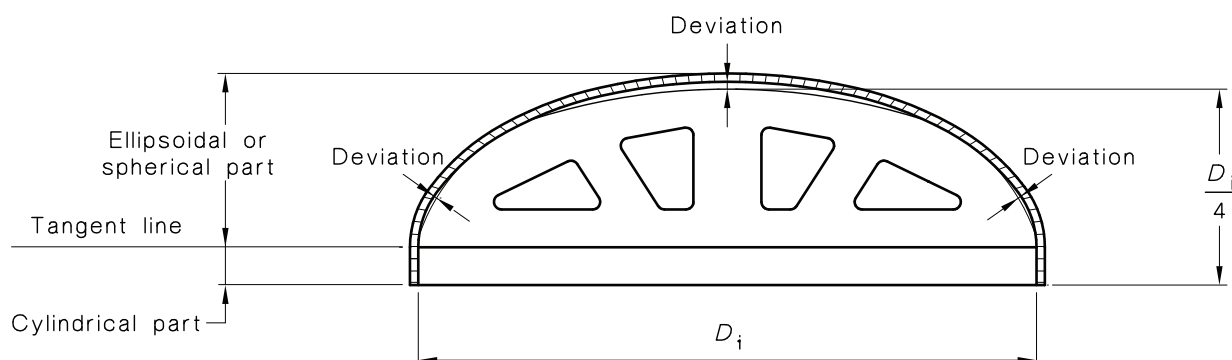
$$= \frac{1}{4} \left[3 + \left(\frac{R_i}{r} \right)^{1/2} \right]$$

TABLE 2.2
VALUES OF FACTOR M

(Use nearest value of $\frac{R_i}{r}$ interpolation unnecessary)

$\frac{R_i}{r}$	1.0	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
M	1.00	1.03	1.06	1.08	1.10	1.13	1.15	1.17	1.18
$\frac{R_i}{r}$	3.25	3.50	4.0	4.5	5.0	5.5	6.0	6.5	—
M	1.20	1.22	1.25	1.28	1.31	1.34	1.36	1.39	—
$\frac{R_i}{r}$	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	—
M	1.41	1.44	1.46	1.48	1.50	1.52	1.54	1.56	—
$\frac{R_i}{r}$	11.0	11.5	12.0	13.0	14.0	15.0	16.0	16.66*	—
M	1.58	1.60	1.62	1.65	1.69	1.72	1.75	1.77	—

* Maximum ratio allowed when R_i equals the outside diameter (D_o) of the end.



NOTE: This Figure illustrates a true ellipsoidal internal template of 2 to 1 ratio at the surface in position.

FIGURE 2.1(A) TRUE ELLIPSOIDAL INTERNAL TEMPLATE

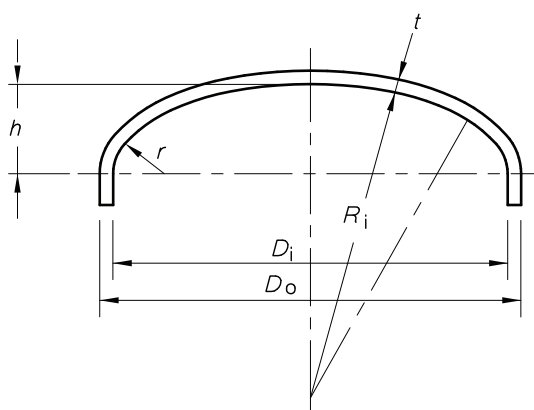


FIGURE 2.1(B) DIMENSIONS OF TORISPHERICAL END