

Australian/New Zealand Standard™

Gas distribution networks

Part 2: Steel pipe systems



AS/NZS 4645.2:2018

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Engineers Australia
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Australian/New Zealand Standard™

Gas distribution networks

Part 2: Steel pipe systems

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee AG-008 Gas Distribution, through its subcommittee AG-008-02, Installation and Maintenance of Steel Pipe Systems for Gas, to supersede AS/NZS 4645.2:2008.

The objective of this Standard is to provide for the protection of the general public, gas distribution network operating personnel and the environment, and to ensure safe and reliable operation of gas distribution networks that reticulate gas to consumers.

This Standard covers steel piping within gas distribution networks covered by AS/NZS 4645.1, where the maximum allowable operating pressures up to or equal to 1050 kPa and the hoop stress is less than or equal to 20% SMYS of the pipe. Steel piping systems for gas outside these limits are generally covered by the AS 2885 suite of Standards and for some jurisdictions. AS/NZS 4645.1 provides for limited use up to 1965 kPa.

This series of Standards includes the following parts:

AS/NZS

4645 Gas distribution networks

4645.1 Part 1: Network management

4645.2 Part 2: Steel pipe systems (this Standard)

4645.3 Part 3: Plastics pipe systems

The Standard is not a design handbook, nor a manual on distribution practices. It does not remove the need for qualified and experienced engineering design, installation and operation or for competent engineering judgment, and does require interpretation and implementation by competent engineers.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard. Alternative means of conformance may be acceptable provided the required safety outcomes can be demonstrated with AS/NZS 4645.1.

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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FOREWORD

This Standard achieves its purpose through five fundamental principles as follows:

- (a) A gas distribution network is designed and constructed to have sufficient controls to withstand the threats to which it may be subjected during construction, testing and operation.
- (b) Before a gas distribution network is placed into operation it needs to be inspected and tested to prove its integrity.
- (c) Important matters relating to safety, engineering design, materials, testing, operation and inspection needs to be reviewed, documented and approved by a responsible person(s). The responsible person(s) is defined in each case.
- (d) Operations and maintenance needs to provide for continued monitoring and safe operation of the gas distribution network.
- (e) Where changes occur in or to a gas distribution network, which alter the design assumptions or affect the original integrity, appropriate steps need to be taken to assess the changes, to ensure continued safe operation of the network.

The Australian and New Zealand Technical Regulators have advised that this Standard will only apply to the life cycle of new gas distribution networks and modifications or augmentations to existing assets within gas distribution networks. However, the sections on operations, maintenance, repair, decommissioning, gas quality and risk assessment may be suitable for application to existing assets in existing networks.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Gas distribution networks

Part 2: Steel pipe systems

SECTION 1 SCOPE AND GENERAL**1.1 SCOPE**

This Standard specifies materials, design, construction, installation, testing and maintenance requirements for steel piping systems for use in conjunction with AS/NZS 4645.1, for the distribution of fuel gas suitable for domestic, commercial or industrial uses, where—

- (a) the pressure of the gas is not greater than 1050 kPa and the operating temperature range of the materials is from -30°C to 60°C ; and
- (b) where the hoop stress level is not greater than 20% of the specified minimum yield stress (SMYS) of the pipe used in that system.

NOTE: The relevant statutory authority may regard this Standard as appropriate for fluids other than fuel gas.

1.2 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

NOTE: Documents for informative purposes are listed in the Bibliography.

AS	
1074	Steel tubes and tubulars for ordinary service
1110	ISO metric hexagon precision bolts and screws—Product grades A and B
1110.1	Part 1: Bolts
1111	ISO metric hexagon bolts and screws—Product grade C
1111.1	Part 1: Bolts
1112	ISO metric hexagon nuts
1112.1	Part 1: Style 1—Product grades A and B
1112.2	Part 2: Style 2—Product grades A and B
1112.3	Part 3: Product grade C
1112.4	Part 4: Chamfered thin nuts—Product grades A and B
1210	Pressure vessels
1579	Arc-welded steel pipes and fittings for water and waste-water
1674	Safety in welding and allied processes
1674.1	Part 1: Fire precautions
1674.2	Part 2: Electrical
1817	Metallic materials
1817.1	Part 1: Vickers hardness test Test methods

AS	
2129	Flanges for pipes, valves and fittings
2205	Methods for destructive testing of welds in metal
2205.2.1	Method 2.1: Transverse butt tensile test
2205.3.1	Method 3.1: Transverse guided bend test
2205.5.1	Method 5.1: Macro metallographic test for cross-section examination
2205.6.1	Method 6.1: Weld joint hardness test
2205.7.1	Method 7.1: Charpy V-notch impact fracture toughness test
2528	Bolts, studbolts and nuts for flanges and other high and low temperature applications
2832	Cathodic protection of metals
2832.1	Part 1: Pipes and cables
2885	Pipelines—Gas and liquid petroleum
2885.1	Part 1: Design and construction
2885.2	Part 2: Welding
3688	Water supply and gas systems—Metallic fittings and end connectors
4041	Pressure piping
4617	Manual shut off gas valves
4728	Electric resistance welded steel pipe for pressure purposes
4799	Installation of underground utility services and pipelines within railway boundaries
4882	Shielding gases for welding
4458	Pressure equipment—Manufacture
AS ISO	
7	Pipe threads where pressure-tight joints are made on the threads
7.1	Part 1: Dimensions, tolerances and designation
AS/NZS	
1252	High-strength steel fastener assemblies for structural engineering—Bolts, nuts and washers
1252.1	Part 1: Technical requirements
1518	External extruded high-density polyethylene coating system for pipes
1167	Welding and brazing—Filler metals
1167.2	Part 2: Filler metal for welding
2885	Pipelines—Gas and liquid petroleum
2885.5	Part 5: Field pressure testing
3862	External fusion-bonded epoxy coating for steel pipes
4645	Gas distribution networks
4645.1	Part 1: Network management
4853	Electrical hazards on metallic pipelines
4855	Welding consumables—Covered electrodes for manual metal arc welding of non-alloy and fine grain steels—Classification
4857	Welding consumables—Covered electrodes for manual metal arc welding of high-strength steels—Classification

AS/NZS

16834 Welding consumables—Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels—Classification

AS/NZS ISO

18276 Welding consumables—Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of high-strength steels—Classification (ISO 18276:2005, MOD)

ISO

636 Welding consumables—Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels—Classification

2560 Welding consumables—Covered electrodes for manual metal arc welding of non-alloy and fine-grain steels—Classification

14171 Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels—Classification

16834 Welding consumables—Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels—Classification

17632 Welding consumables—Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels—Classification

18275 Welding consumables—Covered electrodes for manual metal arc welding of high-strength steels—Classification

18276 Welding consumables—Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high strength steels—Classification

26304 Welding consumables—Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels—Classification

EN

1515 Flanges and their joints—Bolting

1515-1 Part 1: Selection of bolting

1515-3 Part 3: Classification of bolt materials for steel flanges, class designated

1759 Flanges and their joints—Circular flanges for pipes, valves, fittings and accessories, class designated

1759-1 Part 1: Steel Flanges, NPS 1/2 to 24

12068 Cathodic protection—External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection—Tapes and shrinkable materials

API

598 Valve Inspection and Testing

599 Metal Plug Valves—Flanged, Threaded, and Welding Ends

609 Butterfly Valves: Double flanged, Lug and Wafer-type

623 Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets

Spec 5L Specification for line pipe

Spec 6D Specification for pipeline valves

ASME	
B1.20.1	Pipe threads, general purpose (inch)
B16.1	Gray iron pipe flanges and flanged fittings: Classes 25, 125, and 250
B16.5	Pipe flanges and flanged fittings: NPS1/2 through NPS 24 metric/inch Standard
B16.9	Factory-made wrought butt welding fittings
B16.11	Forged fittings, socket-welding and threaded
B16.20	Metallic gaskets for pipe flanges: Ring-joint spiral-wound, and jacketed
B16.21	Nonmetallic flat gaskets for pipe flanges
B16.34	Valves—Flanged, Threaded, and Welding End
B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch series)
B18.2.2	Nuts for general applications: Machine screw nuts, hex, square, hex flange, and coupling nuts (Inch series)
B31.3	Process piping
ASTM	
A53/ A53M	Standard specification for pipe, steel, black and hot-dipped, zinc-coated welded and seamless
A106A/ A106M	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A193/ A193M	Standard specification for alloy-steel and stainless steel bolting materials for high-temperature or high-pressure service and other special purpose applications
A194/ A194M	Standard specification for carbon steel, alloy steel, and stainless steel nuts for bolts for high-pressure or high-temperature service, or both
A307	Standard specification for carbon steel bolts, studs, and threaded rod 60 000 PSI tensile strength
A320/ 320M	Standard specification for alloy-steel bolting for low-temperature service
A325	Standard specification for structural bolts, steel, heat treated, 120/105 ksi minimum tensile strength
A333	Standard specification for seamless and welded steel pipe for low-temperature service and other applications with required notch toughness
A354	Standard specification for quenched and tempered alloy steel bolts, studs, and other externally threaded fasteners
A449	Standard specification for hex cap screws, bolts and studs, steel, heat treated, 120/105/90 ksi minimum tensile strength, general use
AWS	
A5.1/ A5.1M	Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
A5.5/ A5.5M	Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
A5.17/ A5.17M	Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
A5.18/ A5.18M	Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding

AWS

A5.20/A5.20 Specification for Carbon Steel Electrodes for Flux Cored Arc Welding
M

A5.28/
A5.28M Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc
Welding

A5.29/
A5.29M Specification for Low-alloy Steel Electrodes for Flux Cored Arc Welding

A5.36/
A5.36M Specification for Carbon And Low-Alloy Steel Flux Cored Electrodes for
Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc
Welding

BS

143 and
1256 Threaded pipe fittings in malleable cast iron and cast copper alloy

1640 Specification for steel butt-welding pipe fittings for the petroleum industry

1640-1 Part 1: Wrought carbon and ferritic alloy steel fittings

1640-3 Part 3: Wrought carbon and ferritic alloy steel fittings. Metric units

3381 Specification for spiral wound gaskets for steel flanges to BS 1560

3799 Specification for steel pipe fittings, screwed and socket-welding for the
petroleum industry

4882 Specification for bolting for flanges and pressure containing purposes

IGE

SR/22 Purging operations for fuel gases in transmission, distribution and storage

TD/13 Pressure regulating installations for natural gas, liquefied petroleum gas and
liquefied petroleum gas/air

MSS

SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions

SP-67 Butterfly Valves

CAN/CSA

Z245.20 Plant applied external coatings for steel pipe

WTIA

Technical The Weldability of Steels (2006)

Note 1

Technical Care and conditioning of ARC weld consumables (2006)

Note 3

Technical Health and Safety in Welding (2013)

Note 7

Technical Repair of Steel Pipelines

Note 20

KiwiRail

Specification Specification for the Installation of Pipelines on Railway Land

E1322

1.3 APPLICATION

This Standard shall be read in accordance with the document and record requirements in AS/NZS 4645.1.

NOTE: Refer to Clause 4.13 of AS/NZS 4645.1.

1.4 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 4645.1 apply.

SECTION 2 MATERIALS AND COMPONENTS

2.1 NEW MATERIALS AND NEW COMPONENTS

New materials and new components shall conform with one or more of the relevant Standards listed in Tables 2.1(A) and 2.1(B).

TABLE 2.1(A)
MATERIALS

Component	Standard
Pipe	See Table 2.1(B)
Fittings	AS 1074, AS 3688, ASME B16.1, ASME B16.9, ASME B16.11, BS 143 and 1256, BS 1640-3, BS 1640-1, BS 3799 (see also Table 2.3)
Valves	ASME B16.34, API Spec 6D, API 609, API Std 623, API Std 598, API Std 599 MSS SP25, MSS SP67, AS 4617 (Type 1)
Flanges	AS 2129, ASME B16.1, ASME B16.5, EN 1759-1, BS 4882
Gaskets	ASME B16.20, ASME B16.21, BS 3381
Bolting	AS/NZS 1252.1, ASTM A 325, IS EN 1515-1, IS EN 1515-3 AS 1110.1*, AS 1111.1, AS 1112.1, AS 1112.2, AS 1112.3, AS 1112.4, AS 2528, ASME B18.2.1, ASME B18.2.2, ASTM A 193/A 193M, ASTM A 194/A 194M, ASTM A 307, ASTM A 354, ASTM A 449
Coatings and linings	AS/NZS 1518, AS/NZS 3862, CAN/CSA-Z245.20.14, IS EN 12068
Welding consumables	(See Section 4)

NOTES:

- 1 Bolting standards in the group marked ‘*’ describe fasteners with standard flat to flat hexagonal sections. Because flanges have relatively large holes, special care is needed when these fasteners are used on flanges. The result can be that the edges of the holes and mating areas of the fasteners may be loaded excessively even at moderate torques.
- 2 When consulting gasket manufacturer’s pamphlets, the nominated gasket crush forces result often in relatively high loads when gaskets are used in natural gas. It may be necessary to apply specialized lubricants, torque spanners and specially machined washers to prevent flange and fastener damage.
- 3 Fasteners that conform with ASTM A325 (imperial threads) and AS/NZS 1252.1 (metric threads) have much larger flat-to-flat dimensions and may not require machined washers to prevent damage. Thread lubricants and torque spanners are still required when so established from engineering considerations.

TABLE 2.1(B)
MATERIALS FOR STEEL PIPES

Standard	Grade	Additional limitations and specific requirements
AS 1074	Light, medium or heavy	Light pipe shall not be threaded
AS 1579	Grade C	
AS 4728	All grades and sections	Schedule 10, Extra light and light pipe shall not be threaded
API Spec 5L	All grades except strength $\geq$ X56 pipe	None
ASTM A106/A 106/M	Grades A, B, C	None
ASTM A 53/A 53 M	All grades except Type F	None
ASTM A333	All	

NOTES:

- 1 Material selection shall be made to ensure design parameters are met, including pipe specified for low temperature service.
- 2 Galvanized pipes shall not be welded until any external and internal galvanizing has been removed for a sufficient length to permit a sound weld.

2.2 MATERIALS AND COMPONENTS IDENTIFICATION

Materials and components shall be identified in accordance with AS/NZS 4645.1.

2.3 PIPE THREADS, THREADED PIPE FITTINGS, FLANGED PIPE JOINTS AND WELDED PIPE JOINTS

Pipe threads, threaded pipe fittings, flanged pipe joints and welded pipe joints shall conform with Table 2.3.

Attention should be given during the design to prevent galvanic corrosion of dissimilar metals joined in buried systems. This includes the joining of the same materials where replacement of a section would see existing piping being connected to new piping.

The use of expansion joints should be avoided. However, where an expansion joint is used, it shall meet the functional requirements and shall be installed in accordance with the manufacturer's instructions.

TABLE 2.3
PIPE THREADS, THREADED PIPE FITTINGS,
FLANGED PIPE JOINTS AND WELDED PIPE JOINTS

Specification No.	Item	Limitations on use	Other requirements
AS ISO 7.1	Pipe threads	For use on pipe to AS 1074	Taper male and parallel female threads shall not be used for pressures above 7 kPa
ASME B1.20.1	Pipe threads	For use on pipe to API and ASTM specification	Taper male and taper female threads may be used at all pressures Threaded joints are not recommended on pipes over 100 mm nominal size Threaded joints shall be made with approved jointing material Parallel male threads shall not be used.
AS 1074	Steel pipes and tubulars	For use with pipe to AS 1074	
BS 3799	Forged steel pipe fittings screwed and socket welding for the petroleum industry	For use with pipe to API and ASTM specifications	
ASME B16.11	Forges steel fittings socket welding and threaded	For use with pipe to API and ASTM specifications	
AS 2129 (see Note 2)	Flanges and bolting for pipes, valves and fittings	For use with pipe to AS 1074	Raised faces are recommended for steel flanges Screwed flange to pipe joints shall be taper male and taper female Refer to Section 3 for specifications of jointing materials All welding shall conform to the requirements of Section 4
EN 1759-1 ASME B16.5	Steel pipe flanges and flanged fittings for petroleum industry (metric dimensions) Steel pipe flanges and flanged fittings.	For use with pipe to API and ASTM specifications	
BS 1640-3	Wrought carbon and ferritic alloy steel fittings	For pipes to API and ASTM specification	All fittings shall be at least standard weight
BS 3799	Forged steel pipe fittings screwed and socket welding for petroleum industry		
ASME B16.9	Factory made wrought steel Butt welding fittings		All welding shall conform to the requirements of Section 4

NOTES:

- 1 Threaded joints are not recommended in buried locations.
- 2 Flange rating shall be in accordance with AS 2129.

2.4 VALVES, FITTINGS AND ACCESSORIES

2.4.1 General

Valves, fittings and accessories shall be manufactured in accordance with a design based on a Standard as nominated in Table 2.1(A).

Where the component is to be joined by welding it shall be made of a steel that can be successfully welded on site.

Valves, fittings and accessories shall be capable of withstanding the service conditions for which the system is designed. Where the valves, fittings and accessories are to be incorporated in the piping system after it has been pressure tested, they shall—

- (a) be pressure tested to the same pressure as the piping system; or
- (b) have pressure and temperature ratings at least equivalent to those of the pipe to which they are to be attached.

2.4.2 Flanges and flanged fittings

Flanges and flanged fittings shall conform with a Standard nominated in Table 2.1(A) and the following requirements:

- (a) Stubs on weld neck flanges that have dimensions conforming with ASME B16.5 shall be taper bored where they are to be attached to thin wall pipe.
- (b) The flange thickness of slip-on flanges with a rectangular cross-section shall provide a strength of not less than that of the corresponding hubbed flange specified in ASME B16.5, as determined by calculations made in accordance with AS 1210.
- (c) Bolting of steel flanges shall conform to ASME B16.5 or BS 4882. Bolting of flanges in accordance with AS 2129 shall conform with AS 2528.

NOTE: Additional items are included as notes at bottom of Table 2.1(A).

2.4.3 Gaskets and ring joints

Gaskets and ring joints shall conform with a Standard nominated in Table 2.1(A) and the following properties:

- (a) Resistance to the gases that will be distributed.
- (b) Rated to withstand the MAOP of the gas distribution network.
- (c) Rated for the full range of operating temperatures of the gas distribution network.
- (d) Retain the physical and chemical properties necessary for safe use.

2.4.4 Valves

Valves shall conform with Standards nominated in Table 2.1(A) and the following requirements:

- (a) Lubricants and sealants shall be suitable for the service conditions.
- (b) Working pressure ratings of steel parts of valves shall apply within the temperature range of -30°C to $+60^{\circ}\text{C}$.
- (c) Resilient plastic materials used for seats and seals shall be capable of withstanding the design pressure and temperature.
- (d) Parts in contact with gas shall be of materials that are compatible with the gas.
- (e) The bodies of valves shall be pressure tested to the relevant requirements of API Spec 6D and shall not leak.
- (f) The seat of valves shall conform with API Spec 6D.

- (g) Other than non-return valves, a means shall exist for indicating the setting of the valve (e.g. closed, a third open).
- (h) Valves shall be indelibly marked, on the body or on a permanently attached nameplate, giving the following information:
 - (i) Manufacturer's name or trademark.
 - (ii) Class designation or the maximum working pressure for which the valve has been designed.
 - (iii) Body material designation (and the end connection material where more than one type is used).
 - (iv) Nominal valve size.

2.5 COATING FOR BURIED METAL MAINS OR SERVICES

All below ground mains or services shall be coated to prevent external corrosion for the operational life or conditions. Coatings shall conform with a Standard nominated in Table 2.1(A) and the following requirements:

- (a) The coating system used shall be appropriate for underground service and the operating conditions.
- (b) Main or service surface preparation, controlled application and quality testing of the final coating shall be in accordance with these Standards and manufacturer's instructions.
- (c) The coating system shall be compatible with and will not be adversely impacted by the cathodic protection system applied for the main or service.
- (d) Coated pipe shall be supplied with certification indicating conformance with the nominated coating standard.

SECTION 3 DESIGN

3.1 GENERAL

The requirements of this Section are to be applied in addition to the general design requirements of AS/NZS 4645.1.

3.2 MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP)

The MAOP of a steel main or service shall be no greater than the test pressure divided by 1.4. The MAOP shall be calculated and recorded for each pressure system within the gas distribution network.

3.3 HOOP STRESS

The pipe hoop stress at the MAOP shall be less than or equal to 20% SMYS.

Hoop stress shall be determined by the following Equation 3.3:

$$\sigma_Y = \frac{PD}{2t_{Dp}} \quad \dots 3.3$$

where

σ_Y = hoop stress, in megapascals (MPa)

P = MAOP, in megapascals (MPa)

D = outside diameter, in millimetres

t_{Dp} = pressure design thickness, in millimetres

3.4 MAINS AND SERVICES

3.4.1 Wall thickness

3.4.1.1 Nominal wall thickness (t_N)

The nominal wall thickness (t_N) shall be—

- (a) the thickness nominated on the pipe purchase order (design stage); or
- (b) the thickness nominated on the manufacturer's material certificates (for operating pipes).

The nominal wall thickness shall not be less than the required wall thickness plus any allowances plus any manufacturing tolerances as shown in Equation 3.4.1.1:

$$t_N \geq t_W + G + H \quad \dots 3.4.1.1$$

where

t_N = nominal wall thickness, in millimetres

t_W = required wall thickness, in millimetres

G = summation of appropriate allowances, in millimetres

H = allowances for manufacturing tolerances, in millimetres

3.4.1.2 Required wall thickness (t_w)

The required wall thickness (t_w) for any steel pipe system shall be the greatest of the following:

- (a) The thickness required to ensure that the hoop stress at MAOP is less than or equal to 20% SMYS.
- (b) The thickness required for maintainability of the pipe, including provision for future hot tapping, where required.
- (c) The thickness required to satisfy external loads.
- (d) The thickness required for stress and strain criteria due to operation, including thermal, bending, constraint and mechanical loading.
- (e) The thickness required for constructability of the pipe including weldability, special construction requirements or construction loads.

3.4.1.3 Allowances (G)

Allowances shall be added to the required wall thickness of pipe to provide for identified factors that may, during construction or over the life of the pipe, result in loss of thickness. Allowance may be made to compensate for a reduction in thickness due to corrosion, erosion, threading, machining and any other necessary additions. The allowance G is the sum of all allowances made to the pipe wall thickness.

The components of the allowance shall conform with the following:

- (a) *Corrosion or erosion allowance* Where a pipe or a pressure-containing component made from pipe is subject to any corrosion or erosion, G shall include an amount equal to the expected loss of wall thickness. A corrosion allowance is not required where satisfactory corrosion mitigation methods are employed (see Section 8).
- (b) *Threading, grooving and machining allowance* Where a pipe or a pressure containing component made from pipe is to be threaded, grooved or machined, G shall include an amount equal to the depth that will be removed. Where a tolerance for the depth of cut is not specified, the allowance shall be increased by 0.5 mm.

3.4.1.4 Resistance to penetration

Where a pipe is laid in an environment where encroachment is unavoidable, additional wall thickness should be considered to provide additional resistance to penetration.

NOTE: While additional wall thickness can increase resistance to penetration it is not intended to eliminate penetration.

3.4.1.5 Pipe manufacturing tolerance (H)

For pipe manufactured from strip or plate to nominated Standards, such as API Spec 5L, manufacturing tolerance shall not be added to the required wall thickness t_w .

Seamless pipe manufacturing can result in local thinning or minimum thickness along the length of one side while still conforming with specified weight tolerance. Pipe manufactured by the seamless process may require addition of a manufacturing tolerance (H) to the required wall thickness (t_w).

3.5 STEEL CASING

The use of steel casings for steel mains and services should be avoided.

NOTE: Where casings are required to be installed under railways then AS 4799 should be referenced for requirements in Australia or Kiwirail Specification for installation of pipelines on railway land; E1322 should be referenced in New Zealand.

However, if a steel casing is required, the minimum wall thickness of steel casing for mains and services shall be sufficient to provide the necessary protection for the planned life of the main or service. The minimum wall thickness of steel casing shall not be less than the values in Table 3.5.

TABLE 3.5
MINIMUM NOMINAL WALL THICKNESS
OF STEEL CASING

Nominal outside diameter of casing pipe mm	Minimum nominal wall thickness mm	
	Roads	Railways
88.9	4.8	4.8
114.3	4.8	4.8
141.3	4.8	4.8
168.3	4.8	4.8
219.1	4.8	4.8
273.0	4.8	4.8
323.9	4.8	4.8
355.6	4.8	5.6
406.4	4.8	5.6
457.0	4.8	6.4
508.0	4.8	7.1
559.0	4.8	7.2
610.0	6.4	8.7
660.0	6.4	9.5
711.0	6.4	10.3
762.0	6.4	10.3
813.0	6.4	11.1
864.0	6.4	11.9
914.0	6.4	11.9
965.0	7.9	12.7
1016.0	7.9	14.3
1068.8	7.9	14.3

3.6 WARNING MARKERS FOR MAINS AND SERVICES

The purpose of markers is to alert parties contemplating excavation or drilling in the area, of the presence of significant infrastructure. The design of mains and services shall provide for marking in accordance with the following requirements:

- (a) Marker signs or ground markers shall be installed as required by Table 3.6. The marking method shall enable a third party to identify the presence of the gas main or service.
- (b) Marker signs shall be installed in locations where gas mains are not expected, for example, in paddocks or along roads where there are no buildings.
- (c) Marker tape or an equivalent shall be installed above the main or service when laid in an open trench to indicate for future excavations the presence of the main or service.
- (d) The marker tape or equivalent shall be installed at least 200 mm above the main or service.

TABLE 3.6
MARKER SIGNS/GROUND MARKERS

Diameter DN	MAOP kPa			
	≤210	>210 ≤420	>420 ≤600	>600
≤150	Optional	Optional	Optional	Required
>150, ≤250	Optional	Optional	Optional	Required
>250	Optional	Required	Required	Required

LEGEND:

DN = nominal pipe diameter (mm)

Where signs are used they should indicate the network operator and their contact details.

3.7 OFFSET DISTANCES

Gas mains shall be offset from the expected predominant building line to enable constructability and access for maintenance.

3.8 DEPTH OF COVER

Gas mains and services shall be buried at a depth in accordance with Tables 3.8(A) and 3.8(B).

For additional protection, critical supply mains to large numbers of consumers or special high reliability supplies, increased depth of cover should be specified wherever appropriate.

TABLE 3.8(A)
MINIMUM DEPTH OF COVER—MAINS

Location	Type of main		
	MAOP below and equal to 210 kPa	MAOP above 210 kPa	
		≤500 kPa and ≤DN 150 Steel	>500 kPa or >DN 150 Steel
	Cover mm		
High density community use areas:			
Sandy/clay areas	600	750	750
Rock	450	450	600
Other areas:			
Sandy/clay areas	500	600	750
Rock	450	450	500
Railways			
Note 1: In Australia, refer to AS 4799 and relevant rail authority in Australia. Note 2: In New Zealand, refer to KiwiRail Specification E1322.			
Major roadways			
Refer to relevant road authority			

NOTE: Depth of cover should not exceed 1.5 m to enable access during emergencies.

TABLE 3.8(B)
MINIMUM DEPTH OF COVER—SERVICES

Location	Type of service for various MAOPs		
	≤DN 50	>DN 50 ≤ DN 100	
		≤210 kPa	>210 kPa
	Cover mm		
Roadways	450	450	600
Private property	300	300	450
Rock	300	300	375

NOTES:

- 1 Minimum depth for rock applies in roadways/private property.
- 2 For service with a diameter of greater than DN 100, the depths of cover in accordance with Table 3.8(A) apply.

When a main or service trench is cut in rock or shale, it shall be excavated 75 mm deeper than the depth of the main or service and this excess depth filled with approved padding material before laying main or service thereon.

3.9 SEPARATION FROM OTHER UTILITY ASSETS

Location of all other utilities shall be identified during either design and/or pre-construction phase using the available one-call system (e.g. Dial Before You Dig).

Where a main or service is laid parallel to other utility assets, a minimum separation distance is required in order to effect repairs. The minimum separation distance shall be 250 mm.

Where a main or service is crossed by other services, the minimum separation distance shall be 150 mm. Additional separation may be required for large utility assets in order to effect repairs.

3.10 CORROSION MITIGATION

The design of steel pipe systems for a gas distribution network shall include the design for corrosion mitigation. As a minimum, corrosion mitigation shall be achieved by the use of anti-corrosion coatings. Where steel pipe systems are buried, a cathodic protection system should be designed, documented and implemented. Where cathodic protection systems are not used the reason(s) shall be documented.

The design, installation, operation and maintenance of cathodic protection systems shall be in accordance with AS 2832.1.

3.11 ELECTRICAL HAZARDS

Hazardous voltages may occur on mains or services. Hazard sources shall be identified and measures put in place to mitigate the associated hazards. The design shall document the necessary equipment and requirements to mitigate hazards identified.

NOTE: AS/NZS 4853 provides guidance on some of the considerations.

3.12 EXPANSION AND FLEXIBILITY

3.12.1 General

For the design of above ground gas mains, services or components, flexibility analysis shall be conducted. Any analysis conducted shall be done so by a competent person.

NOTE: AS 2885.1 provides guidance on flexibility design.

3.12.2 Supports

3.12.2.1 Anchoring

Piping shall be anchored to prevent strain on connected equipment that may affect the integrity or operation of the connected equipment.

3.12.2.2 Flexibility

Piping shall be designed to have the flexibility to minimize stresses in the pipe, joints, connections to equipment and anchors where the integrity or operation of the pipe, joints or connected equipment may be effected. Such stresses can result from expansion and contraction being resisted by restraints (e.g. support friction, branch connections, lateral interferences) and angular movement of attached equipment.

3.12.2.3 Vibration

Piping shall be supported to prevent or damp out any vibration.

3.12.2.4 Material for supports

Permanent hangers, supports and anchors shall be fabricated from durable non-combustible materials that suit the service conditions. Materials at the interface between either hangers or supports and the carrier pipe shall be selected to protect the carrier pipe from corrosion and will not impact the performance of any carrier pipe coating. The design shall also prevent pooling of water around the carrier pipe interface.

3.12.2.5 Forces on pipe joints

The design shall ensure that the end-forces due to internal pressure, thermal expansion or contraction and the mass of the pipe on pipe joints, shall not exceed the strength of the joint. Piping system forces shall not exceed the maximum specified nozzle loading of connected equipment.

3.12.2.6 Attachment of supports or anchors

The proportioning and welding strength of structural supports and anchors shall not cause excessive stress concentrations. Structural supports or anchors may be welded directly to the pipe. This weld shall be in accordance with the specified pressure equipment welding Standards in Section 4.

3.12.2.7 Interference

Supports, hangers and anchors shall not interfere with free expansion or contraction of piping between anchors, such as by providing suitable spring hangers or sway bracing.

3.12.2.8 Electrical insulation

For pipes that are cathodically protected, the supports shall be electrically insulated from the pipes.

3.13 BENDS, ELBOWS AND MITRES

Where gas mains or services change direction by the use of bends, elbows or mitres, the following requirements apply:

- (a) Where practicable, the longitudinal weld of the pipe shall be near to the neutral axis of the bend.