

AS/NZS 2280:2020
(Incorporating Amendment No. 1)



Australian/New Zealand Standard™

Ductile iron pipes and fittings



AS/NZS 2280:2020

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- Australian Water Association
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- Plastics Industry Pipe Association of Australia
- Plastics New Zealand
- SAI Global (Certification Interests Australia)
- Water New Zealand
- Water Services Association of Australia

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Australian/New Zealand Standard™

Ductile iron pipes and fittings

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WS-016, Cast Iron Pressure Pipes and Fittings, to supersede AS/NZS 2280:2014.

[A1] *This Standard incorporates Amendment No. 1 (June 2021). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.* **[A1]**

The objective of this Standard is to provide a standard manufacturing specification to be used by manufacturers and purchasers of ductile iron pressure pipes and fittings.

The major changes to this revision **[A1]** are as follows **[A1]**:

- (a) Inclusion of a calculation method to determine minimum wall thickness values for fittings with alternative pressure classifications.
- (b) Inclusion of prescriptive wall thickness values for PN 16 and PN 20 fittings.
- (c) Modification to fittings design verification test procedures.
- (d) Amendment to tensile properties of ductile iron for fittings.
- (e) Removal of liquid applied coatings and cement mortar lining options for fittings.
- (f) Modification to lifting lug and thrust pad requirements.

Relevant Standards relating to the installation of ductile iron pipes and fittings are listed in the Bibliography.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

Notes to text are for information and guidance only.

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Introduction

This Standard sets out manufacturing requirements and dimensions for ductile iron pipes and fittings up to DN 750.

The class of ductile iron pipe has been determined on the basis of the allowable operating pressure (AOP) to give a minimum wall thickness. It provides a factor of safety of 3 on AOP, but does not include a separate corrosion allowance. Most users now consider the issue of corrosion to be best addressed by the specification of appropriate protection systems.

This Standard permits a range of pressure classifications with standard classifications of PN 20 and PN 35 for pipe and PN 16, PN 20 and PN 35 for fittings.

The AOP of a pipeline is limited to the lowest AOP of all pipes, fittings and appurtenances within the pipeline system.

Requirements for DN 900 to DN 2600 ductile pipes and fittings are given in ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*.

Fittings covered by this Standard are intended primarily for use with water supply pressure pipes having outside diameters nominated herein.

Other factors to be considered in selecting the wall thickness of ductile iron pipes and fittings are as follows:

- (a) External loads that can be expected to be applied to pipes and fittings during and after installation.
- (b) The depth of the pipeline in the ground and other pipe-laying conditions.
- (c) Stresses due to expansion and contraction.
- (d) Stresses incurred during handling of pipes and fittings.

A designer of a pipeline has, among other duties, the responsibility of evaluating the possible conditions to which component pipes and fittings may be exposed. The designer has to consider whether pipes and fittings manufactured in accordance with this Standard are of sufficient strength for a proposed application.

Ductile iron pressure pipes and fittings with spigot and socket ends are manufactured for use with flexible joints in which the seal is made by means of a suitably retained rubber gasket. It is not possible to include complete details of such joints and joint surfaces without restricting future developments in their design.

Where pipeline designers are combining plastics pipes with fittings manufactured to this Standard, the following needs to be considered when assessing required minimum depth of pipe entry into fitting sockets:

- (i) Thermal expansion and contraction.
- (ii) Joint deflection.
- (iii) Viscoelasticity of pipeline material.
- (iv) Off-square pipe cuts and chamfer lengths.

Guidelines for the use of plastic pipes with ductile iron fittings specified in this Standard are given in the Water Services of Australia Information and Guidance Note WSAA TN2, *Guidelines for the use ductile iron elastomeric joint fittings with plastic pipes*, available from <https://www.wsaa.asn.au>.

Ductile iron pipelines can be subject to corrosion in some soils. The need for protection can be assessed by various methods, including the ANSI approved AWWA C105/A21.5, *Polyethylene Encasement for Ductile-Iron Pipe Systems*, and the Orstad Chart. The most accurate and commonly used method is

Australia is the linear polarization resistance (LPR) technique. Advice on assessment can be obtained from manufacturers of ductile iron pipeline systems.

Protection against corrosive soils is most commonly provided by loose polyethylene sleeving, manufactured to AS 3680, *Polyethylene sleeving for ductile iron piping*, applied in accordance with AS 3681, *Application of polyethylene sleeving for ductile iron piping*. This system of protection has been in use in Australia for over 40 years and has been shown to be a most cost-effective means of corrosion protection. Training in the use of loose polyethylene sleeving is recommended by ductile iron pipe manufacturers and has been accredited by the Australian Skills Quality Authority.

Australian/New Zealand Standard

Ductile iron pipes and fittings

Section 1 Scope and general

1.1 Scope

This Standard specifies requirements for ductile iron pressure pipes centrifugally cast in moulds, and ductile iron fittings of nominal sizes up to and including DN 750.

NOTE 1 Ductile iron is also known as spheroidal graphite iron, SG iron or nodular graphite iron.

The specified pipes and fittings are intended primarily for conveying water under pressure, but may be used for conveying sewage or other liquids.

Fittings covered by this Standard are intended primarily for use with water supply pressure pipes.

NOTE 2 Fittings are also used in non-metallic pipeline systems.

NOTE 3 Fittings may also be used with pressure pipes of alternative outside diameters by the adoption of compatible sockets or utilization of compensating elastomeric seals, provided the joint meets the performance requirements of this Standard. Ductile iron spigots should not be inserted into plastic pipe sockets.

This Standard specifies pressure classifications of pipe on the basis of the allowable operating pressure (AOP); however, Flange Class (FLCL) pipe has been specified for manufacture of flanged pipe with screw-on flanges.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

NOTE Documents referenced for informative purposes and relevant Standards relating to the installation of ductile iron pipes and fittings are listed in the Bibliography.

AS 1111.1, *ISO metric hexagon commercial bolts and screws—Product grade C, Part 1: Bolts*

AS 1349, *Bourdon tube pressure and vacuum gauges*

AS 1353.2, *Flat synthetic-webbing slings, Part 2: Care and use*

AS 1391, *Metallic materials—Tensile testing at ambient temperature*

AS 1580.408.4, *Paints and related materials—Methods of test, Method 408.1: Adhesion (crosscut)*

AS 1646, *Elastomeric seals for waterworks purposes*

AS 1816.1, *Metallic materials—Brinell hardness test, Method 1: Test method (ISO 6506-1:2005, MOD)*

AS 1831, *Ductile cast iron*

AS 2317.1, *Lifting points, Part 1: Collared eyebolts and collared eyenuts—Grade 4*

AS 2345, *Dezincification resistance of copper alloys*

AS 2758.1, *Aggregates and rock for engineering purposes, Part 1: Concrete aggregates*

AS 3972, *General purpose and blended cements*

AS ISO 7.1, *Pipe threads where pressure-tight joints are made on the threads, Part 1: Dimensions, tolerances and designation*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

AS/NZS 3500.0, *Plumbing and drainage, Part 0: Glossary of terms*

AS/NZS 4020, *Testing of products for use in contact with drinking water*

AS/NZS 4087:2011, *Metallic flanges for waterworks purposes*

AS/NZS 4158, *Thermal-bonded polymeric coatings on valves and fittings for water industry purposes*

ISO 8179-1, *Ductile iron pipes, fittings, accessories and their joints — External zinc-based coating — Part 1: Metallic zinc with finishing layer*

ISO 16132, *Ductile iron pipes and fittings — Seal coats for cement mortar linings*

WSAA WSA 109, Industry Standard for flange gaskets and O-rings

Standard Methods for the Examination of Water and Wastewater, Part 2540: Solids, American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF)

A1 Standard Methods for the Examination of Water and Wastewater, Part 3500: Sodium. American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF) **A1**

Standard Methods for the Examination of Water and Wastewater Part 4500–C1–Chloride; American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF)

Standard Methods for the Examination of Water and Wastewater, Part 4500–H⁺: PH Value, American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF)

Standard Methods for the Examination of Water and Wastewater, Part 4500–SO₄²⁻: Sulfate American Public Health Association (APHA), American Water Works Association (AWWA), Water Environment Federation (WEF)

Standard Methods for the Examination of Water and Wastewater, Part 5520: Oil and Grease,

1.3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in AS/NZS 3500.0 and those below apply.

1.3.1

allowable operating pressure

AOP

allowable internal pressure, excluding surge, that a component can safely withstand in service

1.3.2

allowable site test pressure

ASTP

maximum pressure applied on site in a newly installed pipeline, which includes a safety factor and allowances for surge

1.3.3

coating

corrosion-control barrier applied to the external surface of a pipe or fitting

1.3.4

effective length

overall length of a pipe or fitting measured along its centre-line, excluding the depth of any socket

1.3.5**egg-shelling**

polygonal surface pattern on cement mortar lining resembling the crazing effect exhibited by the shell of an egg with multiple fractures

1.3.6**entry depth**

required distance past the seal that a pipe is inserted in a socket to provide satisfactory sealing

1.3.7**fettling**

cleaning of castings, removal of fins, gates and similar superfluous material by chipping, grinding or other mechanical means

1.3.8**flanged pipe**

pipe manufactured in accordance with this Standard having a flange (conforming to AS/NZS 4087:2011) attached to one or both ends by welding, threaded connection or other suitable means

1.3.9**laitance**

chalky surface layer composed of finer fractions of mortar, which can readily be removed from the lining by scraping with a blade after the lining has cured

Note 1 to entry: Laitance does not include the cement-rich layer, which is an integral part of the lining and cannot be easily removed.

1.3.10**lining**

corrosion-preventing barrier applied to the internal surface of a pipe or fitting

1.3.11**maximum allowable operating pressure****MAOP**

maximum internal pressure, including surge, that a component can safely withstand in service

1.3.12**mortar**

cement mortar consisting of cement, aggregates and water

1.3.13**ovality****out of roundness**

difference between the maximum outside diameter and the minimum outside diameter, measured in the same cross-section

1.3.14**pressure classification**

a classification of pipes, fittings and flanged pipe by a PN number based on the allowable operating pressure (AOP) expressed in megapascals

Note 1 to entry: $PN = 10 \times AOP$.

1.3.15**seal coat**

coating applied over a cement mortar lining to control the interactions between the lining and the contents of the pipe or fitting

1.3.16**shall**

indicates that a statement is mandatory

1.3.17**should**

indicates a recommendation

1.4 Notation

The following symbols are used in this Standard:

a	=	minimum wall thickness of pipe and fittings, in millimetres
t	=	nominal wall thickness of pipe, in millimetres
y	=	mean pipe barrel outside diameter, in millimetres
D	=	mean outside diameter of pipe, in metres
F	=	$Y \times DN$, in newtons
K_A	=	safety factor for allowable operating pressure
	=	3
K_T	=	stress concentration factor associated with the design of each fitting
M	=	weight of the spigot pipe and its contents, in newtons
P_A	=	AOP, excluding surge, in megapascals
PN	=	pressure classification $\boxed{A_1}$ (see Clause 1.3.14) $\boxed{A_1}$
r	=	radius
R	=	minimum ultimate tensile strength of material, in megapascals
W	=	applied vertical force, in newtons
Y	=	1.5 PN with a minimum value of 30 and a maximum value of 50
ω	=	spinning speed, in revolutions per second

1.5 Product conformity evaluation to this Standard

Product conformity to this Australian Standard shall be evaluated in accordance with [Appendix A](#).

NOTE The information that should be supplied by the purchaser, or by the manufacturer, is given in the purchasing guidelines set out in [Appendix B](#).

1.6 Pressure classification**1.6.1 General**

Pipes, fittings and flanged pipe shall be classified by rated pressure in accordance with [Clauses 1.6.2](#), [1.6.3](#) and [1.6.4](#), as applicable. The pressure classification of pipes, fittings and flanged pipe shall be by PN number, except for Flange Class (FLCL) pipe.

1.6.2 Pipe

Ductile iron pipe shall be classified by a PN number, based on the AOP.

Standard pressure classifications shall be PN 20 and PN 35 for pipe sizes up to and including DN 750.

NOTE Other pressure classifications may be used, including for example PN 16, PN 25, PN 30, PN 40 and PN 45.

The minimum wall thickness of pipe (a) shall be determined from the following equation:

$$a = \frac{P_A K_A y}{(2R + P_A K_A)} \quad 1.6.2(1)$$

NOTE The above equation is derived from Barlow's equation, i.e. $\sigma = PD/2a$.

The minimum wall thickness shall be not less than 3.0 mm for pressure classifications up to and including PN 20, and not less than 3.5 mm for all higher pressure classifications.

The nominal wall thickness of pipe (t) shall be determined from the following equation:

$$t = a + 1.3 + 0.001 \times \text{DN} \quad 1.6.2(2)$$

Pipe wall thicknesses for pressure classifications PN 20 and PN 35 shall be as given in [Figure H.1](#) and [Table H.1, Appendix H](#), for pipe sizes up to DN 750.

A special pipe classification, Flange Class (FLCL), for manufacture of flanged pipe with screw-on flanges, is specified in [Figure H.1](#) and [Table H.1, Appendix H](#).

NOTE Guidelines for the ring bending stiffness and allowable deflection of ductile iron pipe are given in WSAA TN3.

1.6.3 Fittings

1.6.3.1 General

Ductile iron fittings shall be classified by PN number, based on the AOP.

Standard pressure classifications shall be PN 16, PN 20 and PN 35 for fitting sizes up to and including DN 750, unless they incorporate a lower pressure classification flange.

NOTE 1 Other pressure classifications are allowable, including for example PN 25, PN 30, PN 40 and PN 45.

NOTE 2 PN 35 wall thicknesses and ratings were adopted on the basis of historical water industry experience.

The minimum wall thickness of fittings shall be determined by one of two methods given in [Clause 1.6.3.2](#) or [1.6.3.3](#) based on the following equation:

$$a = \frac{P_A K_A K_T y}{(2R + P_A K_A K_T)} \quad 1.6.3.1$$

The safety factor for allowable operating pressure (K_A) shall be 3.

The minimum wall thickness of fittings shall be not less than 5.0 mm.

1.6.3.2 Calculation method

The stress concentration factors given in [Table 1.6.3.1](#) shall be used in the equation. The dimensions for bend radii, tee crotch radii and strengthening details for large diameter tees shall be as given in [Appendix H](#), as applicable.

 Fittings wall thicknesses for pressure classifications PN16, PN20 and PN35 shall be as given in [Appendix H Figures H.2 to H.16](#) and [Tables H.2 to H.16](#). 

Table 1.6.3.1 — Stress concentration factors for fittings

DN	K_T
100	5.4
	4.1
200	3.5
225	3.1
250	2.8
300	2.6
375	2.3
450	2.1
500	2.0
600	1.8
750	1.7

1.6.3.3 Computational method

The stress concentration factor and other dimensions, including strengthening requirements, shall be determined for each of the various shapes and configurations of fittings using appropriate engineering techniques. Each fitting designed in accordance with this Clause shall undergo a design verification test in accordance with [Clause 4.2.5](#).

NOTE Finite Element Analysis (FEA) is a recognized contemporary method to meet this requirement.

1.6.4 Flanged pipe

Flanged pipe, including pipes with bolt-on puddle flanges, shall be classified by PN number. The PN number of flanged pipe shall be classified by the PN number of the flange. The PN number of the pipe shall be at least equivalent to the PN number of the flange. The PN number of the pipe shall be determined from minimum wall thickness, using [Equation 1.6.2\(2\)](#) of [Clause 1.6.2](#), after allowing for any loss of wall thickness resulting from the method of attachment.

NOTE Pipe thread depth is regarded as loss of wall thickness.

1.7 Allowable pipeline pressures

Allowable pipeline pressures shall be as follows:

- (a) Allowable operating pressure (AOP) = (PN number)/10, in megapascals.
- (b) Maximum allowable operating pressure (MAOP) = 1.20 × Allowable operating pressure (AOP), in megapascals.
- (c) Allowable site test pressure (ASTP) = 1.25 × Allowable operating pressure (AOP), in megapascals.

The allowable pressures within a pipeline system shall be limited to the lowest pressure classification of all pipe, fittings, flanges and appurtenances within the system.

Allowable pipeline pressures for Class PN 16, PN 20 and Class PN 35 shall be as given in [Table 1.7\(A\)](#). Allowable pressures for pipelines incorporating Class PN 16 and Class PN 35 flanged joints shall be as given in [Table 1.7\(B\)](#).

Table 1.7(A) — Allowable pressures for pipelines with elastomeric seal joints

PN	Allowable operating pressure (AOP) MPa	Maximum allowable operating pressure (MAOP) MPa	Allowable site test pressure (ASTP) MPa
16	1.60	1.92	2.00
20	2.00	2.40	2.50
35	3.50	4.20	4.38

Table 1.7(B) — Allowable pressures for pipelines with flanged joints

PN	AS/NZS 4087:2011 flange reference	Allowable operating pressure (AOP) MPa	Maximum allowable operating pressure (MAOP) MPa	Allowable site test pressure (ASTP) MPa
16	Figure B5	1.60	1.92	2.00
35	Figure B6	3.50	4.20	4.38

NOTE Pipelines using PN 20 pipes and PN 35 fittings and incorporating PN 16 flanges are classified as PN 16 pipelines.

1.8 Marking

1.8.1 Pipes

Each pipe shall be clearly marked with the following:

- Manufacturer's name or mark.
- Nominal size (see [Figure H.1](#) and [Table H.1, Appendix H](#)).
- Pressure classification.
- The number of this Standard, i.e. AS/NZS 2280.
- Colour coding of pipe classes, as given in [Table 1.8.1](#).
- The words "SUITABLE FOR CUTTING" for pipes greater than DN 300 as applicable.

Sewer pipes shall have a red external coating.

NOTE Manufacturers making a statement of conformance to this Australian/New Zealand Standard on a product, packaging or promotional material related to that product, are advised to ensure that such conformance is capable of being verified.

Table 1.8.1 — Colour coding of pipe classes

PN	Socket end marking
20	Green
35	Red
FLCL	Blue
Key FLCL = Flange Class pipe	

1.8.2 Fittings

A1 Each fitting shall be clearly marked with the following, cast onto the fitting in raised form:

- (a) Manufacturer's name or mark.
- (b) Nominal size.
- (c) The word "DUCTILE" or "DI".
- (d) Where applicable, the angle of the bend.
- (e) Pressure classification.
- (f) The number of this Standard, i.e. AS/NZS 2280. **A1**

NOTE Manufacturers making a statement of conformance to this Australian/New Zealand Standard on a product, packaging or promotional material related to that product, are advised to ensure that such conformance is capable of being verified.

1.8.3 Flanged pipe

Each flange shall be clearly marked with the following:

- (a) Manufacturer's name or mark.
- (b) Nominal size.
- (c) Pressure classification
- (d) The number of this Standard, i.e. AS/NZS 2280.

NOTE Manufacturers making a statement of conformance to this Australian/New Zealand Standard on a product, packaging or promotional material related to that product, are advised to ensure that such conformance is capable of being verified.

1.8.4 Pipes and fittings not suitable for drinking water

Pipes or fittings that do not conform to AS/NZS 4020 shall be marked continuously along their length with the words "NOT SUITABLE FOR DRINKING WATER" in legible lettering of minimum 20 mm height.

NOTE Manufacturers making a statement of conformance to this Australian/New Zealand Standard on a product, packaging or promotional material related to that product, are advised to ensure that such conformance is capable of being verified.

Section 2 Materials and manufacture

2.1 Ductile iron

2.1.1 Properties

Processed metal, from which the pipes and fittings (including flanges and puddle flanges for flanged pipe) are manufactured, shall be ductile iron conforming to the requirements of [Clauses 2.1.2 to 2.1.4](#).

NOTE After withdrawal from the moulds, pipes and fittings may require heat treatment to achieve conformance with [Clauses 2.1.2 to 2.1.4](#).

2.1.2 Tensile properties

2.1.2.1 Pipes

Pipes shall be tested in accordance with AS 1391 and [Appendix C](#). The tensile properties of the ductile iron shall be as follows:

- (a) Minimum tensile strength of 420 MPa.
- (b) Minimum elongation of 10 %.

2.1.2.2 Fittings (including flanges and puddle flanges for flanged pipe)

Fittings, including flanges and puddle flanges for flanged pipe, shall be tested in accordance with AS 1391 and [Appendix C](#).

The tensile properties of the ductile iron shall be as follows:

- (a) Minimum tensile strength of 400 MPa.
- (b) Minimum elongation of 10 %.

2.1.3 Hardness

2.1.3.1 Pipes

Pipes shall be tested in accordance with AS 1816.1 and [Appendix C](#). The Brinell hardness of the ductile iron shall not exceed 230 HB.

2.1.3.2 Fittings (including flanges and puddle flanges for flanged pipe)

Fittings, including flanges and puddle flanges for flanged pipe, shall be tested in accordance with AS 1816.1 and [Appendix C](#). The Brinell hardness of the ductile iron shall not exceed 250 HB.

2.1.4 Microstructure

Pipes and fittings shall be tested in accordance with the metallographic procedures of AS 1831. The microstructure of the ductile iron shall have a nodularity of 75 % (min.) Form V and Form VI.

2.1.5 Mode of pipe casting

Pipes shall be cast in moulds by means of a centrifugal casting process.

2.1.6 Finish

Small surface imperfections, inseparable from the method of manufacture and not detrimental to the functional quality of the castings, shall be accepted, provided conformance with all requirements of this Standard is maintained.

Minor surface defects may be rectified by fettling, provided conformance with all requirements of this Standard is maintained.

Cracks and tears in the metal shall not be repaired.

2.2 Contact with drinking and recycled water

All products, including pipe and fittings end coatings and linings, seals and gaskets that are intended for contact with drinking and recycled water shall conform to AS/NZS 4020. The scaling factor shall be as follows:

- (a) For pipe linings — 1.
- (b) For fitting linings (i.e. for fittings comprising not more than 5 % of the total pipeline length) — 0.05.
- (c) For pipe end coatings and linings in contact with drinking water (i.e. the total length of the end coating and lining on a pipe comprises not more than 5 % of the pipe length) — 0.05.

2.3 Preparation of pipes and fittings for coatings and linings

All surfaces of pipes and fittings to be coated and lined shall be clean, dry and free from rust at the time of application. Internal surfaces are not required to be dry for cement mortar lining.

2.4 Coatings

2.4.1 General

Where a coating is specified, it shall be in accordance with [Clause 2.4.2](#) for pipes and [Clause 2.4.3](#) for fittings.

NOTE Other coating systems for pipes and fittings may be specified by the purchaser. The availability of coating systems should be checked with the manufacturer.

2.4.2 Pipe coatings

A metallic zinc coating shall be applied in accordance with ISO 8179-1. The mean mass of zinc coating shall be not less than 200 g/m² with a local minimum of not less than 180 g/m².

A finishing liquid-applied coating shall be applied to metal spray coatings at a minimum coating thickness of 80 µm. The finishing coating shall have an adhesion rating of not greater than 2 when tested to AS 1580.408.4.

NOTE Polyurethane coatings meeting the requirements of EN 15189 may be applied as an alternative to metal spray coatings by agreement between the purchaser and supplier.

2.4.3 Fitting coatings

Thermal-bonded polymeric coatings on fittings shall be in accordance with AS/NZS 4158.

2.5 Linings

2.5.1 General

Pipes shall be lined in accordance with either [Clause 2.5.2](#) or [Clause 2.5.3](#) (see Note 1).

Fittings shall be lined in accordance with [Clause 2.5.4](#) (see Note 2).

Internal surfaces of sockets shall conform to [Clause 2.4](#).

Linings shall not affect the sealing of elastomeric seals and flange gaskets.

NOTE 1 Polyurethane linings meeting the requirements of EN 15655-1 may be applied as an alternative to cement mortar lining by agreement between the purchaser and supplier.

NOTE 2 Other lining systems for pipes and fittings may be specified by the purchaser.

NOTE 3 Guidelines for the use of cement mortar linings in sewerage applications are given in WSAA TN6.

2.5.2 Cement mortar lining intended for drinking and recycled water applications

Unless an alternative lining is specified, pipes shall be cement mortar lined along their effective length in accordance with [Appendix D](#). The cement shall be in accordance with AS 3972 GP, GB or SR cement.

The cement mortar lining thickness shall be as specified in [Table 2.5.2](#).

During manufacture, the thickness of the freshly applied lining shall be measured by a calibrated spear having a diameter of 1.5 mm or less, or by another verifiable method. When using a spear, it shall be inserted perpendicular to the lining surface at a minimum distance of 100 mm from the end face of the pipe or fitting.

Where specified, seal coatings shall conform to ISO 16132.

NOTE 1 Seal coatings are applied over the cement mortar lining of pipes for use in aggressive water situations, particularly for small diameter pipelines where the residence time of water in the pipeline is long.

NOTE 2 Guidance on the use of a seal coating should be sought from the manufacturer. In general, consideration should be given to the use of seal coatings where the total alkalinity of the water being conveyed is less than 30 mg/L.

Table 2.5.2 — Cement mortar lining thickness

DN	Product	Lining thickness, mm	
		Nominal	Minimum
100-600	Pipes	5	3.5
750		6	4.5
NOTE Where the fluid being conveyed is aggressive to a cement mortar, a thicker cement mortar lining or an alternative lining may be specified by the purchaser.			

2.5.3 Calcium aluminate cement mortar lining

Where specified, pipes shall be calcium aluminate cement mortar lined along their effective length in accordance with [Appendix D](#). The calcium aluminate cement shall have a minimum alumina content of 48 %.

The cement mortar lining thickness shall be as specified in [Table 2.5.2](#).

During manufacture, the thickness of the freshly applied lining shall be measured by a calibrated spear having a diameter of 1.5 mm or less, or by another verifiable method. When using a spear, it shall

be inserted perpendicular to the lining surface at a minimum distance of 100 mm from the end face of the pipe.

NOTE 1 Calcium aluminate cement mortar lining is intended for aggressive water applications and is not suitable for drinking water applications.

NOTE 2 For aggressive water applications, consideration should be given to protection of the pipe end not covered by the mortar lining and thus exposed to the aggressive water.

2.5.4 Thermal-bonded polymeric linings

Thermal-bonded polymeric linings on fittings shall be in accordance with AS/NZS 4158.

A1 The corrosion protection system shall be fully effective for all internally wetted surfaces. **A1**

2.6 Elastomeric seals

Elastomeric seals shall be in accordance with AS 1646.

2.7 Flange gasket materials

Flange gaskets materials shall be in accordance with WSA 109.

Section 3 Design of pipes, fittings and joints

3.1 Spigot and socket pipes

3.1.1 Dimensions

Minimum wall thickness of spigot and socket pipes shall be in accordance with [Clause 1.6.2](#). Other dimensions for spigot and socket pipe shall be in accordance with [Figure H.1](#) and [Table H.1, Appendix H](#) (see Note 1).

The effective length of spigot and socket pipe shall be not less than 5000 mm (see Note 2).

NOTE 1 [Figure H.1](#) of [Appendix H](#) gives nominal wall thickness and minimum wall thickness for pressure classifications PN 20, PN 35 and Flange Class (FLCL).

NOTE 2 The effective length of spigot and socket pipe are specified by the manufacturer.

NOTE 3 Spigot chamfer and socket profile are components of the manufacturer's joint design, which is subject to the tests of [Section 4](#).

3.1.2 Tolerances on dimensions

3.1.2.1 Outside diameter

Pipe mean outside diameter (y) tolerances shall be in accordance with [Figure H.1](#) and [Table H.1, Appendix H](#).

3.1.2.2 Length

Pipe effective length tolerance shall be ± 30 mm, except for pipes from which a test specimen was taken. The tolerance on pipe cut to purchaser-specified lengths shall be ± 6 mm.

3.1.2.3 Ovality of pipe

The maximum allowable pipe ovality measured at the spigot shall be in accordance with [Figure H.1](#) and [Table H.1, Appendix H](#).

3.1.2.4 Straightness

Where pipes are tested by means of a straightedge, the deviation from straightness shall not exceed 1.5 mm in any 1 m length, and the total deviation over a full length of pipe shall not exceed 8.5 mm.

3.2 Flanged pipe

3.2.1 Dimensions

Flanged pipe shall be manufactured from pipes conforming to [Clause 3.1](#) and [Figure H.1](#) and [Table H.1, Appendix H](#), and shall be classified in accordance with [Clause 1.6.4](#). Where flanges are fitted by the screw-on method, Flange Class (FLCL) pipe shall be used. The nominal maximum length of a flanged pipe shall be 5850 mm.

3.2.2 Flanges

Flanges shall be square to the axis of the pipe and concentric to the bore. For double flanged pipe, the sealing faces of the flanges shall be parallel and bolt holes shall be aligned. PN 16 flanges shall conform

to the dimensional requirements of AS/NZS 4087:2011 Figure B5 and PN 35 flanges shall conform to the dimensional requirements of AS/NZS 4087:2011 Figure B6.

NOTE Alternative flange dimensions may be specified by the purchaser.

3.2.3 End options

Flanged pipes may be supplied with one the following end options:

- (a) Flange and spigot.
- (b) Flange and socket.
- (c) Flange and flange.

3.2.4 Tolerances

Tolerances on the length of flanged pipes shall be as follows:

- (a) Flanged one end ± 6 mm.
- (b) Flanged both ends as follows:
 - (i) DN 100 to DN 300 (± 1.5) mm.
 - (ii) DN 375 to DN 600 (± 2.5) mm.
 - (iii) DN 750 (± 4.0) mm.

3.3 Pipes with bolt-on puddle flanges

Where fitted, puddle flanges shall provide full thrust restraint.

A machined groove shall be cut on the outside surface of the pipe to produce a groove of the average depth shown in [Figure H.18, Appendix H](#). The pipe shall be classified according to the minimum wall thickness remaining.

Puddle flanges shall be machined to provide a nominal interference fit on the diameter when bolted to a pipe.

Bolts used to clamp two halves of a puddle flange together shall be of commercial quality, low-carbon steel conforming to AS 1111.1.

3.4 Fittings

3.4.1 Dimensions

The minimum wall thickness of fittings shall be in accordance with [Clause 1.6.3](#). Other dimensions of fittings shall be in accordance with [Figures H.2 to H.21](#) and [Tables H.2 to H.21](#) of [Appendix H](#), as appropriate to the type and size of fitting.

NOTE 1 [Figures H.2 to H.16](#) of [Appendix H](#) give minimum wall thickness for PN 16, PN 20 and PN 35 fittings.

NOTE 2 Alternative effective length dimensions for fittings specified in [Appendix H](#) may be agreed between the purchaser and the manufacturer. However, alternative effective length dimensions for all-flanged fittings ([Figures H.14 to H.16](#) and [Tables H.14 to H.16](#)) should not be considered for critical applications such as, for example, in treatment plants or pump stations. Alternative effective length dimensions for tapers, given in [Figure H.8](#) and [Table H.8](#), should not be considered without assessment of head loss impact on flow.

All other fitting configurations not given in [Appendix H](#) may be deemed to conform to this Standard, provided they conform to all the relevant requirements of this Standard.

3.4.2 Spigots

The external diameter and chamfer dimensions of fitting spigots shall be in accordance with [Figure H.17](#) and [Table H.17](#) of [Appendix H](#). An appropriate stop shall be cast on the extremity of the machined surface to prevent over-insertion into a socket.

3.4.3 Sockets

NOTE Socket profile is a component of the manufacturer's joint design, which is subject to the tests of [Section 4](#). Guidelines for the use of non-metallic pipe with ductile iron sockets are given in WSAA TN2.

3.4.4 Integral cast flanges

Fitting flanges shall be integrally cast. The overall length dimensions of fittings shall apply irrespective of the flange classification adopted.

3.4.5 Tolerance on fitting dimensions

The tolerances on fitting dimensions shall be the following:

- (a) For outside diameter of spigots, in accordance with [Figure H.17](#) and [Table H.17](#), [Appendix H](#).
- (b) For length of fittings with any combination of ends, except 2 or more flanges, ± 6 mm.
- (c) For length of fittings with 2 or more flanges, as follows:
 - (i) DN 80 to DN 300, ± 1.5 mm (for dimensions h , $L/2$, and b).
 - (ii) DN 375 to DN 600, ± 2.5 mm (for dimensions h , $L/2$, and b).
 - (iii) DN 750, ± 4.0 mm (for dimensions h , $L/2$, and b).

3.4.6 Lugs and pads

3.4.6.1 Jointing lugs

Jointing lugs shall be provided on 90° and 45° socketed bends, for sizes DN 200 and greater. Dimensions of jointing lugs shall be in accordance with [Figure H.19](#) and [Table H.19](#), [Appendix H](#).

3.4.6.2 Lifting methods

Fittings exceeding 25 kg mass shall be designed to allow slinging in accordance with AS 1353.2. Where provided, the number and location of lifting lugs shall facilitate balanced lifting and handling and eyebolts shall be in accordance with AS 2317.1.

3.4.6.3 Thrust pads

Thrust pads shall be provided on DN 100 and DN 150 bends, except 11 ¼° bends. Dimensions shall be in accordance with [Figure H.20](#) and [Table H.20](#), [Appendix H](#).

3.4.7 Design verification

The design of fittings with wall thicknesses not conforming to [Figures H.2](#) to [H.16](#) and [Tables H.2](#) to [H.16](#), [Appendix H](#) shall be verified in accordance with [Clause 4.2.5](#).

DN 300 tees and above [identified in the relevant [Appendix H](#) figures with the symbol (S)] shall be reinforced in the crotch area and body section to ensure that they have the nominated ratings.

3.5 Pipe and fitting joints

3.5.1 General

Pipes and fittings specified in this Standard may be used with a variety of jointing systems and materials.

NOTE Where pipes and fittings of differing designs or materials are to be jointed, the manufacturer's guidance should be obtained in regard to interchangeability.

3.5.2 Elastomeric seal joints

3.5.2.1 Spigot chamfer

Spigot ends of pipes and fittings shall be chamfered to facilitate jointing without damaging the seal.

3.5.2.2 Minimum depth of entry for fittings sockets

The minimum depth of entry beyond the elastomeric seal for fittings sockets shall be measured in accordance with [Appendix E](#), and shall be in accordance with [Table 3.5.2.2](#).

Table 3.5.2.2 — Minimum depth of entry for ductile iron fittings sockets

Nominal size DN	Minimum depth of entry beyond elastomeric seal for ductile fittings with ductile iron pipe mm	Minimum depth of entry beyond elastomeric seal for ductile fittings with plastics pipe mm
100	42	42
	50	50
200	58	58
225	62	62
250	66	66
300	71	71
375	83	83
450	60	95
500	60	102
600	60	118
750	80	131

NOTE Guidelines for the use of non-metallic pipes with ductile iron sockets are given in WSAA TN2.

3.5.2.3 Joint deflections

When tested in accordance with [Clause 4.2](#), the design of sockets and elastomeric seals shall permit the minimum allowable joint deflections specified in [Table 3.5.2.3](#).

NOTE Profiles and dimensions of sockets are not specified because the joint design is the responsibility of individual manufacturers.

Table 3.5.2.3 — Elastomeric seal joint deflections

Nominal size DN	Minimum joint deflections degrees
100–250	3 ½
300–600	2 ½
750	1

3.5.3 Flanged joints

Flanges for pipes and fittings shall conform to AS/NZS 4087:2011. PN 16 flanges shall conform to the dimensional requirements of AS/NZS 4087:2011 Figure B5, and PN 35 flanges shall conform to the dimensional requirements of AS/NZS 4087:2011 Figure B6, unless specified otherwise in [Appendix H](#).

NOTE Alternative flange dimensions may be specified by the purchaser.

3.6 Measurement

The dimensions of pipes, fittings and joints shall be measured in accordance with [Appendix E](#).

3.7 Symbols for pipes and fittings

NOTE The recommended symbols to be used for pipes and fittings are given in [Appendix G](#).

Section 4 Performance requirements

4.1 Production hydrostatic tests

4.1.1 Purpose

The production hydrostatic tests are primarily intended to demonstrate leak-tightness of the pipes, fittings and flanged pipes.

4.1.2 Pipes with elastomeric seal joints

When pipes with elastomeric seal joints are tested to the pressures specified in [Table 4.1.2](#) for a minimum period of 15 s, they shall not leak or sweat.

4.1.3 Fittings and flanged pipes

When fittings and flanged pipes are tested to the pressures specified in [Table 4.1.2](#) for a minimum period of 15 s, they shall not leak or sweat.

NOTE The production hydrostatic test pressure is lower for fittings and flanged pipes compared to pipes with elastomeric seal joints because —

- (a) the shape of fittings makes it difficult to provide sufficient restraint for high internal pressures during the test; and
- (b) the flanged pipe barrel has been tested under [Clause 4.1.2](#).

Table 4.1.2 — Production hydrostatic test pressures

Nominal diameter DN	Minimum test pressure, MPa	
	Pipes with elastomeric seals	Fittings and flanged pipes
100–300	The lesser of AOP and 5.0	The lesser of AOP and 2.5
375–600	The lesser of AOP and 4.0	1.6
750	The lesser of AOP and 3.5	1.0
Key AOP = allowable operating pressure (see Clause 1.7)		

4.2 Type tests

4.2.1 General

DN 100–DN 750 joints shall be tested in accordance with [Clauses 4.2.2](#) to [4.2.4](#).

4.2.2 Elastomeric seal joints

When the following are tested in accordance with [Appendix F](#), no leakage shall be allowed:

- (a) Each elastomeric seal joint type on new designs, and where there are changes to an existing design.

NOTE 1 Testing of elastomeric seal joints on fittings is not required where the seal joint design is identical to the pipe.

- (b) One joint from the diameter range DN 100 to DN 300, which shall qualify all joints of the same design up to the joint size tested.