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Australian/New Zealand Standard™

Polyethylene (PE) pipes for pressure applications

Standards Australia

STANDARDS NEW ZEALAND
Paerewa Aotearoa

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New Zealand Water and Waste Association
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Australian/New Zealand Standard™

Polyethylene (PE) pipes for pressure applications

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committees PL-006, Polyolefin Pipe Systems, to supersede AS 4130—2001, *Polyethylene (PE) pipes for pressure applications*, which is withdrawn.

The objective of this document is to provide a standard specification for manufacturers and purchasers of polyethylene pipes used for pressure applications.

This revision is based largely on the latest ISO and CEN documents. The notable exception is the inclusion of Series 3 gas pipes, which are included for reasons of compatibility with existing systems. Series 2 gas pipe dimensions are such as to ensure compatibility with existing systems that conform to the ISO 11922-1 size series. Series 1 pressure pipes are for general pressure applications and are compatible with the ISO 11922-1 size series dimensions.

For installation requirements, see AS 2033, *Installation of polyethylene pipe systems*; AS 3723, *Installation and maintenance of plastics pipe systems for gas*; and NZS 5258, *Code of practice for gas distribution*.

Changes in this revision include the introduction where possible of terminology and definitions adopted in ISO standards. The long-term hydrostatic strength of compounds is referred to as the Lower Prediction Limit (LPL) of the stress when evaluated in accordance with ISO 9080.

The range of pipe dimensions has been extended to cover likely demand for the foreseeable future and the range of standard pressure classes has been extended to include PN 20 and PN 25.

The basic Service (Design) Coefficient of 1.25 has been applied to establish the Hydrostatic Design Stress for Series 1 pipes. A series of cumulative design factors taking into account pipe configuration, location and application has been included in Tables C1 and C2 to allow calculation of maximum allowable operating pressure (MAOP) for both gas and water.

Additional requirements for compatibility, UV resistance and thermal stability have been added for striping and jacket compounds, and the base resin requirements have been established by reference to the revised AS/NZS 4131.

The Committee considered at length the requirements for Slow Crack Growth (SCG) and for the PE 80B and PE 100 materials adopted a minimum test value of 500 hours following ISO decisions for gas applications. These materials are intended for use in more demanding applications, such as high pressure gas and water transmission.

Rapid crack propagation resistance (RCP) requirements have not been included in AS/NZS 4130 but have been included in AS/NZS 4131 for PE 100 materials. For high-pressure gas, and high-pressure water applications with air entrapment, where RCP may be a controlling feature, the designer is advised to seek specific advice from the pipe supplier.

The means of demonstrating compliance with this Standard (Appendix A) have been modified for minimum sampling and testing frequency plans to include batch release tests, process verification tests and type tests requirements, to simplify and improve product quality verification.

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

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard. Other notes are for information only.

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FOREWORD

This Standard includes three series of pipe dimensions. Series 1 for general pressure applications and Series 2 and 3 for fuel gas applications.

Pipes made from similar polyethylene compounds from different manufacturers may need to be evaluated to ensure compatibility in welding and similar operations (see AS 2033).

Resistance to rapid crack propagation (RCP) has not been included as a requirement in this Standard. RCP is a potential failure mode in thick wall pipes carrying compressible fluids and operating at high stresses and low temperatures.

Wall thicknesses for the specified pipes have been calculated from equations that take into account the hydrostatic design stress HDS of the material and the working pressure and diameter of the pipe. HDS values for Series 1 pipes (C = 1.25) are given in the table below. In the interest of serviceability of the pipe and irrespective of the calculated minimum wall thickness, this Standard does not provide for a wall thickness of less than 1.6 mm.

HDS VALUES FOR SERIES 1 (C = 1.25)

Compound	Series 1 HDS (MPa)
PE 80	6.3
PE 100	8.0

In this Standard, there is a partial pressure limitation for liquefied petroleum gas (LPG). The aim of this limitation is to prevent the formation of aliphatic hydrocarbon liquids under normal service conditions and subsequent deleterious effects on the long-term performance of the pipe. At a partial pressure of 300 kPa absolute, the dewpoint for a typical propane LPG is below 0°C. The designer of a polyethylene reticulation system should be aware that if service temperatures lower than this are likely to occur or if LPG containing significant quantities of butane gases are to be reticulated, the partial pressure limitation must be revised to avoid condensation of hydrocarbon liquids.

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Australian/New Zealand Standard
Polyethylene (PE) pipes for pressure applications

1 SCOPE AND APPLICATION

1.1 Scope

This Standard specifies requirements for polyethylene pipes for the conveyance of fluids under pressure. Such fluids include, but are not restricted to, water, wastewater, slurries, compressed air, and fuel gas. Fuel gas includes natural gas, liquefied petroleum gas (LPG) in the vapour phase and LPG/air mixtures. The partial pressure of the LPG is not to exceed 300 kPa.

Methods for demonstrating compliance with this Standard are given in Appendix A.

1.2 Application

Pipes intended for the transmission of fuel gas are hereinafter referred to as ‘gas pipes’ and shall be operated up to a MAOP of 1050 kPa gauge.

This Standard does not apply to gas pipes for use with petroleum liquids, including liquid LPG and liquid pentane, or with manufactured or mixed gas distribution systems, which may contain more than 1% aromatics by volume, unless resistance to aromatic constituents has been demonstrated, as required in ISO 4437.

Pipes that do not contain carbon black, in compliance with this Standard, are not intended for extended exposure in direct sunlight, and gas pipes are not intended for service temperatures outside of the range –20°C to +35°C.

The test requirements specified in this Standard may be achieved by alternative test methods if such methods can be shown to provide equal or greater accuracy than those specified herein. In all cases of dispute, the methods specified in this Standard shall be considered the reference test methods.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1199 Sampling procedures and tables for inspection by attributes

1462 Methods of test for plastics pipes and fittings

1462.24 Part 24: Determination of resistance to crack propagation—Test methods for slow crack growth in notched pipes (notch test)

1745 Outdoor weathering of plastics in the Australian environment

1745.2 Part 2: Guide for design purposes

AS/NZS

1462 Methods of test for plastics pipes and fittings

1462.1 Part 1: Method for determining the dimensions of pipes and fittings

1462.4 Part 4: Method of determining reversion UPVC pipes

1462.6 Part 6: Method for hydrostatic pressure testing of pipes

1462.26 Part 26

1462.28 Part 28: Method for the assessment of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds

2566	Buried flexible pipes
2566.1	Part 1: Structural design
3500	National Plumbing and Drainage Code
3500.0	Part 0: Glossary of terms
AS/NZS	
4020	Products for use in contact with drinking water
4131	Polyethylene (PE) compounds for pressure pipes and fittings
SAI/SANZ	
HB18	Guidelines for third-party certification and accreditation
HB18.28 (ISO/IEC Guide 28)	Guide 28 General rules for a model third-party certification scheme for products
ISO	
3	Preferred numbers—Series of preferred numbers
497	Guide to the choice of preferred numbers and of series containing more rounded values of preferred numbers
2505	Thermoplastic pipes—Longitudinal reversion
2505-1	Part 1: Determination methods
2505-2	Part 2: Determination parameters
2859	Sampling procedures for inspection by attributes
2859-1	Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection
3951	Sampling procedures and charts for inspection by variables for percent nonconforming
4437	Buried polyethylene (PE) pipes for the supply of gaseous fuels—Metric series—Specifications
9080	Plastics piping and ducting systems—Determination of the long term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
11357	Plastics—Differential scanning calorimetry (DSC)
11357-6	Part 6: Determination of oxidation induction time
12162	Thermoplastics materials for pipes and fittings for pressure applications—classification and designation—Overall service (design) coefficient
13479	Polyolefin pipes for the conveyance of fluids—Determination of resistance to crack propagation—Test method for slow crack growth on notched pipes (notch test)
13954	Plastics pipes and fittings—Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm

3 DEFINITIONS

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

3.1 Brittle failure

The type of failure of the material in pipe form during pressure testing, where the pipe exhibits no plastic deformation visible to the naked eye (normal or corrected vision).

3.2 Co-extruded 'jacket' pipes

A pipe comprising of two layers, where the melts are bonded simultaneously in a die head as part of the extrusion process.

3.3 Ductile mode

The type of failure of the material in pipe form during pressure testing, where the pipe exhibits plastic deformation visible to the naked eye (normal or corrected vision).

3.4 Hoop stress

The stress in a pipe or fitting under pressure acting tangentially to the perimeter of a transverse section.

3.5 Hydrostatic design stress (HDS)

Hoop stress due to internal hydrostatic pressure, which can be applied continuously at a specified temperature, and which is obtained by the application of a design factor to the minimum required strength (MRS).

3.6 Liquefied petroleum gas (LPG)

A hydrocarbon fluid composed predominantly of any of the following hydrocarbons or mixtures of all or any of them: propane (C_3H_8), propylene (C_3H_6), butane (C_4H_{10}) or butylenes (C_4H_8) (see Note 1).

NOTES:

1 Unless specifically stated otherwise, any reference to 'propane', 'butane', or similar means the commercial grade of that product.

2 The characteristics of the various LP gases, either pure or commercial grades, together with methods for their determination, are given in the ALPGA publication '*Liquefied Petroleum Gas—Specifications and Test Methods*'.

3.7 Lower prediction limit of the predicted hydrostatic strength (σ_{LPL})

Quantity with the dimensions of stress, which represents the 97.5% lower prediction limit of the predicted hydrostatic strength for a single value at temperature T and a time t. It is denoted as:

$$\sigma_{LPL}=\sigma_{(T,\ t,\ 0.975)}$$

NOTE: This value is calculated using the statistical procedures outlined in the standard extrapolation method of ISO 9080.

3.8 Maximum allowable operating pressure (MAOP)

The maximum pressure that can be sustained, with a design factor, by the type or class of pipe for its estimated useful life under the anticipated operating conditions.

3.9 Minimum required strength (MRS)

The required value of σ_{LPL} for a temperature of 20°C and a time of 50 years ($\sigma_{(20,50years,0,975)}$), rounded down to the next smaller value of the R10 series or of the R20 series conforming to ISO 3, ISO 497 and ISO 12162, depending on the value of σ_{LPL}. The MRS is expressed as a hoop stress in megapascals.

3.10 Out-of-roundness (ovality)

The difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section of the pipe.

3.11 Pipe material temperature

Average temperature estimated as applying through the full wall thickness.

3.12 Standard dimension ratio (SDR)

A nominal ratio of the pipe outside diameter to its wall thickness.

3.13 Working pressure

Maximum pressure that can be sustained by the class of pipe for its estimated useful life under the expected working conditions.

4 NOTATION

The following apply to this Standard:

D_m = the mean outside diameter, in millimetres

DN = the nominal size, in millimetres

D_I = mean inside diameter, in millimetres

C = overall service (design) coefficient

HDS = MRS/C

σ_{LPL} Lower prediction limit

MRS = minimum required strength, in megapascals

PN = nominal working pressure designated in bar but normally referenced in MPa, (that is, $\frac{\text{PN (in bar)}}{10} = \text{MPa}$)

SDR = standard dimension ratio

T = the wall thickness, in millimetres

T_{max} = maximum wall thickness, in millimetres

$T_{min.}$ = minimum wall thickness, in millimetres

5 OVERALL SERVICE (DESIGN) COEFFICIENT

The service (design) coefficient (C), used to determine the nominal pressure rating (PN) for Series 1 pipes, is 1.25. For calculation of maximum allowable operating pressure (MAOP) for Series 2 and Series 3, see Appendix B. For Series 1 pipes with increased design coefficient also see Appendix B.

NOTE: Advisory information on the selection of design factors for gas and water pipes is given in Appendix C.

6 CLASSIFICATION

Series 1 pipes are classified in terms of the nominal pressure rating (PN). The number used to describe PN is 10 times the value of the maximum allowable operating pressure (MAOP) at 20°C based on C = 1.25 and given in megapascals.

The classifications for Series 1 pipes shall be as follows:

PN 3.2 Nominal working pressure of 0.32 MPa

PN 4 Nominal working pressure of 0.40 MPa

PN 6.3 Nominal working pressure of 0.63 MPa

PN 8 Nominal working pressure of 0.80 MPa

PN 10 Nominal working pressure of 1.00 MPa

PN 12.5 Nominal working pressure of 1.25 MPa

PN 16 Nominal working pressure of 1.60 MPa

PN 20 Nominal working pressure of 2.00 MPa

PN 25 Nominal working pressure of 2.50 MPa

Series 2 and Series 3 pipes are classified according to SDR.

Standard dimension ratios for Series 1 pipes made from PE 80 and PE 100 compounds are given in Table 1.

Series 1 pipe dimensions are given in Table 2, Series 2 in Table 3, and Series 3 in Table 4.

TABLE 1

STANDARD DIMENSION RATIOS (SDRs) FOR SERIES 1 PIPES

Compound	PN 3.2	PN 4	PN 6.3	PN 8	PN 10	PN 12.5	PN 16	PN 20	PN 25
PE 80	41	33	21	17	13.6	11	9	7.4	—
PE 100	—	41	26	21	17	13.6	11	9	7.4

TABLE 2

DIMENSIONS FOR SERIES 1 PIPES FOR STANDARD DIMENSION RATIOS

millimetres

SDRs 41, 33 and 26															
Nominal outside diameter (DN)	Mean outside diameter (D_m)		Maximum out-of-roundness	SDR 41				SDR 33				SDR 26			
				Wall thickness (T)		Mean inside diameter (D_i)		Wall thickness (T)		Mean inside diameter (D_i)		Wall thickness (T)		Mean inside diameter (D_i)	
	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
16	16.0	16.3	1.2	—	—	—	—	—	—	—	—	—	—	—	—
20	20.0	20.3	1.2	—	—	—	—	—	—	—	—	—	—	—	—
25	25.0	25.3	1.2	—	—	—	—	—	—	—	—	—	—	—	—
32	32.0	32.3	1.3	—	—	—	—	—	—	—	—	—	—	—	—
40	40.0	40.4	1.4	—	—	—	—	—	—	—	—	—	—	—	—
50	50.0	50.5	1.4	—	—	—	—	—	—	—	—	—	—	—	—
63	63.0	63.6	1.5	—	—	—	—	—	—	—	—	2.4	2.8	57.4	58.8
75	75.0	75.7	1.6	—	—	—	—	2.3	2.7	69.6	71.1	2.9	3.3	68.4	69.9
90	90.0	90.9	1.8	—	—	—	—	2.8	3.2	83.6	85.3	3.5	4.0	82.0	83.9
110	110.0	111.0	2.2	2.7	3.1	103.8	105.6	3.4	3.9	102.2	104.2	4.3	4.9	100.2	102.4
125	125.0	126.2	2.5	3.1	3.6	117.8	120.0	3.9	4.4	116.2	118.4	4.8	5.4	114.2	116.6
140	140.0	141.3	2.8	3.5	4.0	132.0	134.3	4.3	4.9	130.2	132.7	5.4	6.1	127.8	130.5
160	160.0	161.5	3.2	4.0	4.5	151.0	153.5	4.9	5.5	149.0	151.7	6.2	7.0	146.0	149.1
180	180.0	181.7	3.6	4.4	5.0	170.0	172.9	5.5	6.2	167.6	170.7	6.9	7.7	164.6	167.9
200	200.0	201.8	4.0	4.9	5.5	189.0	192.0	6.2	7.0	186.0	189.4	7.7	8.6	182.8	186.4
225	225.0	227.1	4.5	5.5	6.2	212.6	216.1	6.9	7.7	209.6	213.3	8.6	9.6	205.8	209.9
250	250.0	252.3	5.0	6.2	7.0	236.0	239.9	7.7	8.6	232.8	236.9	9.6	10.7	228.6	233.1
280	280.0	282.6	9.8	6.9	7.7	264.6	268.8	8.6	9.6	260.8	265.4	10.7	11.9	256.2	261.2
315	315.0	317.9	11.1	7.7	8.6	297.8	302.5	9.7	10.8	293.4	298.5	12.1	13.5	288.0	293.7
355	355.0	358.2	12.5	8.7	9.7	335.6	340.8	10.9	12.1	330.8	336.4	13.6	15.1	324.8	331.0
400	400.0	403.6	14.0	9.8	10.9	378.2	381.8	12.3	13.7	372.6	379.0	15.3	17.0	366.0	373.0
450	450.0	454.1	15.6	11.0	12.2	425.6	432.1	13.8	15.3	419.4	426.5	17.2	19.1	411.8	419.7
500	500.0	504.5	17.5	12.3	13.7	472.6	479.9	15.3	17.0	466.0	473.9	19.1	21.2	457.6	466.3
560	560.0	565.0	19.6	13.7	15.2	529.6	537.7	17.2	19.1	521.8	530.7	21.4	23.7	512.6	522.3
630	630.0	635.7	22.1	15.4	17.1	595.8	604.9	19.3	21.4	587.2	597.1	24.1	26.7	576.6	587.5
710	710.0	716.4	24.9	17.4	19.3	671.4	681.6	21.8	24.1	661.8	672.8	27.2	30.1	649.8	662.0
800	800.0	807.2	28.0	19.6	21.7	756.6	768.0	24.5	27.1	745.8	758.2	30.6	33.8	732.4	746.0
900	900.0	908.1	31.5	22.0	24.3	851.4	864.1	27.6	30.5	839.0	852.9	34.4	38.0	824.0	839.3
1 000	1 000.0	1 009.0	35.0	24.5	27.1	945.8	960.0	30.6	33.8	932.4	947.8	38.2	42.2	915.6	932.6
1 200	1 200.0	1 210.0	42.0	29.4	32.5	1 135.0	1 151.2	36.7	40.5	1 119.0	1 136.6	45.9	50.6	1 098.8	1 118.2
1 400	1 400.0	1 410.0	49.0	34.4	38.0	1 324.0	1 341.2	42.9	47.3	1 305.4	1 324.2	53.2	58.7	1 282.6	1 303.6
1 600	1 600.0	1 610.0	56.0	39.3	43.4	1 513.2	1 531.4	49.0	54.0	1 492.0	1 512.0	61.3	67.6	1 464.8	1 487.4

(continued)

TABLE 2 (*continued*)

millimetres

SDRs 21, 17 and 13.6															
Nominal outside diameter (DN)	Mean outside diameter (D_m)		Maximum out-of-roundness	SDR 21				SDR 17				SDR 13.6			
				Wall thickness (T)		Mean inside diameter (D_1)		Wall thickness (T)		Mean inside diameter (D_1)		Wall thickness (T)		Mean inside diameter (D_1)	
	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
16	16.0	16.3	1.2	—	—	—	—	—	—	—	—	—	—	—	—
20	20.0	20.3	1.2	—	—	—	—	—	—	—	—	1.6	1.9	16.2	17.1
25	25.0	25.3	1.2	—	—	—	—	1.6	1.9	21.2	22.1	1.9	2.2	20.6	21.5
32	32.0	32.3	1.3	1.6	1.9	28.2	29.1	1.9	2.2	27.6	28.5	2.4	2.8	26.4	27.5
40	40.0	40.4	1.4	1.9	2.2	35.6	36.6	2.4	2.8	34.4	35.6	3.0	3.4	33.2	34.4
50	50.0	50.5	1.4	2.4	2.8	44.4	45.7	3.0	3.4	43.2	44.5	3.7	4.2	41.6	43.1
63	63.0	63.6	1.5	3.0	3.4	56.2	57.6	3.8	4.3	54.4	56.0	4.7	5.3	52.4	54.2
75	75.0	75.7	1.6	3.6	4.1	66.8	68.5	4.5	5.1	64.8	66.7	5.5	6.2	62.6	64.7
90	90.0	90.9	1.8	4.3	4.9	80.2	82.3	5.4	6.1	77.8	80.1	6.6	7.4	75.2	77.7
110	110.0	111.0	2.2	5.3	6.0	98.0	100.4	6.6	7.4	95.2	97.8	8.1	9.1	91.8	94.8
125	125.0	126.2	2.5	6.0	6.7	111.6	114.2	7.4	8.3	108.4	111.4	9.2	10.3	104.4	107.8
140	140.0	141.3	2.8	6.7	7.5	125.0	127.9	8.3	9.3	121.4	124.7	10.3	11.5	117.0	120.7
160	160.0	161.5	3.2	7.7	8.6	142.8	146.1	9.5	10.6	138.8	142.5	11.8	13.1	133.8	137.9
180	180.0	181.7	3.6	8.6	9.6	160.8	164.5	10.7	11.9	156.2	160.3	13.3	14.8	150.4	155.1
200	200.0	201.8	4.0	9.6	10.7	178.6	182.6	11.9	13.2	173.6	178.0	14.7	16.3	167.4	172.4
225	225.0	227.1	4.5	10.8	12.0	201.0	205.5	13.4	14.9	195.2	200.3	16.6	18.4	188.2	193.9
250	250.0	252.3	5.0	11.9	13.2	223.6	228.5	14.8	16.4	217.2	222.7	18.4	20.4	209.2	215.5
280	280.0	282.6	9.8	13.4	14.9	250.2	255.8	16.6	18.4	243.2	249.4	20.6	22.8	234.4	241.4
315	315.0	317.9	11.1	15.0	16.6	281.8	287.9	18.7	20.7	273.6	280.5	23.2	25.7	263.6	271.5
355	355.0	358.2	12.5	16.9	18.7	317.6	324.4	21.1	23.4	306.2	316.0	26.1	28.9	297.2	306.0
400	400.0	403.6	14.0	19.1	21.2	357.6	365.4	23.7	26.2	347.6	356.2	29.4	32.5	335.0	344.8
450	450.0	454.1	15.6	21.5	23.8	402.4	411.1	26.7	29.5	391.0	400.7	33.1	36.6	376.8	387.9
500	500.0	504.5	17.5	23.9	26.4	447.2	456.7	29.6	32.7	434.6	445.3	36.8	40.6	418.8	430.9
560	560.0	565.0	19.6	26.7	29.5	501.0	511.7	33.2	36.7	486.6	498.7	41.2	45.5	469.0	482.7
630	630.0	635.7	22.1	30.0	33.1	563.8	575.7	37.3	41.2	547.6	561.1	46.3	51.1	527.8	543.1
710	710.0	716.4	24.9	33.9	37.4	635.2	648.6	42.1	46.5	617.0	632.2	52.2	57.6	594.8	612.0
800	800.0	807.2	28.0	38.1	42.1	715.8	731.0	47.4	52.3	695.4	712.4	58.8	64.8	670.4	689.6
900	900.0	908.1	31.5	42.9	47.3	805.4	822.3	53.5	59.0	782.2	801.1	—	—	—	—
1 000	1 000.0	1 009.0	35.0	47.7	52.6	894.8	913.6	59.3	65.4	869.2	890.4	—	—	—	—
1 200	1 200.0	1 210.0	42.0	57.2	63.1	1 073.8	1 095.6	—	—	—	—	—	—	—	—
1 400	1 400.0	1 410.0	49.0	—	—	—	—	—	—	—	—	—	—	—	—
1 600	1 600.0	1 610.0	56.0	—	—	—	—	—	—	—	—	—	—	—	—

(continued)

TABLE 2 (*continued*)

millimetres

SDRs 11, 9 and 7.4																
Nominal outside diameter (DN)	Mean outside diameter D_m		Maximum out-of-roundness	SDR 11				SDR 9				SDR 7.4				
				Wall thickness (T)		Mean inside diameter (D_I)		Wall thickness (T)		Mean inside diameter (D_I)		Wall thickness (T)		Mean inside diameter (D_I)		
	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
16	16.0	16.3	1.2	1.6	1.9	12.2	13.1	1.8	2.1	11.8	12.7	2.2	2.6	10.8	11.9	
20	20.0	20.3	1.2	1.9	2.2	15.6	16.5	2.3	2.7	14.6	15.7	2.8	3.2	13.6	14.7	
25	25.0	25.3	1.2	2.3	2.7	19.6	20.7	2.8	3.2	18.6	19.7	3.5	4.0	17.0	18.3	
32	32.0	32.3	1.3	2.9	3.3	25.4	26.5	3.6	4.1	23.8	25.1	4.4	5.0	22.0	23.5	
40	40.0	40.4	1.4	3.7	4.2	31.6	33.0	4.5	5.1	29.8	31.4	5.5	6.2	27.6	29.4	
50	50.0	50.5	1.4	4.6	5.2	39.6	41.2	5.6	6.3	37.4	39.3	6.9	7.7	34.6	36.7	
63	63.0	63.6	1.5	5.8	6.5	50.0	52.0	7.1	8.0	47.0	49.4	8.6	9.6	43.8	46.4	
75	75.0	75.7	1.6	6.8	7.6	59.8	62.1	8.4	9.4	56.2	58.9	10.3	11.5	52.0	55.1	
90	90.0	90.9	1.8	8.2	9.2	71.6	74.5	10.1	11.3	67.4	70.7	12.3	13.7	62.6	66.3	
110	110.0	111.0	2.2	10.0	11.1	87.8	91.0	12.3	13.7	82.6	86.4	15.1	16.8	76.4	80.8	
125	125.0	126.2	2.5	11.4	12.7	99.6	103.4	14.0	15.5	94.0	98.2	17.1	19.0	87.0	92.0	
140	140.0	141.3	2.8	12.7	14.1	111.8	115.9	15.7	17.4	105.2	109.9	19.2	21.3	97.4	102.9	
160	160.0	161.5	3.2	14.6	16.2	127.6	132.3	17.9	19.8	120.4	125.7	21.9	24.2	111.6	117.7	
180	180.0	181.7	3.6	16.4	18.2	143.6	148.9	20.1	22.3	135.4	141.5	24.6	27.2	125.6	132.5	
200	200.0	201.8	4.0	18.2	20.2	159.6	165.4	22.4	24.8	150.4	157.0	27.3	30.2	139.6	147.2	
225	225.0	227.1	4.5	20.5	22.7	179.6	186.1	25.1	27.8	169.4	176.9	30.8	34.0	157.0	165.5	
250	250.0	252.3	5.0	22.7	25.1	199.8	206.9	27.9	30.8	188.4	196.5	34.2	37.8	174.4	183.9	
280	280.0	282.6	9.8	25.4	28.1	223.8	231.8	31.3	34.6	210.8	220.0	38.3	42.3	195.4	206.0	
315	315.0	317.9	11.1	28.6	31.6	251.8	260.7	35.2	38.9	237.2	247.5	43.0	47.4	220.2	231.9	
355	355.0	358.2	12.5	32.2	35.6	283.8	293.8	39.6	43.7	267.6	279.0	48.5	53.5	248.0	261.2	
400	400.0	403.6	14.0	36.3	40.1	319.8	331.0	44.7	49.3	301.4	314.2	54.6	60.2	279.6	294.4	
450	450.0	454.1	15.6	40.9	45.1	359.8	372.3	50.2	55.4	339.2	353.7	61.5	67.8	314.4	331.1	
500	500.0	504.5	17.5	45.4	50.1	399.8	413.7	55.8	61.5	377.0	392.9	—	—	—	—	
560	560.0	565.1	19.6	50.8	56.0	448.0	463.5	—	—	—	—	—	—	—	—	
630	630.0	635.7	22.1	57.2	63.1	503.8	521.3	—	—	—	—	—	—	—	—	
710	710.0	716.4	24.9	—	—	—	—	—	—	—	—	—	—	—	—	
800	800.0	807.2	28.0	—	—	—	—	—	—	—	—	—	—	—	—	
900	900.0	908.1	31.5	—	—	—	—	—	—	—	—	—	—	—	—	
1 000	1 000.0	1 009.0	35.0	—	—	—	—	—	—	—	—	—	—	—	—	
1 200	1 200.0	1 210.0	42.0	—	—	—	—	—	—	—	—	—	—	—	—	
1 400	1 400.0	1 410.0	49.0	—	—	—	—	—	—	—	—	—	—	—	—	
1 600	1 600.0	1 610.0	56.0	—	—	—	—	—	—	—	—	—	—	—	—	

NOTE: In the interest of pipe serviceability and irrespective of calculated wall thicknesses, the minimum pipe wall thickness for Series 1 pipes shall be 1.6 mm.

TABLE 3

DIMENSIONS FOR SERIES 2 PIPES—GAS (NOMINAL OUTSIDE DIAMETER SERIES)

millimetres

Nominal outside diameter (DN)	Mean outside diameter D_m		Maximum out of roundness	Wall thickness (T)					
				SDR 17.6		SDR 13.6		SDR 11	
	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.
16	16.0	16.3	1.2	2.3	2.6	3.0	3.4	3.0	3.4
20	20.0	20.3	1.2	2.3	2.6	3.0	3.4	3.0	3.4
25	25.0	25.3	1.2	2.3	2.6	3.0	3.4	3.0	3.4
32	32.0	32.3	1.3	2.3	2.6	3.0	3.4	3.0	3.4
40	40.0	40.4	1.4	2.3	2.6	3.0	3.4	3.7	4.2
50	50.0	50.4	1.4	2.9	3.3	3.7	4.2	4.6	5.2
63	63.0	63.4	1.5	3.6	4.1	4.7	5.3	5.8	6.5
75	75.0	75.5	1.6	4.3	4.8	5.5	6.2	6.8	7.6
90	90.0	90.6	1.8	5.2	5.8	6.6	7.4	8.2	9.2
110	110.0	110.7	2.2	6.3	7.0	8.1	9.1	10.0	11.1
125	125.0	125.8	2.5	7.1	7.9	9.2	10.3	11.4	12.7
140	140.0	140.9	2.8	8.0	8.9	10.3	11.5	12.7	14.1
160	160.0	161.0	3.2	9.1	10.1	11.8	13.1	14.6	16.2
180	180.0	181.1	3.6	10.3	11.4	13.3	14.8	16.4	18.2
200	200.0	201.2	4.0	11.4	12.6	14.7	16.3	18.2	20.2
225	225.0	226.4	4.5	12.8	14.2	16.6	18.4	20.5	22.7
250	250.0	251.5	5.0	14.2	15.7	18.4	20.4	22.7	25.1
280	280.0	282.6	9.8	16.0	17.7	20.6	22.8	25.4	28.1
315	315.0	317.9	11.1	17.9	19.8	23.2	25.7	28.6	31.6
355	355.0	358.2	12.5	20.2	22.3	26.1	28.9	32.3	35.6
400	400.0	403.6	14.0	22.8	25.2	29.4	32.5	36.4	40.1
450	450.0	454.1	15.6	25.6	28.5	33.1	36.6	41.0	45.1
500	500.0	504.5	17.5	28.5	31.5	36.8	40.6	45.5	50.1
560	560.0	565.0	19.6	31.9	35.2	41.2	45.5	51.0	56.2
630	630.0	635.7	22.1	35.8	39.5	46.3	51.1	57.3	63.1

NOTES:

1 This pipe series is based on ISO metric sizes.

2 In the interest of serviceability of pipe and irrespective of the calculated wall thickness, this Standard does not provide for a wall thickness of less than 2.3 mm for Series 2 pipes for SDR 17.6 and 3.00 mm for SDR 13.6 and SDR 11.

TABLE 4

DIMENSIONS FOR SERIES 3 PIPES—GAS (NOMINAL INSIDE DIAMETER SERIES)

millimetres

Nominal inside diameter (DN)	Mean outside diameter (D_m)		Maximum out of roundness	Wall thickness (T)													
				SDR 9.9		SDR 11		SDR 15		SDR 17		SDR 21		SDR 26		SDR 32	
	Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
10	15.7	16.0	0.7	2.3	2.5	2.3	2.5	—	—	—	—	—	—	—	—	—	—
13	18.9	19.2	0.7	2.3	2.5	—	—	—	—	—	—	—	—	—	—	—	—
15	21.4	21.7	0.7	2.3	2.5	2.3	2.5	—	—	—	—	—	—	—	—	—	—
18	22.5	22.8	0.7	2.3	2.5	—	—	—	—	—	—	—	—	—	—	—	—
20	26.6	26.9	0.9	2.7	3.0	2.4	2.7	2.3	2.5	2.3	2.5	—	—	—	—	—	—
25	33.4	33.7	0.9	3.4	3.7	3.1	3.4	2.3	2.5	2.3	2.5	—	—	—	—	—	—
32S	42.1	42.4	1.1	—	—	—	—	2.8	3.1	—	—	—	—	—	—	—	—
32	42.1	42.4	1.1	4.3	4.7	3.9	4.2	3.4	3.7	2.3	2.5	—	—	—	—	—	—
40	48.1	48.4	1.3	4.9	5.4	4.4	4.8	3.4	3.7	2.7	2.9	—	—	—	—	—	—
50	60.2	60.5	1.5	6.1	6.7	5.5	6.1	4.0	4.4	3.6	3.9	—	—	—	—	—	—
65	76.0	76.7	1.5	—	—	6.9	7.6	—	—	4.5	4.9	—	—	—	—	—	—
80	88.7	89.2	2.3	—	—	8.1	8.9	—	—	5.2	5.8	4.2	4.7	—	—	—	—
100	114.1	114.7	2.9	—	—	10.4	11.4	—	—	6.7	7.4	5.4	6.0	—	—	—	—
150	168.0	168.9	3.3	—	—	15.3	16.8	—	—	9.9	10.9	8.0	8.8	6.5	7.1	—	—
200	218.8	219.9	3.3	—	—	19.9	21.9	—	—	13.0	14.3	10.4	11.5	8.4	9.3	6.8	7.5
250	272.6	274.0	3.8	—	—	24.9	27.3	—	—	16.1	17.7	13.0	14.3	10.5	11.6	8.5	9.4
300	323.4	326.7	4.7	—	—	29.5	32.4	—	—	19.1	21.0	15.4	17.0	12.5	13.7	10.1	11.1

NOTES:

1 This pipe series is based on the iron pipe sizes (IPS).

2 In the interests of serviceability of the pipe and irrespective of the calculated wall thickness, this Standard does not provide for a wall thickness of less than 2.3 mm for Series 3 pipes.

3 Hot tool saddle fusion should only be used on Series 3 pipe with a minimum wall thickness of 3.4 mm for SDR 21 and 4.3 mm for SDR 9.9.

4 Nominal diameter DN 32S Series 3 pipe should only be used for low pressure services.

5 SDR 9.9 was formerly called Class 575, and sizes up to DN 80 of SDR 15 and SDR 21 were formerly called Class 250.

7 COMPOSITION

7.1 General

Pipes shall be manufactured from fully pre-compounded pipe extrusion compounds that comply with AS/NZS 4131.

NOTE: Pipes for the transport of fuel gas or compressed air should be made from PE 80B or PE 100 compounds only.

7.2 Rework material

Clean rework, which is generated from the manufacturer's own production of pipe in accordance with this Standard, may be used if it is derived from the same grade of resin as used for the relevant production.

When rework material is added to a production run, the manufacturer shall treat this run as a new batch.

7.3 Striping and jacket compounds

7.3.1 *General*

The base resin used for striping and jacket compounds shall be a base resin used to produce a compound conforming with AS/NZS 4131.

The MRS classification of the base resin used for stripes or jackets shall be greater than or equal to the MRS classification of the compound used for the parent pipe.

Striping and jacket compounds shall be fully precompounded and shall comply with the test requirements of Clauses 7.3.2 and 7.3.3.

Coloured striping and jacket compounds shall be UV-stabilized with a minimum of 0.2% of a hindered amine light stabilizer (HALS). Alternatively, the striping or jacket compound shall meet the requirements of Clause 7.3.4.

The minimum thickness for the jacket shall be 0.2mm.

7.3.2 *Thermal stability of striping compounds*

Striping and jacket compounds shall contain antioxidants either singly or in combination, such that when determined in accordance with ISO 11357-6, the oxidation induction time shall be not less than 40 min at a test temperature of 200°C or a demonstrated equivalent time at a higher temperature.

7.3.3 *Dispersion*

Antioxidants, ultraviolet light stabilizers and pigments shall be evenly dispersed in the striping or jacket compounds.

When striping or jacket compounds containing carbon black or other pigments are tested in accordance with AS/NZS 1462.28, the rating of appearance shall not be worse than Micrograph B in Annex B of AS/NZS 1462.28, and the arithmetic average of the maximum sizes of pigment agglomerations or foreign bodies shall not exceed 60 μm (corresponding to Grade 3 of AS/NZS 1462.28).

NOTE: Because the dispersion of antioxidants and ultraviolet light stabilizers is difficult to assess, it is assumed that if the pigment is evenly dispersed, the other components will also be evenly dispersed.

7.3.4 *Weathering resistance*

The weathering resistance test shall apply to all coloured striping and jacket compounds with less than 0.2% by mass of HALS. The weathering resistance, including resistance to ultraviolet light radiation, determined in accordance with AS/NZS 1462.26 on samples exposed to at least 3.5 GJ/m^2 shall be such that the mean elongation at break shall be ≥350%.

NOTE: The intent of the weathering test is to provide assurance of resistance to weathering encountered during storage and transport of pipes. The test does not provide similar assurance for installations exposed to the elements long term. Reference should be made to AS 1745.2 for typical incident energy at various sites around Australia.

7.3.5 *Cohesive resistance*

Jacketed and striped pipe shall be tested in accordance with ISO 13954. Decohesion between jacket or stripe and parent pipe shall not occur over more than 30% of the socket fusion zone as defined in AS/NZS 4129.

8 COLOUR

8.1 General

Pipes that are not intended for fuel gas application shall not be visibly coloured yellow in whole or in part.

Series 1 pipes shall be black or blue, or black with blue stripes or jacket. For recycled water, Series 1 pipes shall be lilac, or black with lilac stripes or jacket.

Series 2 and Series 3 pipes (gas pipes) shall be yellow, or black with yellow stripes or jacket.

NOTE: Pipes of other colours may be supplied by agreement between the purchaser and the manufacturer.

8.2 Stripes and jackets

8.2.1 *General*

Yellow, blue and lilac stripes and jackets shall meet the colour requirements of Clauses 8.2.2, 8.2.3 and 8.2.4, respectively. Colour requirements for stripes and jackets of other colours shall be as agreed between the purchaser and the manufacturer.

Stripes shall be opaque with the angular separation between stripes no greater than 130° and the width of stripes as shown in Table 5

TABLE 5

WIDTH OF STRIPES

Nominal pipe diameter mm	Minimum width of stripes mm
16, 20, 25	1
32, 40, 50	2
63 and above	3

8.2.2 *Yellow*

The colour of yellow stripes or jackets on pipes shall be as follows:

(a) PE 80, no darker than RAL 1018.

(b) PE 100, no lighter than RAL 1033.

8.2.3 *Blue*

The colour of blue stripes or jackets on pipes shall be as follows:

(a) PE 80, no darker than RAL 5012.

(b) PE 100, no lighter than RAL 5005.

8.2.4 *Lilac*

PE 80/PE 100, no lighter than RAL 3015 and no darker than RAL 4001.

NOTE: Information on the RAL colour range may be obtained from RAL Deutsches Institut fur Gutesicherung und Kennzeichnung e.V., Siegburger Straβe 39 D-53757 Sankt Augustin, Telephone 49-2241-1605-60, Fax 49-2241-1605-16, www.ral.de

9 GENERAL REQUIREMENTS

9.1 Diameter and wall thickness

9.1.1 *Tables 2, 3 and 4*

The thickness at any point shall not fall below the minimum specified in Tables 2, 3 or 4, as appropriate to the DN and SDR, and the average thickness shall not exceed the maximum specified. When measured at a distance not less than 5% of DN from the cut end of the pipe, in accordance with AS/NZS 1462.1, the mean outside diameter (D_m) shall comply

with the requirements of Table 2, 3 or 4, as appropriate. The mean inside diameter may be determined by subjecting the mean wall thickness from the mean outside diameter.

9.1.2 *Special applications*

Where it is desired to determine the wall thickness appropriate for a special application, the calculation in Appendix D shall be used.

9.2 Length

Straight pipe shall be supplied in nominated lengths with a tolerance of +0.05, –0 m. The length of pipes supplied in coils shall be not less than that designated by the manufacturer.

NOTE: All measurements should be adjusted to an equivalent length at 20°C. The coefficient of thermal expansion for PE may be taken for reference purposes as 2×10^{-4}/°C.

9.3 Coiled pipe

The internal diameter for a coil of pipe shall be such that kinking is prevented.

9.4 Out of roundness

Ovality requirements shall apply at the time of manufacture and before coiling. These requirements are not applicable to pipe of SDR >17.6.

9.5 Freedom from defects

9.5.1 *General*

Defects shall not affect the performance or function of the pipe in service. Pipes shall not have any blisters, voids, burnt particles or heat marks. When grooves, wrinkles, rippling, dents or projections are present, the pipe shall comply with the dimensional requirements of Tables 2, 3 or 4, as appropriate. Where defects are present and the product is submitted for acceptance, the manufacturer shall be able to demonstrate its conformance to this Standard.

9.5.2 *Pipe ends*

Pipe ends shall not have any chips, burrs or rough edges and shall be nominally square.

9.5.3 *Cleanliness*

Pipes shall be internally clean and free from swarf and other manufacturing debris.

NOTE: The defects described in Clause 9.5 cannot be completely quantified. Where the presence, size or frequency of any of these are considered to be of concern, arrangements should be made between the purchaser/approving authority/certifying body (as appropriate), and the manufacturer. This may be achieved by the provision of acceptable type samples or methods of test.

9.6 Effect on water

Series 1 pipes for the use of potable water, shall comply with AS/NZS 4020 with a scaling factor of 1.

10 PERFORMANCE REQUIREMENTS

10.1 Resistance to internal pressure

When tested in accordance with AS/NZS 1462.6, at 80 ±1°C, using conditioning times as defined in Table 6, pipe specimens shall withstand the test parameters shown in Table 7 without failure. Failure is defined as leaking, weeping or rupturing of the test specimen.

TABLE 6

CONDITIONING OF TEST SPECIMENS

Min. wall thickness mm	Conditioning time in water
≤10	1 h
>10 ≤20	3 h
>20 ≤30	6 h
>30 ≤40	12 h
>40 ≤50	18 h
>50 ≤65	21 h

TABLE 7

80°C TEST

Compound classification	Applied stress MPa	Min. time to rupture h
PE 80	4.5	165
	4.0	1 000
PE 100	5.4	165
	5.0	1 000

10.2 Reversion

The reversion properties of pipe shall be determined in accordance with the requirements of AS/NZS 1462.4. Calculated reversion shall not exceed 3%.

10.3 Thermal stability

The oxidation induction time shall be equal to or greater than 20 min, when tested in accordance with ISO 11357-6, at a test temperature of 200°C. The test specimen shall be taken from the inside surface of the pipe. Other test methods and procedures for determining the oxidation induction time may be used, provided that they have been demonstrated to give an accuracy of the same or higher degree than that given in ISO 11357-6.

10.4 Slow crack growth resistance

When SDR 11 pipe is tested in accordance with AS 1462.24 to the values given in Table 8, the pipe shall not rupture.

TABLE 8

SLOW CRACK GROWTH TEST VALUES

Test criteria	PE 80B	PE 80C	PE 100
Pressure, kPa	800	800	920
Minimum test time, h	500	100	500

11 MARKING

Marking details shall be legibly printed or formed directly on the pipe in such a way that—

(a) the marking does not initiate cracks or other types of failure,

(b) and with normal storage, weathering and processing, and the permissible method of installation and use, legibility shall be maintained for the life of the pipe.

The letters of the marking shall be minimum heights of 3 mm for pipes up to and including nominal outside diameter 32 mm, and 5 mm for larger sizes. Marking shall be repeated at intervals such that the distance between markings is not greater than 1 m. Marking shall show the following:

(i) Manufacturer's name or registered trade mark, and pipe series number, in the form TRADE MARK S1, as appropriate. Use 'SA' for special applications in accordance with Appendix D.

(ii) For Series 1 pipes: Nominal diameter, Classification and SDR, in the form 'DN 25 PN 4 SDR 33', as appropriate.

(iii) For Series 2 pipes: Nominal diameter and SDR, in the form 'DN 160 SDR 11', as appropriate, and the word 'GAS'.

(iv) For Series 3 pipes: Nominal diameter, $T_{min.}$ and SDR, in the form 'DN 40 × 4.4 SDR 11', as appropriate, and the word 'GAS'.

(v) For pipes dimensions in accordance with Appendix D: Nominal diameter and minimum wall thickness, in the form 'DN 250 × 11.2', as appropriate.

(vi) PE material classification number in the form 'PE 80B', as appropriate.

(vii) Date of manufacture in the form '010515', i.e. the 15th of May, 2001, as appropriate.

(viii) Identification of the place of manufacture. The manufacturer's code is acceptable, e.g., F1.

(ix) The number of this Standard, i.e., AS/NZS 4130.

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

Examples of mandatory marking:

Series 1: TRADEMARK S1 DN 25 PN 4 SDR 33 PE 80B 010515 F1 AS/NZS 4130

Series 2: TRADEMARK S2 DN 110 SDR 11 GAS PE 80B 010515 F1 AS/NZS 4130

Series 3: TRADEMARK S3 DN 40 × 4.4 SDR 11 GAS PE 80B 010515 F1 AS/NZS 4130

Special applications: TRADEMARK SA DN 250 × 11.2 PE 100 010515 F1 AS/NZS 4130

APPENDIX A

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Normative)

A1 SCOPE

This Appendix sets out two means by which compliance with this Standard shall be demonstrated by a manufacturer:

(a) The use of a product certification scheme.

(b) The use of a minimum sampling and testing frequency plan.

A2 RELEVANCE

The long-term performance of pipeline systems is critical to the operating efficiency of water agencies in terms of operating licences and customer contracts. The long-term performance of plumbing systems is similarly critical to the durability of building infrastructure, protection of public health and safety and protection of the environment.

A3 DEFINITIONS

A3.1 Acceptable quality level (AQL)

When a continuous series of lots or batches is considered, the quality level which, for the purpose of sampling inspection, is the limit of a satisfactory process average (see ISO 2859.1 and ISO 3951).

NOTE: The designation of an AQL does not imply that a manufacturer has the right knowingly to supply any non-conforming unit of product.

A3.2 Batch

Schedule of pipes, all of the same nominal diameter, wall thickness and marking, manufactured from the same material or compound on the same machine.

NOTE: The batch is defined and identified by the pipe manufacturer.

A3.3 Batch release test (BRT)

A test performed on a sample from the batch or lot, to confirm conformance to the requirements of this Standard before the batch can be released.

A3.4 Inspection level

The relationship between the batch or lot size and the sample size (see ISO 2859-1).

A3.5 Lot

A clearly identifiable subdivision of a batch for inspection purposes.

A3.6 New formulation

A change in material or compound formulation that exceeds the limits given in Appendix A of AS/NZS 4131.

A3.7 Process verification test (PVT)

A test performed on a sample at specific intervals, to confirm conformance to the requirements of this Standard before further batches can be released.

A3.8 Sample

One or more units of product drawn from a batch or lot, selected at random without regard to quality.

NOTE: The number of units of product in the sample is the sample size.

A3.9 Sampling plan

A specific plan that gives the number of samples and the frequency of inspection or testing.

A3.10 Type test (TT)

A test performed on a sample to confirm conformance to the requirements of this Standard before any batches can be released.

A4 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with this Standard.

The certification scheme shall meet the criteria described in SAI HB 18.28/SANZ HB 18.28 (ISO/IEC Guide 28) in that, as well as full type testing from independently sampled production and subsequent verification of conformance, it requires the manufacturer to maintain effective planning to control production.

The certification scheme serves to indicate that the products consistently conform to the requirements of this Standard.

Product certification shall be conducted by a certification body accredited by the Joint Accreditation System for Australia and New Zealand (JAS-ANZ) or by another certification body that is acceptable to JAS-ANZ.

The frequency of the sampling and testing plan, as detailed in Paragraph A5, shall be used by the certifying body for product compliance auditing. However, where the manufacturer can demonstrate adequate process control to the certifying body, the frequency of sampling and testing nominated in the manufacturer's quality and/or documented procedures shall take precedence for the purpose of product certification.

A5 MINIMUM SAMPLING AND TESTING FREQUENCY PLAN

A5.1 General

Table A1 sets out the minimum sampling and testing frequency plan for a manufacturer to demonstrate compliance of product(s) to this Standard.

A5.2 Retesting

In the event of a test failure, the products manufactured since the previous test(s) conforming to the requirements outlined in Table A1 shall be quarantined as a batch. A further set of samples shall be selected randomly from the quarantined batch using a sampling plan to AS 1199 for an acceptable quality level (AQL) of 2.5 and an inspection level of S3, unless otherwise specified. If the retest requirements are met, the batch may be released and compliance with this Standard for the quarantined batch may be claimed.

Should a failure occur on retesting, then the quarantined batch shall be rejected and claims and/or marking indicating compliance to this Standard shall be suspended until the cause of the failure has been identified and corrected.

A5.3 Rejection after test

In the event of a quarantined batch being rejected after retesting in accordance with the procedures set out in Paragraph A5.2, it may be subjected to 100% testing for the failed requirement(s), and only those items found to comply may be claimed and/or marked as complying with this Standard.

TABLE A1

MINIMUM SAMPLING AND TESTING FREQUENCY PLAN

Characteristics	Clause	Requirement	Test method	Frequency
TYPE TESTS (TT)				
Material property	7	Composition	Process control	Any new material formulation or design or once every 5 years, whichever occurs first
	8, 9.5	Colour and freedom from defects	Visual Inspection	Any new material formulation or design
	9.6	Effect on water	AS/NZS 4020	Any new material formulation or once every 5 years, whichever occurs first
	7.3.5	Cohesive resistance	ISO 13954	Any new jacket compound or once every 5 years, whichever occurs first
Performance	9.1–9.4	Dimensions	AS/NZS 1462.1	Any new material formulation
	10.1	Resistance to internal pressure at 80°C	AS/NZS 1462.6 Appendix E	
	10.2	Reversion	AS/NZS 1462.4	
	10.3	Thermal stability	ISO 11357-6	
	10.4	Slow crack growth	AS 1462.24	
	11	Marking	Visual Inspection	
PROCESS VERIFICATION TESTS (PVT)				
Performance	10.1	Resistance to internal pressure at 80°C	AS/NZS 1462.6 Appendix E	To manufacturer's sampling plan. Samples to be evenly selected from all pressure groups in such a way that units of each DN produced are tested regularly and continuously, at least once every 3 years
BATCH RELEASE TESTS (BRT)				
Material property	8.1, 8.2	Colour	Visual inspection	One per batch
Performance	7.3.3	Dispersion	AS/NZS 1462.28	One per batch of compound
	9.5	Freedom from defects	Visual Inspection	One per 4 h
	10.1	Resistance to internal pressure at 80°C and 165 h	AS/NZS 1462.6 Appendix E	One per batch
	10.2	Reversion	AS/NZS 1462.4	One per batch
	10.3	Thermal stability	ISO 11357-6	One per batch
Dimensions	9.1	Diameter and wall thickness	AS/NZS 1462.1*	One per hour or start and end of coil
	9.2	Length	AS/NZS 1462.1	One per 4 h
	9.3	Coiled pipe ID	Visual inspection	One per 4 h
	9.4	Out of roundness	AS/NZS 1462.1*	One per 4 h
	11	Marking	Visual Inspection	One per 4 h

* May also be tested by attributes (e.g. no and no-go gauges)

APPENDIX B

CALCULATION OF MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) AT 20°C FOR SERIES 1, 2 AND 3 PIPES

(Normative)

B1 SCOPE

This Appendix sets out equations to calculate the maximum allowable operating pressure (MAOP) at 20°C for Series 1, 2 and 3 pipes.

B2 SERIES 1 PIPES

MAOP shall not be greater than the nominal working pressure given in Clause 5. *C* shall not be less that 1.25 for general pressure applications and not less than 2.0 for transmission of compressible fluids, such as compressed air.

Where *C* is greater than 1.25, the MAOP is obtained from the following:

$$\text{MAOP} = \frac{0.125\ \text{PN}}{C} \qquad \ldots \text{B1}$$

Example:

A PN 12.5 water supply pipe is to be installed by directional drilling under the pavement of a major urban road. Normal operating temperature is to be taken as 16°C. Determine the MAOP for the pipeline.

From Appendix C, Table C2, the design factor $C = f_0 \times f_1 \times f_2 \times f_3$ f_0 = 1.0 (water); f_1 = 1.0 (16°C); f_2 = 1.2 (under major urban road); f_3 = 1.2 (directional drilling)

$C = 1.0 \times 1.0 \times 1.2 \times 1.2 = 1.44 > 1.25$

$$\text{MAOP} = \frac{0.125 \times 12.5}{1.44} = 1.09\ \text{MPa}$$

B3 SERIES 2 PIPES

MAOP shall be calculated from the following equation:

$$\text{MAOP} = \frac{2\ \text{MRS}}{C(\text{SDR} - 1)} \qquad \ldots \text{B2}$$

C shall not be less than 2.0.

NOTE: Guidance on the selection of design factors is given in Appendix C of this Standard.

B4 SERIES 3 PIPES

MAOP shall be calculated from the following equation:

$$\text{MAOP} = \frac{2\ \text{MRS}\ T_{\text{min.}}}{C\left(D_{\text{mmin.}} - T_{\text{min.}}\right)} \qquad \ldots \text{B3}$$

C shall not be less than 2.0

NOTE: Guidance on the selection of design factors is given in Appendix C of this Standard.

APPENDIX C

DESIGN FACTORS

(Informative)

Recommendations on the selection of appropriate factors for the design of gas pipes are given in Table C1, and for water pipes in Table C2.

TABLE C1

DESIGN FACTORS FOR GAS PIPE SYSTEMS

Condition	Installation	Factor	Index
Fluid	Natural gas LPG Manufactured gas	2.0 2.2 (see Note 1)	f_o
Pipe Form	Straight Coiled from factory	1.0 1.2	f_1
Soil temperature (Average t°C)	$-20 < t \leq -10$ $-10 < t \leq 0$ $0 < t \leq 20$	(see Note 2) 1.2 1.0	f_2
	$20 < t \leq 30$ $30 < t \leq 35$	1.1 1.3	
Designation	Distribution Transport	1.0 0.9	f_3
Resistance to rapid crack propagation	All	(see Note 3)	f_4
Population density and area loading	Open field area Less trafficked roads in built-up areas Heavily trafficked roads in built-up areas	0.9 1.05 1.15	f_5
	Roads in populated areas Roads in industrial areas Residential area	1.20 1.25 1.05	
	Industrial area	1.2	

NOTES:

1 To be evaluated for each case taking into account the various constituents of that gas with special reference to liquefiable hydrocarbons and aromatics.

2 If the value is greater than 1.2, then consult with manufacturer.

3 Use value 1.0.

4 Design factor $C = f_0 \times f_1 \times f_2 \times f_3 \times f_4 \times f_5$.

Example:

For a natural gas distribution pipeline in an industrial area with roads, operating at 15°C and laid with straight pipe:

$f_0 = 2.0$; $f_1 = 1.0$; $f_2 = 1.0$; $f_3 = 1.0$; $f_4 = 1.0$; $f_5 = 1.25$

Design factor $C = 2.0 \times 1.0 \times 1.0 \times 1.0 \times 1.25 = 2.5$

TABLE C2

DESIGN FACTORS FOR WATER AND SEWERAGE PIPE SYSTEMS

Condition	Installation	Factor	Index
Fluid	Water	1.0	f_o
	Domestic sewage	1.0	
	Industrial sewage	1.2	
Soil, fluid or pipe temperature (Average t°C)	$-20 < t \leq -10$	Refer manufacturer	f_1
	$-10 < t \leq 0$	0.6	
	$0 < t \leq 20$	1.0	
	$20 < t \leq 30$	1.1	
	$30 < t \leq 35$	1.25	
	$35 < t$	Refer manufacturer	
Location based on minimum depth of cover specified in AS/NZS 2566.1	Open field	1.0	f_2
	Minor country road shoulder	1.0	
	Major country road shoulder	1.0	
	Minor country road—under pavement	1.1	
	Major country road—under pavement	1.2	
	Residential—paved and unpaved nature strip (footpath)	1.0	
	Residential roadway—under pavement	1.1	
	Major urban road—under pavement	1.2	
	Commercial/Industrial paved and unpaved nature strip (footpath)	1.1	
	Commercial/Industrial roadway—under pavement	1.2	
	Central Business District	1.4	
	Private land—easement	1.0	
	Above ground	1.0	
	Submarine crossings	1.4	
Installation method	Standard trenching	1.0	f_3
	Plough-in	1.1	
	Directional drilling	1.2	
	Slip line with back grouting	1.0	
	Slip line without back grouting	1.2	
	Pipe cracking—with liner pipe in situ	1.0	
	Pipe cracking—with liner pipe removed	1.2	

NOTES:

1 Choose only one factor from each condition.

2 This table applies to PE 80B and PE 100 pipe with a life expectancy of >100 years.

3 Pumped installations require further design consideration.

4 Design factor $C = f_0 \times f_1 \times f_2 \times f_3$

Example:

For a water reticulation pipeline in a commercial area paved mall used primarily for pedestrian traffic, operating at maximum summer water temperature of 24°C, and laid using pipe cracking with liner pipe removed:

$f_0 = 1.0$; $f_1 = 1.1$; $f_2 = 1.1$; $f_3 = 1.2$.

Design Factor $C = 1.0 \times 1.1 \times 1.1 \times 1.2 = 1.5$

APPENDIX D

DIMENSIONAL REQUIREMENTS OF PIPES FOR SPECIAL APPLICATIONS

(Normative)

For special applications, the pipe wall thickness requirements shall be calculated from the following equations:

$$T_{\text{min.}} = \frac{PD_{\text{m min.}}}{2S + P} \quad \text{. . . D1}$$

where

$D_{\text{m min.}}$ = minimum mean outside diameter from Table 2, 3 or 4, as appropriate, in millimetres

P = maximum design operating pressure of pipe, in megapascals

S = MRS/C

$$T_{\text{max.}} = 1.10\ T_{\text{min.}} + 0.1 \quad \text{. . . D2}$$

All other provisions of this shall Standard apply.

NOTES:

1 Guidance on the selection of design factors is given in Appendix C of this Standard.

2 Where saddle fusion is used with pipe designed for special application, the wall thickness may need to be greater than the value calculated above.

NOTES

NOTES

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