WATER SERVICES
ASSOCIATION OF AUSTRALIA

WSA 402 PRODUCT AND MATERIAL INFORMATION AND GUIDANCE

Supplement to the Gravity Sewerage Code of Australia WSA 02—2014

WSA 402:2024

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About WSAA

The Water Services Association of Australia (WSAA) is the peak industry body representing the urban water industry. Our members provide water and sewerage services to over 24 million customers in Australia and New Zealand and many of Australia's largest industrial and commercial enterprises.

ACKNOWLEDGEMENT OF COUNTRY

The Water Services Association of Australia acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation. We recognise their continuing connection to land and waters and thank them for protecting our waterways and environment since time immemorial.

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PRODUCTS AND MATERIALS OVERVIEW

Purpose

Water Agencies typically expect sewerage infrastructure to have a life of at least 100 years. This requirement reflects community expectations of Agencies' operational and financial performance. The performance of a sewer system significantly depends on the attributes of the materials and products used in its construction. The appropriate selection of pipeline system products and materials is paramount to achieving life expectancies.

Unless otherwise specified by the Water Agency, products should comply with recognised national or industry standards. The involvement of third party certification bodies to independently verify conformance is stipulated for many products.

The purpose of Part 1 is to:

(a) provide information on the principal pipeline system attributes and some details of ancillary products used in the construction of sewerage networks and referenced in Gravity Sewerage Code of Australia WSA 02.

(b) outline aspects such as product specifications, product descriptions and classifications, joint types, water industry experience and recommendations on use.

> NOTE:
>
> It does not provide instructions on life expectancy for pipeline systems as this is dependent upon design, manufacture, transport, handling, installation, operation, protection from third party damage and other external factors.

The purpose of Part 2 is to

(i) provide information on standards and product specifications for products commonly used in sewer construction and listed on the WSAA website www.wsaa.asn.au.

(ii) provide information

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PART: 1 PRINCIPAL PIPELINE SYSTEM ATTRIBUTES

Product and Materials Information and Guidance Supplement to the Gravity Sewerage Code of Australia WSA 02–2014

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1 UNPLASTICISED POLYVINYLCHLORIDE (PVC-U) FOR NON-PRESSURE APPLICATIONS SEWERAGE

1.1 PRODUCT SPECIFICATION

WSA PS – 230.

1.2 PIPES

AS/NZS 1260 defines the technical requirements for PVC-U non-pressure (gravity) pipes. Pipes of DN 100 and above are specified in terms of minimum stiffness. Sufficient dimensional information is provided to ensure compatible joints and resistance to abrasion. AS/NZS 1260 covers three types of manufactured construction of pipes, but only the first two are currently available in Australia:

(a) Plain wall, comprising a product of homogeneous material and having smooth internal and external surface.

(b) Sandwich, comprising smooth internal and external surfaces in which the inner and outer wall layers are of solid PVC-U and are connected by a foamed or solid intermediate layer of PVC-U.

(c) Ribbed or hollow profile, comprising a plain inside surface with an outside helical or annular ribbed or corrugated surface.

Unless otherwise specified by a Water Agency, all are generally accepted to be equivalent in performance.

Plain wall pipes are available in sizes up to DN 600. Sandwich wall pipes are available in sizes up to DN 375.

The standard effective pipe length is 6 m, although 3 m lengths (with elastomeric seal joints) are available for installations where ground movement is anticipated, for example in filled or mine subsidence areas. Mine subsidence pipes have longer sockets to enable them to cope with ground strain, generally up to 0.008 in both compression and tension.

PVC polymer resin is compounded with calcium-zinc, organic or tin stabiliser to prevent thermal degradation of the polymer during the extrusion process by which the pipe is manufactured or by the moulding process by which fittings are manufactured. Other additives are added to improve processing, inhibit degradation by ultraviolet light and to add colour.

1.3 FITTINGS

AS/NZS 1260 defines the technical requirements for PVC-U non-pressure (gravity) moulded and fabricated fittings. Moulded fittings are available with elastomeric seal joints in sizes up to DN 375 and tapered or parallel solvent-welded sockets for reticulation sizes DN 100 to DN 300 and DN 175 to DN 375, respectively.

Fittings are specified in AS/NZS 1260 by minimum wall thickness and are deemed to be compatible with pipes up to SN16.

Feedback from some Water Agencies of high incidences of mechanical failure of some fitting configurations at property service connections due to ground movement, subsidence and settlement related issues led to the introduction of a range of heavy-duty fittings. The minimum wall thicknesses for DN 100 and DN 150 heavy duty fittings is defined in WSA PS 230.

Fabricated PVC-U fittings are usually manufactured using cut sections of solid wall PVC-U pipe, except for taper sections which are formed by wrapping a heated flat section of PVC in a taper mould. The PVC parts are joined to form the fitting configuration using hot air gun welding. The joins are first tack welded then fully welded using PVC filler rods. Welded joints are reinforced with a wrapping of resin impregnated glass-fibre.

The resin is required to physically adhere to the PVC. On bends, junctions and tapers, the glass-fibre reinforcement is continuous and extends the full length and circumference of the fittings to either the socket root or 35 to 50 mm onto a plain spigot or threaded end.

Parallel solvent-welded socket fittings are predominantly imported fittings and have no specific requirements for colour or titanium dioxide content to provide UV protection. Additional marking requirements have been specified for these fittings to highlight the parallel sockets, the need for gap-filling solvent cements and UV protection when used outdoors.

1.4 STIFFNESS CLASSES

Pipes are specified in terms of stiffness classes measured in a standard parallel plate test. The classes are not exactly the same as the earlier classification scheme (Class SH and Class SEH) but are similar.

Class SN6 (DN100) and Class SN4 (DN≥150) are considered to be suitable only for plumbing and domestic use.

Class SN10 (DN100) and Class SN8 (DN≥150) are suitable for sewers and municipal drainage, deeper burial and similar applications where higher pipe stiffness is required to minimise deflection of the installed pipes due to the load imposed by the back fill, surcharge or poor installation practice. However, the use of SN8 or SN10 pipes should not be used as a justification for deliberately using poor installation practices.

Stiffness class, SN16, has been included in AS/NZS1260 in response to a request from New Zealand users who previously specified Class SEH-C for applications where heavy loads, for example traffic loads, acted on buried pipes. Australian Standards for sewer and drainage pipes have not included a pipe of similar stiffness in the past and Australian manufacturers will not have DWV pipes of this class generally available.

Moulded fittings are defined in AS/NZS 1260 by minimum wall thickness, not stiffness.

Fittings complying with the minimum wall thicknesses specified in AS/NZS 1260 are deemed to be compatible with pipes up to SN16.

1.5 JOINTS

Joints may be either elastomeric sealing ring or solvent cement (tapered or parallel socket).

The elastomeric sealing ring joint can accommodate limited longitudinal displacement and angular deflection (approximately 1 – 3 degrees, depending on pipe size and type) and can therefore be used in areas liable to minor ground movement e.g. subsidence. Flexible joints permit minor changes in pipeline direction and grade and may reduce the need for bends (fittings). Guidance on installing pipes on a curved alignment is given in PIPA Industry Guideline POP 202.

Witness marks applied to the spigot end show the insertion depth. Spigots should be inserted into the socket up to the witness mark and not beyond it.

Elastomeric seals are provided with the pipe. Whilst pipes from different manufacturers are compatible, the seals are not interchangeable. It is essential to use the correct seal – socket combination.

Joint seals are manufactured from elastomers complying with AS 1646 and AS 681.1 (vulcanised rubber) or AS 681.2 (thermoplastic elastomer). Vulcanised seals are by far the most common and both EPDM (ethylene propylene diene rubber) and SBR (styrene butadiene rubber) are acceptable, Polychloroprene seals offer slightly greater resistance to oils whilst significantly better oil resistance is provided by NBR (nitrile butadiene rubber).

Joint lubricants, consisting of water-based emulsions provide lubrication during the making of the joint and prevent damage to joint seals during assembly.

For elastomeric pipe joints to resist plant root penetration, AS/NZS 1260 specifies a minimum initial interfacial pressure that must be achieved between the elastomeric ring and the spigot. A study was undertaken by CSIRO Building, Construction and Engineering and Iplex Pipelines to assess the effects of interfacial pressure and spigot deformation upon root intrusion into PVC pipes. This study followed previous work investigating the role of socket geometry and controlled flaws. Root intrusion was found to occur into many joints with average interfacial pressures of 0.04, 0.10, 0.11 and 0.20 MPa. However, no intrusion occurred into joints with interfacial pressures of 0.37 and 0.38 MPa, even though the contact width where pressure exceeded 0.3 MPa was less than 0.5 mm. In response to these findings, the requirement for a minimum interfacial pressure of 0.4 MPa over a minimum contact width of 4 mm is considered more than adequate to prevent root intrusion and was incorporated into AS/NZS 1260.

Thermoplastic elastomeric seals conforming to AS 681.2 have a greater rate of compression stress relaxation than vulcanised seals. They are therefore required to have an initial interface pressure of at least 0.47 MPa to compensate for the higher stress relaxation.

1.6 INTERNAL LINING

Not applicable.

1.7 EXTERNAL CORROSION PROTECTION

PVC-U pipes are generally resistant to corrosion by soil and water and are unaffected by stray electrical currents.

1.8 PROPERTY CONNECTIONS

Service connections to PVC-U pipe may be made using standard moulded and/or fabricated fittings.

1.9 PIPELINE DESIGN AND INSTALLATION

Structural Design is to be performed in accordance with AS 2566.1, the Australian Standard for the structural design of buried flexible pipe. The basis of design is to select appropriate, trench widths, embedment material densities and pipe stiffnesses for the particular loading and native soil stiffnesses so that values for vertical ring deflection, circumferential pipe wall strain and ring buckling resistance do not exceed allowable long-term values.

The ID of plain wall pipes closely approximates to the nominal diameter up to DN 225 but is less than nominal for some larger sizes. The designer should verify actual diameters prior to hydraulic design.

The class of pipe is defined by the ring stiffness, which can be directly used in structural design calculations. Whilst SN16 pipe has twice the ring stiffness of SN8 pipe this does not translate to being able to carry twice the load as the pipe side soil support is accounted for in buried pipe design.

Solvent cement jointed pipes should be used for MH drop types 2, 3 and 4 and for both in-line and MHs with water seals.

PVC-U MSs should preferably be used with PVC-U sewers. Joints may be elastomeric sealing ring or solvent cement.

1.10 WATER INDUSTRY EXPERIENCE

PVC-U gravity sewer systems have been in use in Australia since the early 1970s and are the predominant option for collection sewers up to size DN 375. Overseas experience dates back to the 1960s.

Water industry consensus is that PVC-U gravity systems have performed satisfactorily and that correctly installed PVC-U systems have satisfactory resistance to tree root penetration, whether elastomeric sealing ring jointed or solvent cement jointed.

In 1999 Ipswich Water initiated a sewer exhumation and testing program of their PVC-U gravity sewers jointly with Iplex Pipelines to identify any loss of mechanical properties due to ageing under operating condition. The Ipswich Water sewerage system consists of 1100 km of sewers, which includes 250 km of PVC-U pipes. At the time of the investigation, Ipswich sewer pipes had been in service for up to 25 years and are now approaching 40 years.

There have been a number of overseas studies where the performance of PVC sewer pipes has been examined and the physical properties of exhumed pipes measured. These studies have shown the mechanical properties of the PVC have not changed significantly during its service life.

In the Ipswich study, the influence of age and service conditions upon the anticipated life of PVC-U sewer pipes was investigated. The pipes were made in Australia in accordance with the Australian Standard effective at the time of manufacture. The pipes were installed and operated according to local practice. All the pipes were exhumed with elastomeric seal joints intact.

The six pipes exhumed at Ipswich comprised two sizes, DN 150 and DN 225. Manufacturing years were 1975, 1984 and 1989. Samples were selected from a number of locations under different operating conditions such as age (11 to 25 yrs), depths (800 mm – 3500 mm) and soil conditions (blacksoil, clay etc). A DN 150 PVC-U sewer pipe was also exhumed by Sydney Water; it was approximately 15 years old.

The pipes and joints were subjected to a range of mechanical and performance tests. The elastomeric seal joints all exhibited satisfactory resistance to infiltration and exfiltration with the spigot-to-seal interface pressures still exceeding the minimum requirements of the Australian Standard. The mechanical properties of the exhumed pipes were consistent with contemporary production except for the modulus, which was higher.

Measurement of the pipe wall thickness around the circumferences implied there has been no significant material loss due to abrasion in any of the pipes.

The absence of any significant loss of pipe wall due to abrasion, the retention of the strength and impact resistance of the material and the performance of the joints combined to suggest the pipelines in question have many years of service remaining. In fact, there had been no measurable deterioration to indicate any reduction in capability since they were first installed.

1.11 RECOMMENDATIONS ON USE

PVC-U systems are resistant to many chemicals but should not be used where the ground is or may be contaminated with organic solvents such as acetone or dichloromethane.

1.12 FURTHER INFORMATION

Plastics Industry Pipe Association (PIPA) – download from http://www.pipa.com.au

POP201	1.1	May, 2013	Resistance of Plastics Pipes and Fittings to Water and Wastewater Chemicals
POP202	2.1	Nov 2016	PVC, PP and PE Pressure Pipe Installation on Curved Alignments
POP203	1.0	Dec 2007	Identification Of Buried Pipe Systems
POP204	1.0	Feb 2004	Expected Service Life Of Elastomeric Pipe Seals
TN019	2.0	Apr 2023	Sandwich Construction PVC-U Non-Pressure Pipe
TN006	1.0	Apr 2010	Weathering of PVC Pipes and Fittings

Water Services Association of Australia (WSAA) download from http://www.wsaa.asn.au

WSA – TN2	Guidelines for the use of non-metallic pipes with ductile iron elastomeric joint fittings and spreadsheet calculation

http://www.plasticpipe.org

http://www.uni-bell.org

2 VITRIFIED CLAY NON-PRESSURE APPLICATIONS - SEWERAGE

2.1 PRODUCT SPECIFICATION

WSA PS – 231.

2.2 PIPES AND FITTINGS

VC pipes have been used in the Australian water industry since the 1860s. VC pipes have high strength and are chemically inert. Prior to the mid-1960s, salt glazed pipes with mortar or bituminous joints were used. By the late 1960s, rubber ring jointed VC pipes and fittings were standard. Prior to the late 1990s, the vast majority of VC pipes were manufactured to AS 1741, but due to loss of market share to PVC-U, local production of VC has ceased. The current supply of pipes and fittings is predominantly from Europe. These pipes and fittings are manufactured to EN 295.

Relative to pipe previously made in Australia to AS 1741, pipe manufactured to EN 295 employs special processes and finer clay, resulting in a thinner wall pipe for a given crushing strength being lighter in weight, less permeable and having a smoother bore. A variety of jointing systems are available as are glazed pipes and fittings. The two standards have different dimensional requirements, requiring the use of special couplings to join the two. Not all pipes manufactured to EN 295 are dimensionally compatible. EN 295 specifies seven jointing dimensions; only pipes of the same class and jointing system are compatible.

VC is suitable for all gravity sewer applications using both traditional and trenchless technology installation techniques.

EN 295 preferred sizes differ from those of AS 1741. EN 295 VC pipe is generally available in traditional reticulation sizes DN 150, DN 200 and DN 300, as well as larger sizes for branch and trunk sewers. Suppliers should be consulted regarding availability of larger sizes, which may require adequate lead time for importation.

Hydraulic designers should confirm the actual bore of pipe prior to flow calculations.

Suppliers should be contacted to determine standard lengths. EN 295 states that the preferred nominal lengths of VC pipe are between 1.5 to 3.0 m, depending on DN. Variations should be in multiples of 250 mm. There is no preferred length for DN 100 and DN 150 pipes.

Common fittings include short pipes, 45° and 90° junctions, bends, PVC adaptors, saddles (for retro-fit connections) and tapers. The size range for fittings is more extensive than the previously manufactured Australian fittings. A special coupling is available to allow VC pipes to be used for internal drops.

2.3 CLASSES

Structural strength of VC pipes is categorised by ring crushing strength, measured in kN/m and by beam or bending moment strength, measured in kN.m. Test methods in AS 1741 and EN 295 differ, so that measured strengths are not directly comparable. AS 1741 nominated two classes of pipe, Class 3 and Class 4 with different crushing strengths for each diameter, whereas EN 295 nominates three crushing strengths for each nominal diameter. Generally, there is overlap between the requirements of the two standards. Tests evaluated during WSAA appraisals concluded that the European test methods are more conservative than the AS 1741. The EN 295 strength classification system is somewhat complex. Standard strength class designations are 95/120/160/200, depending on pipe size. DN 150 is not classified under this system, but by its minimum crushing strength. The following table illustrates the strength class designations and minimum crushing strength (kN/m):

Nominal pipe size DN	Minimum Crushing Strength kN/m			
	Class 95	Class 120	Class 160	Class 200
150	*DN 150 not designated by class. Min strength grades are 22,28,34*			
200	-	24	32	40
225	-	28	36	45
250	-	30	40	50
300	-	36	48	60
350	-	42	56	70
400	38	48	64	-
450	43	54	72	-
500	48	60	80	-
600	57	72	-	-
700	67	84	-	-
800	76	-	-	-
1000	95	-	-	-

2.4 JOINTS

Socket and spigot rubber ring joints have traditionally been used, but plain ended pipe is available for which a polypropylene coupling with elastomeric seals is used to make a joint.

Socketed joints employ a rubber ring seal, which, unlike previous rolling rubber rings, requires a lubricant to assemble the joint. Joint seals are generally EPDM, SBR, NBR or other elastomer to AS 1646 and AS681.1, which is the same as EN 681-1.

Joints may be deflected, as below:

(a) DN 100 – DN 200: 4.7° or (80mm / m pipe length).
(b) DN 225 – DN 500: 1.7° or (30mm / m pipe length).
(c) DN 600 – DN 800: 1.2° or (20mm / m pipe length).
(d) > DN 800: 0.6° or (10 mm/m pipe length).

2.5 INTERNAL LINING

VC will not be attacked by sewage or gases and is highly resistant to abrasion.

Vitrified clay pipes and fittings can be internally and externally glazed. The glaze consists of a combination of loam, clay, feldspar, lime, dolomite, quartz and sometimes metallic oxides for colour. The glaze is applied to the raw clay pipe and fitting either during the extrusion process or after drying by dipping into the glaze suspension. As the glaze suspension is applied before firing and fuses inseparably with the body during firing, there is no possibility of “chipping” occurring due to external water pressure. This is the essential difference between glaze and any other kind of supplementary coating.

2.6 EXTERNAL CORROSION PROTECTION

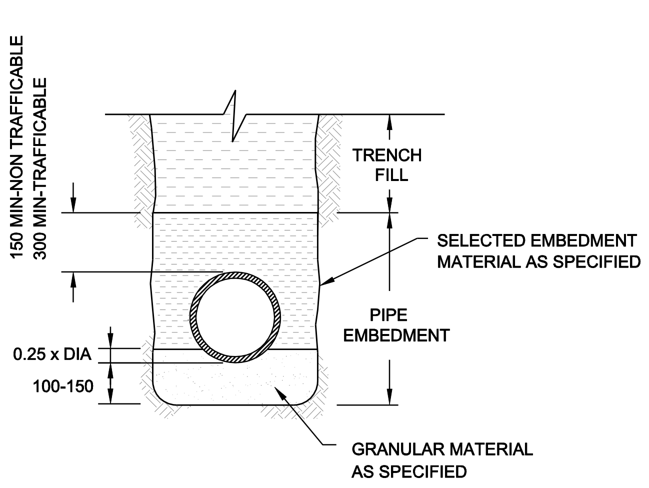
VC pipes are resistant to corrosion by soil and water and are unaffected by stray currents.

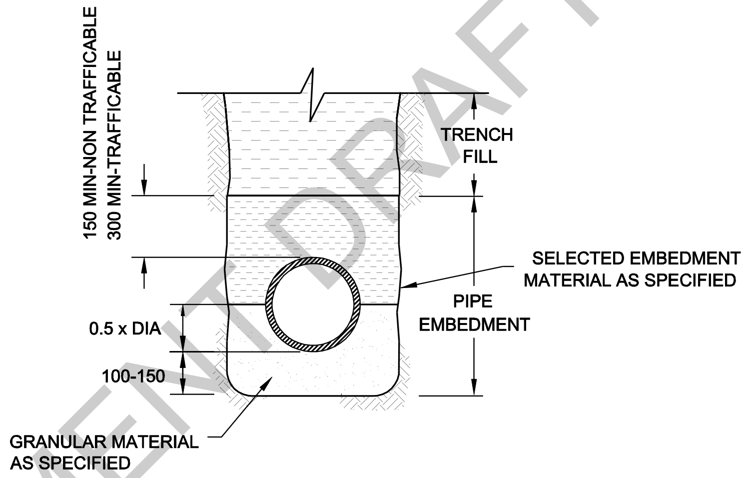
2.7 PROPERY CONNECTIONS

Service connections to VC pipe may be made using standard moulded and/or fabricated fittings.

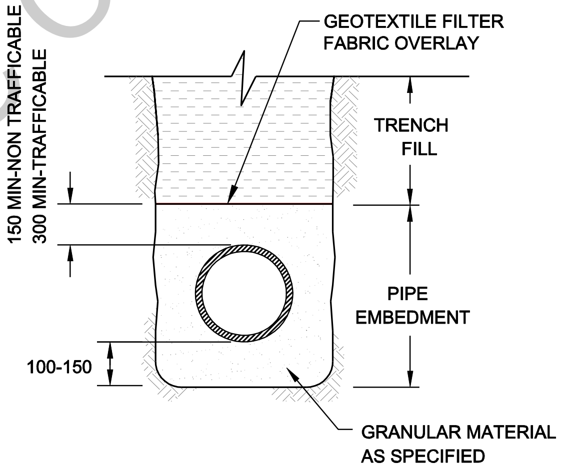
2.8 PIPELINE DESIGN AND INSTALLATION

Pipelines must be designed to resist structural failure under service conditions, using the design method of AS 4060. Figures or Standard drawings allow the use of Types 1, 2 and 3 support for VC, due to the inherent strength of a rigid pipe. Compared to PVC-U, which requires Type 3 support, construction costs may be less for VC. Additionally, VC pipe does not require deflection testing, as may be required for flexible pipes. VC is less buoyant than PVC and less likely to move off grade due to water in the trench. Care is required when handling as pipes are susceptible to impact damage.





TYPE 1 SUPPORT FOR RIGID PIPES ONLY TYPE 2 SUPPORT FOR RIGID PIPES ONLY



TYPE 3 SUPPORTS FOR FLEXIBLE AND RIGID PIPES

2.9 WATER INDUSTRY EXPERIENCE

The main problems experienced with VC pipes have been infiltration and root intrusion of older cracked pipes, at rubber ring and mortar joints and at property connections. Cracking was most likely due to differential ground movement and/or poor bedding. Mortar joints provided no flexibility.

The major problem of root intrusion may be attributed to poor installation and joint design, although the inherent permeability of some unglazed VC pipe is believed to be a contributing factor. New manufacturing techniques (EN 295 pipes) based on calcined clays and glazing reduce permeability to very low levels.

Given the introduction of EN 295 VC pipes, there is little reported operational experience of their use. Recent use has shown that longitudinal pipe cracking as a result of manufacturing problems can occur.

The polypropylene sleeve coupling is believed to be well accepted by constructors, although experiences in Brisbane have demonstrated the importance of only using sleeve couplings that provide the demonstrated seal contact widths and pressures to minimise tree root intrusion.

2.10 RECOMMENDATIONS ON USE

Where the ground is or may be contaminated by chemicals, especially organic solvents, and where aggressive soils may be encountered, precautions may need to be taken with the joints.

2.11 FURTHER INFORMATION

http://www.ncpi.org/

http://www.cpda.co.uk/

3 DUCTILE IRON FOR PRESSURE AND NON-PRESSURE APPLICATIONS - SEWERAGE

3.1 PRODUCT SPECIFICATION

WSA PS – 200 (pipe), WSA PS – 201 (fittings), WSA PS – 202S (ISO size pipe and fittings)

3.2 NON-PRESSURE SEWERAGE APPLICATION

Ductile iron pipes are not a standard option for gravity sewers. They are generally used in special applications where high structural strength is required.

Ordinary Portland cement mortar lining is not suitable for exposure to hydrogen sulphide (septic sewage). Calcium aluminate cement linings are available and have been used with reported good results. The unlined joint surfaces in contact with the sewage are coated with an epoxy coating. Other systems are available with polyurethane or epoxy linings. For non-septic sewage, unlined pipes or pipes lined with ordinary Portland cement mortar lining may be satisfactory.

3.3 PIPES AND FITTINGS

Ductile iron pipes and fittings to AS/NZS 2280 have dimensions based on imperial sizing. The nominal diameter, DN, approximates the internal diameter of the pipe after cement mortar lining.

PN20, PN35 and Flange Class are the standard classifications for DI pipes. Flange Class has a thicker wall and is specified for flanged (screwed) pipe or where additional structural strength is required.

Minimum wall thicknesses for fittings with pressure classifications of PN16, PN20 and PN35 are specified in AS/NZS 2280.

Typical effective laying lengths of pipes are 5.5 m or 5.7 m. The minimum length for AS/NZS 2280 pipes is 5 m.

Ductile iron pipe to EN 598 has dimensions based on metric (ISO) sizing and are not compatible with AS/NZS 2280 pipe and fittings. Pipe of Class C40 to the EN standard, when cement mortar lined, has an internal diameter closely matching nominal sizes. The internal diameters of cement mortar lined AS/NZS 2280 and EN 598 pipe and fittings are different in most cases with the EN 598 bores being 4 to 6% less than AS/NZS 2280 bores. This results in AS/NZS bores delivering 10 to 15% more flow for a given head loss.

3.4 SUPERSEDED K CLASS

The classification of the superseded K class pipe and fittings was not related to pressure rating but instead a parameter that specifies the minimum wall thickness for various nominal diameters.

3.5 JOINTS

3.5.1 Flexible

Elastomeric seal spigot and socket flexible joints with elastomeric sealing rings are generally used for joining ductile iron mains. The joint can accommodate limited longitudinal displacement and angular deflection (approximately 1 – 3½ degrees, depending on pipe size) and can therefore be used in areas liable to minor ground movement e.g. subsidence. Flexible joints permit minor changes in pipeline direction and grade and may reduce the need for bends (fittings).

Witness marks applied to the spigot end show insertion depth for the maximum angular deflection and zero angular deflection. Elastomeric seals are provided with the pipe.

Joint seals are manufactured from elastomeric polymers (complying with AS 1646 and AS681.1). EPDM has replaced natural rubber as the default material (See Ancillary Products – Jointing components for more information on joint seal material options).

Joint lubricants, consisting of water-based emulsions, provide lubrication during the making of the joint and prevent damage to joint seals during assembly.

3.5.2 Flanged

Flanged pipe joints made to AS/NZS 2280 are manufactured by threading the ends of Flange Class pipe and screwing on a flange. An epoxy thread sealant is used. The greater wall thickness of Flange Class pipe is used to compensate for the pipe wall lost in thread cutting.

Integrally cast flanges, complying with AS 4087, are produced on cast fittings. PN 16 is the standard pressure rating but PN 35 flanged fittings are also available.

3.6 INTERNAL CORROSION PROTECTION

3.6.1 Pipes

3.6.1.1 *Cement mortar lining*

AS/NZS 2280 ductile iron pipe has internal corrosion protection in the form of calcium aluminate cement mortar lining for sewerage applications. The performance of calcium aluminate cement mortar lining to protect ferrous pipes from internal corrosion in sewerage environments is well documented internationally. The unlined jointing surfaces are coated with epoxy.

3.6.1.2 *Alternative lining options*

Alternative lining include:

(a) Polyurethane to EN 15655.

(b) Fusion bonded epoxy or liquid 2-pack epoxy to EN 14901.

These linings have been used overseas in some areas for 30 years and reports suggest good performance. Only limited local experience of the performance of these linings is available.

3.6.2 Fittings

The standard internal lining for AS/NZS 2280 fittings is thermal bonded polymeric coating to AS/NZS 4158.

Other internal lining options include:

(a) Polyurethane to EN 15655.1.

(b) Liquid 2-pack epoxy to EN 14901

3.7 EXTERNAL CORROSION PROTECTION

3.7.1 Pipe

The standard external coating for ductile iron pipes is metallic zinc coating in accordance with ISO 8179-1, with a finishing liquid-applied red coloured coating.

Other coating options include:

(a) Polyurethane coating to EN 15189

(b) Fusion bonded epoxy or liquid 2-pack epoxy to EN 14901.

The majority of Australian Water Agencies have adopted a policy of specifying loose polyethylene sleeving (LPS) for all ductile iron pipes as a corrosion protection measure, unless specialised coatings such as polyurethane or polyethylene, for example, are employed. Properly installed LPS provides a high degree of corrosion protection by creating a passive uniform environment around the pipe and limiting oxygen exposure. LPS should be installed in accordance with AS 3681 and only accredited pipe layers trained in the application of sleeving should be utilised.

The need for LPS depends on the type of soil and the required service life of the pipeline. Ductile iron pipes may be buried without extra external protection in soils that are not aggressive. In soils that are aggressive, and where either the time or the cost of soil assessment is prohibitive, LPS is the recommended solution.

The application of zinc coatings was not historically utilised on ductile iron pipes in Australia, although they have been used in Europe for more than 60 years. Zinc coatings are now provided in Australia as a standard offering with 200 g/m^2 thickness complete with a finishing layer and are considered to enhance the external corrosion benefits of pipe in buried applications. In some soil applications it is considered acceptable to install zinc coated pipes without polyethylene sleeving.

Enhancements to zinc coatings are also available where 85/15 Zinc-Aluminium alloy, copper enhanced Zinc-Aluminium alloy and rare earth element enhanced Zinc-Aluminium alloys are offered with 400 g/m^2 thickness complete with a finishing layer. It is reported that these coatings provide improved corrosion protection over standard zinc coating and allows for installation in a wider range of soils, without the need for sleeving.

EN 545 nominates that DI pipes with zinc coating of 200 g/m^2 thickness and min 100mm thick finishing layer or enhanced zinc alloy coating with 400 g/m^2 thickness and min 100mm thick finishing layer can be buried without sleeving except:

(i) For Zinc coatings

- (A) soils with a resistivity less than 1500 Ω cm when laid above the water table, or less than 2500 Ω cm when laid below the water table
- (B) mixed soils i.e. comprising two or more soil natures
- (C) soils with a pH below 6 and a high reserve of acidity
- (D) soils containing refuse, cinders, slags or polluted by wastes or industrial effluents
- (E) areas where there is stray current

(ii) For Zinc-Aluminium or enhanced Zinc-Aluminium alloys

- (A) acidic peaty soils
- (B) soils containing refuse, cinders, slag or polluted by wastes or industrial effluents
- (C) soils below the marine water table with a resistivity lower than 500 Ω cm,
- (D) areas where there is stray current

EN 545 also advises that evidence of the long-term performance of the above-mentioned solution (e.g. tests and references) should be provided by the manufacturer.

Manufacturers should be consulted for life expectancy estimates.

> It should be noted that there has been no proven experience or data to support the extrapolation of European experience to Australian conditions and environments. It is considered imperative that testing be undertaken to ensure that the soil environment meets any necessary pre-conditions.

3.7.2 Fittings

The standard option for coating AS/NZS 2280 ductile iron fittings is thermal bonded polymeric coatings.

Other coating options include:

(a) Polyurethane to EN 15655.

(b) Liquid 2-pack epoxy to EN 14901.

3.8 STORAGE

Pipes should be supported on dunnage to keep pipes off the ground. If pipes are to be stored on timbers, the ends of pipes should be chocked to prevent movement. Pipe supports should be located approximately 900 mm from each end.

For pipes being strung along the trench, the socket end should be leading in the direction of laying. For pyramid stacking refer to the manufacturer's instructions.

Fittings should be stored on pallets or other means to keep them off the ground.

Polyethylene sleeving is subject to degradation when exposed to UV radiation and should be sheltered from direct sunlight when stored prior to use. Polyethylene sleeving and sleeved pipes can be stored outside for up to 2 months (refer to AS 3680). Rolls of polyethylene sleeving may be stored for longer periods if protected (e.g. warehouse or under hessian).

3.9 PROPERTY CONNECTIONS

Service connections to ductile iron pipe may be made using standard ductile iron fittings.

3.10 WATER INDUSTRY EXPERIENCE

The major concern in using ductile iron in sewer applications is internal corrosion. The performance of ordinary Portland cement mortar linings is extremely variable. In determining the type of cement mortar lining the chemical composition of the sewage should be considered. Portland cement mortar linings could be considered for "normal" sewage that has a pH >6.0 and a magnesium content <300 mg/L. Calcium aluminate cement mortar linings should be used for sewage outside "normal" composition limits. Controlling the width of cracks in the cement mortar lining to <0.3 mm will also improve the performance of the cement mortar lining to provide corrosion resistance.

Calcium aluminate cement mortar linings also have better abrasion resistance.

The Australian water industry is constantly gaining more experience with the use of calcium aluminate cement mortar linings, which are considered to outperform Portland cement mortar linings in many sewer systems.

3.11 RECOMMENDATIONS ON USE

As the sleeving is the primary corrosion barrier, care needs to be exercised during installation to prevent damage. Only accredited pipelayers trained in the application of sleeving should be used.

Loose fit polyethylene sleeving is not recommended where anaerobic estuarine soils are encountered.

Calcium aluminate cement mortar linings should be used as appropriate according to sewage composition and operating conditions.

Ductile iron pipelines may be used for sewers that run parallel to high voltage electricity transmission lines as the rubber ring joints render the pipeline electrically discontinuous.

3.12 FURTHER INFORMATION

http://www.dipra.org/

WSAA TN-6 Guidelines for the use of cement mortar linings in sewerage applications

4 GLASS REINFORCED PLASTIC FOR PRESSURE AND NON-PRESSURE APPLICATIONS - SEWERAGE

4.1 PRODUCT SPECIFICATION

WSA PS – 219, WSA PS – 205J, WSA PS – 206J

4.2 PIPES

Glass reinforced plastics (GRP) pipes are manufactured for the Australian market to ISO 23856 using the filament wound (FW) or centrifugally cast (CC) process. GRP jacking pipe is manufactured to ISO 25780.

GRP nominal sizes range from DN 300 to DN 4000. See 4.4 for more details.

GRP pipes are defined by the nominal stiffness SN, which is the initial ring stiffness in units of Newtons /metre/metre. See 4.5 for more details.

Nominal pressures ratings are from PN1 to PN32. GRP jacking pipe intended for use in non-pressure applications can be supplied with a nominal pressure rating ranging from PN1 to PN2.5.

When specifying the use of ductile iron fittings with GRP pipes, care should be taken to ensure compatibility with the GRP pipe OD.

The nominal length for GRP pipe is 6m. Pipes can be supplied in lengths down to 1 m. The total length of each standard 6m pipe is equal to the specified nominal length with a tolerance of +0/-60 mm. Other tolerances in length are possible with respect to short pipes.

Glass reinforced plastic (GRP) is an engineering composite material. GRP pipe is typically comprised of layers of thermosetting resin, glass fibre reinforcing and sand.

Filament wound GRP pipes are produced by winding continuous glass fibre rovings onto a mandrel resulting in a pipe with controlled internal dimensions.

Centrifugally cast GRP pipes are produced by feeding raw materials into a rotating mould using a fully automated and electronically controlled process.

The mechanical properties of GRP pipes can be varied by adjusting the quantity, proportions and orientation of the various laminates in the pipe wall. The flexibility of this system enables pipes to be designed to meet a wide range of pressure applications. The types of resin may also be varied in order to meet the many duties and environments to which the pipes may be subjected. The inner layer is designed to provide corrosion resistance, abrasion resistance and a smooth flow surface.

The wall construction of non-pressure pipe differs from pressure pipe in that it contains less glass fibre reinforcement.

4.3 FITTINGS

Non-pressure pipe fittings are fabricated from sections of straight pipe, cut to length and joint wrapped externally and internally with additional fibre reinforcement. Fittings are usually supplied with spigot ends and joined using standard pipe couplings.

The standard range of fittings include:

(a) Pipe couplings.
(b) Elbows 11°, 22.5°, 45°, and 90° (available angle range from 1° to 90°) with spigot, socket or flanged ends.
(c) Tees, either equal or reduced with spigot, socket or flanged ends.
(d) Reducers, concentric or eccentric spigot, socket or flanged ends.
(e) Wye’s with spigot, socket or flanged ends.
(f) Other fittings can be manufactured to order.
(g) Flanges, slip-on or plain.

(h) Manhole couplings, connectors with and without puddle flange

(i) Saddles

Ductile iron and steel fittings with elastomeric seals can be used in GRP pipelines. Ductile iron and steel fittings should have compatible performance capability and should be appropriately protected against internal and external corrosion.

GRP fittings used with GRP jacking pipes are fabricated from sections of straight pipe, cut to length, joint wrapped externally and internally with additional fibre reinforcement in accordance with ISO 10467. GRP fittings are supplied with spigot ends suitable for connection to the GRP jacking pipe stainless steel or GRP couplings.

4.4 SIZING

Pipes manufactured by the filament wound method offers DN 300 to DN 750 pipes with spigot outside diameters complying with Australian preferred outside diameters (WSA PS 219) and DN 900 to DN 4000 pipes with spigot outside diameters complying with ISO 23856 Series B1 (Table 5).

Pipes manufactured by the centrifugally cast method offers DN 300 to DN 600 pipes with spigot outside diameters complying with ISO 23856 Series B2 (Table 6) and DN 700 to DN 1400 pipes with spigot outside diameters complying with ISO 23856 Series B1 (Table 5). The external diameters do not align with Australian Standard pipes.

GRP jacking pipe is manufactured in nominal sizes ranging from DN 300 to DN 3000. The declared external and internal pipe diameters are required to be specified by the manufacturers.

4.5 STIFFNESS CLASSES

GRP pipes are defined by the nominal stiffness SN, which is the initial ring stiffness in units of Newtons /metre/metre (N/m/m) (see Pipeline design and installation).

Stiffness of the pipe is varied by increasing the wall thickness and /or varying the level of glass reinforcement.

GRP Pipes are manufactured with nominal pipe stiffness ranging from SN 5000 N/m/m to SN 10,000 N/m/m. WSAA recommends a minimum stiffness rating of SN 10,000 N/m/m for buried applications. GRP non-pressure pipes can also be manufactured with nominal stiffness up to SN 20,000 N/m/m for deep trench and bad soil applications

ISO 25780 requires a minimum pipe stiffness of SN 20,000 N/m/m. GRP jacking pipes can be supplied with jacking loads in the range of 50 to 1000 Tonnes and nominal stiffness ≥ SN 20,000 N/m/m.

4.6 JOINTS

Plain-ended GRP pipes are joined with a sleeve coupling that is factory fitted to one end of the pipe.

The standard ‘FWC’ couplings comprise a filament wound GRP outer shell and inner elastomeric gasket for the full width of the coupling.

An additional special purpose rubber ring joint with a flush external diameter is available for microtunnelling and pipe jacking.

Standard couplings accommodate angular deflection of 1 to 3° depending on pipe size. Witness marks on the spigot identify insertion depth. Spigots should be inserted to but not beyond the witness mark.

Ductile iron fittings can be joined to GRP non-pressure pipe by means of:

(a) Ductile iron socket to GRP spigot.

(b) Ductile iron flange to GRP flange.

(c) Ductile iron spigot (machined to GRP outside dimensions) to GRP spigot with a standard coupling.

GRP pipes (marked Adjustable) can be cut anywhere along the pipe barrel and rejoined using a standard GRP coupling, mechanical gibault type coupling, DI socket or other approved mechanical compression seal joint.

Flange socket/spigot metal (or GRP where permitted) fittings are required to connect pipes to flanged fittings. Dimensions and drilling patterns should comply with AS 4087.

GRP pipe couplings have an outside diameter equal to the pipe external diameter. Couplings are available in different types and pressure classes depending on the application.

4.7 INTERNAL LINING

4.7.1 Pipes

GRP pipes are finished internally with a special purpose liner polyester resin barrier that is highly resistant to attack by sewage and its by-products such as sulphuric acid. The corrosion barrier acts as protection to degradation of glass fibres within the pipe wall. Various resin types are available and provide differing performance levels. For severe applications such as with industrial effluents and temperatures over 35°C vinyl ester resins should be considered.

4.7.2 Metal fittings

Ductile iron fittings lined and coated to AS/NZS 4158 will provide the best combination of internal and external corrosion resistance.

4.8 EXTERNAL CORROSION PROTECTION

4.8.1 Pipes

Standard GRP pipes manufactured from polyester (thermosetting) resins are resistant to corrosion by soil, water and sewage, and are unaffected by stray or induced currents.

Where it is considered there is potential for permeation and degradation of GRP pressure pipe or their EPDM gaskets/rings by organic contaminants specialist advice should be sought. In some instances the use of vinyl ester resins may be warranted.

GRP fittings do not require any special protection.

4.8.2 Metal fittings

Ductile iron fittings lined and coated to AS/NZS 4158 will provide the best combination of internal and external corrosion resistance.

Steel fittings complying with AS 1579 should be externally coated using an approved factory applied PE tape wrap systems or APAS listed solventless epoxy coating.

4.9 PROPERTY CONNECTIONS

GRP pipelines are used in sizes not normally requiring property connections. Where required, specially fabricated saddle fittings are available for fitting in the field using epoxy resin.

4.10 PIPELINE DESIGN AND INSTALLATION

Structural design will determine which of the two common stiffnesses (SN5000 or SN10000) can be used for various soil stiffnesses (i.e. deformation moduli), trench widths and live loadings. However, for very low stiffness native soils (modulus less than 1 MPa) e.g. soft clays, swelling soils, soils containing organic materials, it may be necessary to use a wider than standard trench together with a special embedment to give a satisfactory design.

This will often be the best option because pipe stiffness is only a minor part (about 15%) of the combined pipe-soil stiffness resisting external loading, increase of the pipe stiffness from

SN5000 to SN10000 or even SN15000 will only provide a small decrease in predicted deflection for the same loading.

It should also be noted that although stiffer GRP pipe improves deflection resistance, the wall in a stiffer GRP pipe means that a higher circumferential strain will result for the same deflection. Because of the lower strain limits of GRP pipe than say thermoplastics, this may be the controlling factor for design purposes.

All plastic pipes undergo creep and in the case of GRP pipe this causes the long-term stiffness to be approximately 0.4 times that of the initial (3 minute) stiffness. This creep effect, together with an increase in loading due to backfill settlement, requires that the initial allowable deflection for GRP pipe be less than the long-term limit. Typically, short-term deflection should not exceed 4%.

GRP pipes have a low resistance to bending and shear. It is therefore critical that the foundation and bedding offer a continuous and uniform support to the pipe barrel. Attention needs to be given to the possibility of point loads applying to the pipe barrel such as from an uneven native rock foundation beneath the bedding. Such a condition can be detrimental to the long-term pipe performance. Figures or Standard Drawings show minimum bedding and overlay thicknesses.

4.11 WATER INDUSTRY EXPERIENCE

GRP pipelines have performed satisfactorily where installation conditions have been correctly managed.

There have been a few instances of GRP pipeline failure. Some failure analyses indicate the possibility of point loads during transport initiating failure.

The liner resin type may have to be modified from polyester to vinyl ester to ensure it is suitable for the required environment e.g. sewage at temperatures over 35°C.

The Australasian Society Trenchless Technology has developed Trenchless Guidelines, Standards and Specifications to assist industry users in Australia and New Zealand in utilising these technologies. These documents are not intended ‘to replace any existing relevant manuals or standards. It remains the user’s responsibility to ensure that all relevant laws, standards and specifications are adhered to during the course of a Works with use of these trenchless technologies.

These Guidelines, Standards and Technical specifications are available from the Australasian Society Trenchless Technology (ASTT) website. (http://astt.com.au). Comprehensive technical specifications are available from the ASTT (Australian Society for Trenchless Technology) website. (http://astt.com.au)

4.12 RECOMMENDATIONS ON USE

GRP pipeline systems might not be suitable for use in the following situations:

(a) where there is a high risk of later excavation in the immediate vicinity of the pipeline;

(b) above ground where there is risk of vandalism.

(c) in ground contaminated with certain organic compounds in concentrations that could lead to attack of the EPDM elastomeric gasket

4.13 FURTHER INFORMATION

AWWA M45 Fiberglass Pipe Design

http://www.awwa.org/bookstore

http://www.hobas.com/

http://www.superlit.eu/

http://www.futurepipe.com/en/

https://www.rpcpipesystems.com/

Zhejiang Eastern Haobo Pipes Co Ltd (DFHB)

http://astt.com.au

5 POLYETHYLENE (PE) TWIN WALL FOR NON-PRESSURE APPLICATIONS - SEWERAGE

5.1 PRODUCT SPECIFICATIONS

WSA PS – 241.

5.2 PIPES

PE twin wall sewer pipes complying with AS/NZS 5065 Type B ID series have a smooth bore and corrugated external wall. The pipes are made using polyethylene compounds commonly referred to as HDPE. Materials complying with the requirements for PE100, as given in AS/NZS 4131, may be used but other compounds meeting the material requirements of AS/NZS 5065 can also be used.

Whilst PE compounds have a lower modulus than PP, the appropriate ring bending stiffness can be achieved by selecting appropriate wall profiles and wall thickness. PE exhibits excellent abrasion resistance and broad chemical resistance.

The pipes may be made in nominal 3 m or 6 m lengths (refer to the manufacturer).

Twin wall PE sewer pipes are currently supplied with a black inner and outer wall. According to AS/NZ 5065, black PE compound is required to contain 2.25 ± 0.25% by mass of a carbon black known to provide excellent UV resistance. Black twin wall PE sewer pipes can therefore be stored outdoors for extended periods.

Pipes are available in diameters ranging from DN 100 to DN 4000, the actual sizes available depending upon the manufacturer. PE pipes and fittings are resistant to the corrosive environment encountered in sewerage and industrial waste applications, are unaffected by aggressive ground conditions such as acid sulphate soils or saline ground conditions. The hollow twin wall structure is a material efficient design providing a combination of high stiffness and light weight. Polyethylene sewer pipes are expected to provide a service life in excess of 100 years.

5.3 FITTINGS

A range of fittings is available. Refer to the manufacturer for details and availability of fittings and methods of repair.

5.4 STIFFNESS CLASSES

PE sewer pipes are specified in terms of stiffness class measured in a standard parallel plate test. PE pipes made in Australia for sewer applications are minimum SN8, having a stiffness ≥8,000 N/m/m.

5.5 JOINTS

Twin wall PE pipes used in sewer reticulation work have a socket and spigot joint with an elastomeric seal. The seals are mounted on the corrugated spigot prior to assembly. In order to reduce the likelihood of tree root intrusions, rubber ring joints complying with AS/NZS 5065 are required to have a seal interface pressure of at least 0.4 MPa over at least 4 mm, the same as for PVC-U pipes made to AS/NZS 1260.

Refer to the manufacturer regarding jointing methods for larger diameters, for example up to DN 4000

Polyethylene twin wall sewer pipes are Type B ID Series in accordance with AS/NZS 5065. The dimensions of the corrugations, socket internal diameter and seal profile are not the same for all manufacturers. Elastomeric seals should only be used with pipes from the same manufacturer.

Pipes must be aligned for assembly, but after assembly the joints are usually able to accommodate approximately 1 to 3 degrees deflection at each socket. The pipes are longitudinally stiff and cannot be curved. Manufacturers provide guidance on the acceptable angular deflection at the joints.

Joint lubricants, consisting of water based emulsions provide lubrication during jointing and prevent damage to joint seals during assembly.

Where a witness mark is provided on the spigot, the spigot should be inserted up to the witness mark but not beyond. Otherwise follow the jointing instructions of the manufacturer.

In order to resist plant root penetration, AS/NZS 5065 specifies a minimum initial interfacial pressure between the elastomeric ring and the pipe. A study was undertaken by CSIRO Building, Construction and Engineering and Iplex Pipelines to assess the effects of interfacial pressure and spigot deformation upon root intrusion into plastics pipes. This study followed previous work investigating the role of socket geometry and controlled flaws. Root intrusion was found to occur into many joints with average interfacial pressures of 0.04, 0.10, 0.11 and 0.20 MPa. However, no intrusion occurred into joints with interfacial pressures of 0.37 and 0.38 MPa, even though the contact width where pressure exceeded 0.3 MPa was less than 0.5 mm. This interface pressure, when combined with a smooth pipe material surface and impermeability to moisture, has been shown to provide good resistance to tree root intrusions. PP pipe joints exhibit all these characteristics.

In light of these findings, the requirement that the interfacial pressure of minimum 0.4 MPa over a minimum contact width of 4 mm is considered more than adequate to prevent root intrusion and was incorporated into AS/NZS 5065 (and AS/NZS 1260).

Thermoplastic elastomeric seals conforming to AS 681.2 have a greater rate of compression stress relaxation than vulcanised seals. They are therefore required to have an initial interface pressure of at least 0.47 MPa to compensate for the higher stress relaxation.

5.6 INTERNAL LINING

Not applicable.

5.7 STORAGE

Black twin wall PE pipes and fittings manufactured to AS/NZS 5065 are suitable for storage outdoors for extended periods. Non-black pipes should only be stored outdoors for up to 2 years. If longer storage periods are envisaged, the pipes and fittings should be stored under cover or protected by, for example hessian. Once the non-black pipes are buried they are no longer subject to potential deterioration from exposure to UV radiation. Detailed guidance on site storage is available from the manufacturers.

5.8 EXTERNAL CORROSION PROTECTION

PE pipes are resistant to corrosion by soil and water and are unaffected by stray electrical currents.

5.9 PROPERTY CONNECTIONS

Service connections to PE twin walled pipe may be made using either cut-ins or stainless steel junctions with DN 100 or DN 150 45° branches. Stainless steel junctions made for one twin wall product might not be suitable for another. Compatibility should be confirmed with the pipe manufacturer.

5.10 PIPELINE DESIGN AND INSTALLATION

The internal diameter of twin wall PE pipes closely approximates, but is slightly smaller than the nominal diameter DN. The designer should verify actual diameters prior to undertaking hydraulic design.

Twin wall PE pipes are classified as flexible pipes and the structural design methods used with other flexible pipes are equally applicable to these. The pipes are SN 8 and the ring stiffness can be directly used in structural design calculations in accordance with AS/NZS 2566 Part 1. However, under general gravity sewer pipelaying conditions detailed calculations are not usually necessary. Reference can be made to PIPA Technical Paper TP005, manufacturer’s literature or design software or www.teppfa.eu.

5.11 WATER INDUSTRY EXPERIENCE

PE has been used in both storm water and land drainage applications for many years. Twin wall pipes have increasingly been adopted for sewers and sanitary drains because of their light weight, material efficiency and stiffness.

5.12 RECOMMENDATIONS ON USE

PE corrugated twin-wall pipes are resistant to many chemicals and can be used in both sewerage and industrial wastewater applications. Whilst the material is inherently impact resistant, PE pipes, like all pipes, should be installed in a manner that avoids substantial point loads.

6 POLYETHYLENE (PE) PLAIN WALL PIPE FOR PRESSURE AND NON-PRESSURE APPLICATIONS - SEWERAGE

6.1 PRODUCT SPECIFICATION

WSA PS – 242, WSA PS – 207 (Pipe), WSA PS – 208 (fittings).

6.2 PIPES FOR NON-PRESSURE APPLICATIONS

PE plain pipes for non-pressure sewers are manufactured to AS/NZS 4130 (Series 1) or AS/NZS 5065 OD Series from a pre-compounded PE 100 base resin material that has been assessed for conformity with AS/NZS 4131 and listed in PIPA Guideline POP004 and PIPA Guideline POP004a, respectively.

Plain wall PE100 pipes to AS/NZS 4130 shall be minimum SDR 21 PN8. Plain wall PE pipes to AS/NZS 5065 shall be SDR 21 minimum SN8.

PE plain pipe for non-pressure sewers is provided with grey coloured stripes for identification purposes and a non-light scattering bore to provide superior clarity for inspection purposes.

6.3 PIPES FOR PRESSURE SEWERS

PE plain pipes for pressure sewers are manufactured to AS/NZS 4130 (Series 1) from a pre-compounded PE 100 base resin material that has been assessed for conformity with AS/NZS 4131 and listed in PIPA Guideline POP004 and PIPA Guideline POP004a, respectively.

Plain wall PE100 pipes to AS/NZS 4130 shall be minimum SDR 11 PN16. Pressure classes PN20 and PN25 are available for applications requiring higher pressures.

PE plain pipe for pressure sewers is provided with cream coloured stripes for identification purposes.

6.4 FITTINGS

Fittings manufactured to AS/NZS 4129 for use with polyethylene pipe include:

(a) Electrofusion fittings manufactured from PE100 compounds.

(b) Spigotted fittings manufactured from PE100 compounds. Long spigot fittings are suitable for electrofusion or butt welding and short spigot fittings are available for butt welding only.

(c) Mechanical compression fittings manufactured from various plastics, e.g. polypropylene, ABS, polyethylene.

(d) Mechanical compression fittings manufactured from various metals, e.g. dezincification resistant copper alloys, grade 316 stainless steels.

PE fittings may be fabricated or moulded.

Fabricated fittings with junctions shall be type tested to ISO 13264 to demonstrate adequate mechanical strength and flexibility. The tests shall be conducted on one sample for each DN combination. e.g. 110 x 110, 160 x 160, 160 x 110 etc

6.5 SIZING

PE pipe sizing complies with international standards (metric) with nominal sizes based on the actual outside diameter. Relevant for sewer reticulation mains are DN 63, 110, 125, 160, 180, 225, 250, 280, 315, 355, 400 and 450. For larger mains diameters up to DN 2000 are available.

Sizing of PE pipe is different to copper, PVC and DICL manufactured to Australian Standards.

6.6 PRESSURE CLASS

Pressure class is a function of the pipe diameter to wall thickness ratio (SDR) and the MRS.

The PE material classification is related to the minimum required strength (MRS) of the compound by a factor of 10. i.e. PE100 has an MRS of 10 MPa. Defining PE pipe material by its density only, i.e. Medium Density Polyethylene (MDPE) or High Density Polyethylene (HDPE) is no longer appropriate.

The MRS is the minimum allowable value of hoop stress at the 97.5% lower prediction limit at 20°C extrapolated to 50 years. The 50 years is a convention for establishing the material classification and is not intended to suggest a maximum service life.

De-rating the nominal pressure class is required where PE pipe or fittings will be subjected to cyclic pressures or where temperatures exceed 20°C. WSA 02 Part 1 specifies de-rating requirements.

6.7 JOINTS

Electrofusion or butt fusion joints are normally used for DN 90 and above with butt welding being the preferred choice for very large diameters.

Welded joints require trained and certified welders.

Mechanical compression joints are generally specified in sizes up to DN 110 for temporary services and where welding is impractical.

Flanged PE stubs to join to PE pipe by electrofusion or butt fusion are available in sizes DN 90 to > DN 450. Flanged PE stubs to join to PE pipe by mechanical compression are available in sizes up to DN 160. The flange requires a corrosion resistant backing plate of 316 stainless steel or polymeric coated ductile iron (below ground) or hot dipped galvanised steel (above ground). Bolts, nuts and washers should Grade 316 stainless steel and marked A4.

Flange gaskets are required to comply with WSA 109.

6.8 EXTERNAL CORROSION PROTECTION

PE pipe is resistant to corrosion attack in naturally occurring soils and waters and is immune to stray current corrosion.

6.9 TRANSPORTATION, HANDLING AND STORAGE

6.9.1 General

Pipe and fittings should be transported, handled and stored in accordance with the relevant requirements of AS/NZS 2033 and POP 005 guidelines.

All pipe should be stacked in a manner to minimise pipe ovalisation.

For black pipe with cream stripes or jacket outside storage should be limited to a maximum of two years from the date of pipe manufacture prior to installation. Black pipes with cream stripes or jacket can be stored outside for longer periods if protected and stored in a manner that maximises ventilation (e.g. ventilated warehouse or under hessian).

Fittings and sealing materials should be left in the original sealed cartons until immediately before use and stored in secure areas away from direct sunlight. Black fittings conforming to AS/NZS 4129 have a storage life at least equal to black PE pipe.

For solid black pipe outside storage can be unlimited, although it would be good practice to cover black pipes e.g. with hessian where an extended period of storage (>2 years) was envisaged. Elevating the pipe material temperature can result in pipe distortion and pipe length increase, which can cause installation problems. Therefore, it is beneficial to shield pipe from direct sunlight and to store it in a manner that maximises ventilation.

6.10 PIPELINE DESIGN AND INSTALLATION

Buried pipe structural design should be performed in accordance with AS/NZS 2566.1.

Buried pipes cannot be readily located unless tracer tapes or wires are installed over the pipe during installation.

Hydraulic design requires consideration of the expected pressure regime to enable selection of appropriate pressure class of pipe. Pressure class should be based on the maximum operating pressure with appropriate de-rating for the effects of temperature, surge (positive and negative) and fatigue.

For specific installation information relating to PE pressure pipelines refer to AS/NZS 2033 *Installation of polyethylene pipe systems.* Install single length pipe or pipe with fully welded joints under roads and railways.

Where warm ambient temperatures exist to substantially elevate pipe temperature above a buried service temperature, allow pipe to approximately achieve the service temperature before final connection and backfill.

6.11 WATER INDUSTRY EXPERIENCE

The experience with PE for pumped pressure sewers, especially in larger sizes, is limited, despite its excellent fatigue and corrosion resistance.

PE is commonly specified for low-pressure sewerage applications.

PE pipe is preferred over other pressure sewer materials where substantial longitudinal flexibility (tighter radius of curvature), fewer joints, self-restraining pipelines (i.e. using welded PE pipelines) are required.

6.12 RECOMMENDATIONS ON USE

PE systems should not be used where the ground is or will be contaminated by chemicals, especially low molecular weight hydrocarbons and organic solvents.

Where PE is intended to be used in a non-pressure main and the operating temperature exceeds 20°C, the published de-rating factors should be applied (Refer to AS 2033).

Fabricated PE fittings can require substantial derating and should only be used with considerable caution. The PIPA Industry Guidance Note POP 006 provides information on the pressure derating requirements for plain pipe fabricated into fitting configurations.

Pipes should be handled carefully and pipe containing scratches or scores deeper than 10% should not be used. Installation should be in accordance with AS/NZS 2033.

Grey striping is predominantly used to identify PE pipe used for non-pressure sewers and cream striping for pressure sewers. Where plain black pipe is used, a suitable marker tape should be laid over the pipe to identify it.

Fusion jointing should be conducted and managed in accordance with WSA 02.

6.13 FURTHER INFORMATION

http://www.pipa.asn.au/

http://www.plasticpipe.org

7 POLYPROPYLENE (PP) TWIN WALL FOR NON-PRESSURE APPLICATIONS – SEWERAGE

7.1 PRODUCT SPECIFICATIONS

WSA PS – 240.

7.2 PIPES

PP twin wall sewer pipes complying with AS/NZS 5065 Type B ID series have a smooth bore and corrugated external wall. The pipes are made using a block copolymer polypropylene compound. Whilst sharing many characteristics with polyethylene, the PP used in profile walled pipes has a much higher modulus and is used to make pipes with high ring bending stiffness. The PP material exhibits excellent abrasion resistance and broad chemical resistance.

PP does differ slightly from PE in respect to stress relaxation under constant strain. Whilst both materials exhibit rectilinear behaviour, the rectilinear part of the curve starts at about 1,000 hours for PP and in about 10 – 100 hours for PE. This simply means PP must be tested for a longer period before determining the long term modulus by extrapolation.

The pipes are made in nominal 3 m lengths and utilize an elastomeric seal joint.

Twin wall PP sewer pipes are supplied with a light coloured inner wall to aid CCT inspections. The outer wall is normally light grey.

Pipes may be available in diameters ranging from DN 150 to DN 900. PP pipes and fittings are resistant to the corrosive environment encountered in sewerage and industrial waste applications, are unaffected by aggressive ground conditions such as acid sulphate soils or saline ground conditions. The hollow twin wall structure is a material efficient design providing a combination of high stiffness and light weight. Polypropylene sewer pipes are expected to provide a service life in excess of 100 years.

7.3 FITTINGS

A range of fittings including bends, tees, junctions, couplings, reducers and level invert tapers and saddles are available. Fittings may be fabricated from PP sewer twin wall pipe, GRP or PVC and are also available with socket or spigot ends compatible with incoming PVC or VC sewers.

Components for cut-ins and repairs are also available, including stainless steel jointing and repair clamps and slip couplings. For exact details and availability, refer to the manufacturer.

7.4 STIFFNESS CLASSES

PP sewer pipes are specified in terms of stiffness class measured in a standard parallel plate test. PP pipes are required to be a minimum SN10, having a stiffness ≥10,000 N/m/m. A range of SN20 pipes is also available.

7.5 JOINTS

Twin wall PP pipes have a socket and spigot joint with an elastomeric seal. The seals are either SBR or EPDM and are mounted on the corrugated spigot prior to assembly. Rubber ring joints complying with AS/NZS 5065 are required to have a seal interface pressure of at least 0.4 MPa over at least 4 mm, the same as for PVC-U pipes made to AS/NZS 1260.

The pipes are Type B ID Series in accordance with AS/NZS 5065. The dimensions of the corrugations, socket internal diameter and seal profile are not the same for all manufacturers. Elastomeric seals should only be used with pipes from the same manufacturer.

Pipes must be aligned for assembly, but after assembly the joints are usually able to accommodate approximately 1 to 3 degree deflection at each socket. Note the pipes are longitudinally stiff and cannot be curved. Manufacturers provide guidance on the acceptable angular deflection of the joints.

Joint lubricants, consisting of water based emulsions provide lubrication during jointing and prevent damage to joint seals during assembly.

Where a witness mark is provided on the spigot, the spigot should be inserted up to the witness mark but not beyond. Otherwise follow the jointing instructions of the manufacturer.

In order to resist plant root penetration, AS/NZS 5065 specifies a minimum initial interfacial pressure between the elastomeric ring and the pipe. A study was undertaken by CSIRO Building, Construction and Engineering and Iplex Pipelines to assess the effects of interfacial pressure and spigot deformation upon root intrusion into plastics pipes. This study followed previous work investigating the role of socket geometry and controlled flaws. Root intrusion was found to occur into many joints with average interfacial pressures of 0.04, 0.10, 0.11 and 0.20 MPa. However, no intrusion occurred into joints with interfacial pressures of 0.37 and 0.38 MPa, even though the contact width where pressure exceeded 0.3 MPa was less than 0.5 mm. This interface pressure, when combined with a smooth pipe material surface and impermeability to moisture, has been shown to provide good resistance to tree root intrusions. PP pipe joints exhibit all these characteristics.

In light of these findings, the requirement that the interfacial pressure of 0.4 MPa to be exceeded over a minimum contact width of 4 mm is considered more than adequate to prevent root intrusion and was incorporated into AS/NZS 5065 (and AS/NZS 1260).

Thermoplastic elastomeric seals conforming to AS 681.2 have a greater rate of compression stress relaxation than vulcanised seals. They are therefore required to have an initial interface pressure of at least 0.47 MPa to compensate for the higher stress relaxation.

7.6 INTERNAL LINING

Not applicable.

7.7 STORAGE

Twin wall PP pipes and fittings manufactured to AS/NZS 5065 are suitable for storage outdoors for periods of up to 2 years. If longer storage periods are envisaged, the pipes and fittings should be stored under cover or protected by, for example hessian. Once the pipes are buried they are no longer subject to potential deterioration from exposure to UV radiation. Detailed guidance on site storage is available from the manufacturers.

7.8 EXTERNAL CORROSION PROTECTION

PP pipes are resistant to corrosion by soil and water and are unaffected by stray electrical currents.

7.9 PROPERTY CONNECTIONS

Service connections to PP twin walled pipe may be made using either cut-ins or stainless steel junctions with DN 100 or DN 150 45° branches. Stainless steel junctions made for one twin wall product might not be suitable for another. Compatibility should be confirmed with the pipe manufacturer.

7.10 PIPELINE DESIGN AND INSTALLATION

The internal diameter of twin wall PP pipes closely approximates, but is slightly smaller than the nominal diameter DN. The designer should verify actual diameters prior to undertaking hydraulic design.

Twin wall PP pipes are classified as flexible pipes and the structural design methods used with other flexible pipes are equally applicable to these. The pipes are SN10 or SN20 and the ring stiffness can be directly used in structural design calculations in accordance with AS/NZS 2566 Part 1. However, under general gravity sewer pipelaying conditions detailed calculations are not usually necessary. Reference can be made to PIPA Technical Paper TP005, manufacturer's literature or design software or www.teppfa.eu.

7.11 WATER INDUSTRY EXPERIENCE

PP has been used in both sanitary and storm water drainage applications overseas for many years. Since the 1990s Europe and Scandinavia have increasing adopted twin wall pipes for sewers and sanitary drains, utilising the newer grades of high modulus PP. The product is now also produced in China, India, USA and the Middle East.

In Australia the twin wall PP products were first introduced in the early 2000s. As well as sewer applications there is a separate SN8 product range that has been successfully used in storm water applications. On the basis of its satisfactory performance the use of the product has continued to grow both in Australia and overseas.

7.12 RECOMMENDATIONS ON USE

PP corrugated twin-wall pipes are resistant to many chemicals and can be used in both sewerage and industrial wastewater applications. Whilst the material is inherently impact resistant, PP pipes, like all pipes, should be installed in a manner that avoids substantial point loads.

8 POLYVINYLCHLORIDE (PVC) PRESSURE SEWERS - SEWERAGE

8.1 MATERIALS

PVC covers four variants:

(e) Unplasticised PVC or PVC-U.

(f) Modified PVC or PVC-M.

(g) Orientated PVC or PVC-O.

(h) Fusible PVC

Until 2000, PVC-U was the default PVC pressure pipe material. Since then PVC-O and PVC-M have progressively displaced PVC-U and these are now the preferred materials.

PVC-M and PVC-O have better fracture toughness than PVC-U and offer better hydraulic performance in equivalent sizes and pressure classes. Repetitive, high- pressure waves can cause cyclic fatigue in PVC. However, the fatigue characteristics of the materials have been systematically studied and it is possible to design pipelines to avoid fatigue altogether. That is, if the pipeline system can be designed to operate beneath the fatigue threshold, fatigue failure will not occur.

PVC-O has higher fatigue resistance than PVC-M and PVC-U but all three materials can be used in pressure sewers, provided the conditions are within the appropriate design envelope. Water Agency asset management practices may require authorisation to mix and match variants of PVC, although there are no technical reasons to prohibit mix and matching.

PVC polymer resin is compounded with calcium-zinc, organic or tin stabiliser to prevent thermal degradation of the polymer during the extrusion process by which pipe is manufactured or by the moulding process by which fittings are manufactured. Other additives are added to improve processing, inhibit degradation by ultraviolet light and to add colour.

Fusible PVC is intended for rehabilitation and horizontal directional drilling applications and is joined using a butt-welding technique similar to polyethylene pipes. This product is not yet readily available in Australia.

8.2 UNPLASTICISED PVC (PVC-U) FOR PRESSURE APPLICATIONS – SEWERAGE

8.2.1 Product Specification

WSA PS – 211.

8.2.2 PIPES

Unplasticised PVC (PVC-U) pressure pipes have been commonly used by Australian urban water agencies for reticulation since the 1980’s.

PVC-U pipes are manufactured to AS/NZS 1477 and are available in both imperial (Series 2, DIOD) and metric sizes conforming to ISO standards (Series 1). The Sewage Pumping Station Code of Australia WSA 04 deems Series 2 to be the default option.

PVC-U Series 2 pipes are available in sizes from DN 100 to DN 375 and pressure classes PN12 to PN20, depending on size.

PVC-U Series 1 pipes are available in sizes from DN 80 to DN 450 and pressure classes from PN4.5 to PN18, depending on size.

Relative to overseas, Australian Water Agencies were slow to adopt PVC-U as an option for pressure sewers. Some concerns about the notch-sensitivity and fatigue strength of PVC-U have been expressed but these have been addressed by setting a minimum fracture toughness and by establishing an appropriate design against cyclic loading.

8.3 MODIFIED PVC (PVC-M) FOR PRESSURE APPLICATIONS - SEWERAGE

8.3.1 Product Specification

WSA PS – 209.

8.3.2 PIPES

Modified PVC (PVC-M) was introduced to the Australian market in 1998. PVC-M differs from the traditional PVC-U by way of special additives that greatly improve the toughness whilst retaining strength similar to PVC-U. The design factor for PVC-M is 1.4 (compared to 2.1 for PVC-U). Consequently, the wall thickness of PVC-M is proportionally less for the same PN rating.

PVC-M pipes are manufactured to AS/NZS 4765 and are available in both imperial (Series 2 DIOD) and metric sizes conforming to ISO standards (Series 1). The Sewage Pumping Station Code of Australia WSA 04 deems Series 2 to be the default option.

PVC-M Series 2 pipes are available in sizes from DN 100 to DN 450 and pressure classes from PN6 to PN20, depending on size.

PVC-M Series 1 pipes are available in sizes from DN 100 to DN 575 and pressure classes from PN6 to PN18, depending on size.

8.4 ORIENTED PVC (PVC-O) FOR PRESSURE APPLICATION - SEWERAGE

8.4.1 Product Specification

WSA PS – 210.

8.4.2 PIPES

Molecular oriented PVC (PVC-O) was introduced to the Australian market in 1974 but was not widely promoted due to limitations on manufacturing capacity and cost. Technological advances enabled PVC-O to be produced more efficiently. PVC-O is produced from PVC-U formulations but differs from the traditional PVC-U by way of a special manufacturing process that converts a random orientation of the molecular structure to a more ordered alignment, resulting in improved physical properties including higher strength, higher resistance to cyclic fatigue and higher impact resistance.

The design factor for PVC-O is 1.6 but the higher material strength relative to PVC-M results in a reduction in wall thickness for an equivalent pressure rating.

AS/NZS 4441 classifies PVC-O pipes according to the Minimum Required Strength (MRS) of the material which is based on the degree of orientation. Manufacturers generally select a material strength, either MRS400, MRS450 or MRS500, for a particular PN rating, which then determines the standard specified minimum wall thickness and corresponding pipe stiffness. Some manufacturers manufacture pipes with wall thicknesses greater than the standard specified wall thicknesses for a particular MRS to ensure minimum pipe stiffnesses greater than SN10 are achieved.

PVC-O pipes are manufactured to AS/NZS 4441 and are available in imperial (Series 2 DIOD) sizes only.

PVC-O pipes are available in sizes from DN 100 to DN 450 and pressure classes from PN12.5 to PN20, depending on size.

8.5 EFFECTIVE LENGTHS

The standard effective length of PVC pipes is 6 m, however shorter pipe lengths may be available for unstable ground such as filled, mine subsidence and slip areas.

8.6 PRESSURE CLASS

Pipe wall thicknesses are dependent on the pressure rating, diameter and design stress.

The hydrostatic design stress for PVC-U pipes for diameters ≤ DN150 is 11 MPa and for larger diameters is 12.3 MPa.

The hydrostatic design stress for PVC-M pipes is 17.5 MPa.

The hydrostatic design stress for PVC-O pipes is dependent on the material MRS. A design co-efficient of 1.6 provides for 25 MPa for MRS400, 28 MPa for MRS450 and 32MPa for MRS500.

De-rating of the nominal pressure class is required for PVC pipes when temperatures exceed 20°C and possibly when subjected to cyclic loading. De-rating requirements for fatigue and temperature are specified in WSA 02 Part 1.

8.7 PIPE STIFFNESS

Designers should be aware that the reduced wall thickness of PVC pipes with higher material strengths for the same pressure rating, particularly PVC-O, will result in lower pipe stiffness ratings.

The 2008 publication of AS/NZS 4441 stated “In order to take full advantage of the economics and performance of PVC-O pipes, it is essential that application designers are cognisant of the limitations of thin-walled pipes and information is presented in this Standard on lateral stiffness, negative pressure resistance and aspects of joint performance. Users should refer to AS/NZS 2566 for further advice.”

By way of example, approximate stiffness calculations for the various types of PVC-O pipes are included below for commonly used pressure ratings, using standard mean wall thicknesses.

	Initial Ring Stiffness SN				
PN	**PVC-U**	**PVC-M**	**PVC-O 400**	**PVC-O 450**	**PVC-O 500**
12	49.5	14.1	6.3	4.7	3.3
16	11.9	32.5	13.1	9.4	6.4
20				18.0	13.1

Many water agencies have specified that PVC-O pipe is required to have a minimum stiffness rating of SN10. Some manufacturers provide an increased wall thickness for PVC-O MRS450 PN16 pipes to ensure a minimum of SN10 is achieved.

8.8 JOINTS

8.8.1 Flexible

Push fit spigot and socket elastomeric seal joints are the most common jointing method for PVC-U pipes. However, the joint design, including both the seal and socket, is unlikely to be the same for the variants of PVC from the same manufacturer or from different manufacturers. This does not prevent PVC pipes from the same manufacturer or from different manufacturers being joined together but it is essential to use the correct socket – seal combination.

The elastomeric seal joint can accommodate some longitudinal displacement and angular deflection. Angular deflection at a joint is typically limited to approximately 1 degree. This is sufficient to accommodate minor changes in direction and grade and may reduce the need for bends (fittings).

Witness marks applied to the spigot end by the manufacturer show the insertion depth. Spigots should be inserted into the socket up to the witness mark and not beyond it.

Joint seals provided with the pipe are manufactured from elastomers complying with AS 1646 and AS 681.1. SBR (Styrene Butadiene Rubber) and EPDM (Ethylene Propylene Diene Rubber) seals are most common but polychoroprene and nitrile rubber may be used is special instances, for example where increased oil resistance is necessary. Seals may be locked in place during production of the socket or supplied separately. Except in the case of locked-in seals, the ring groove must be cleaned and the seal inserted prior to joining.

Joint lubricants, consisting of water-based emulsions, provide lubrication during the making of the joint to prevent damage to joint seals during assembly.

Socket depths are designed to accommodate a number of factors including thermal movement, Poisson contraction and angular deflection. PVC pipes with elastomeric seal joints can withstand some ground movement but in locations such as mine subsidence areas longer sockets, possibly in conjunction with shorter pipe lengths, might be required. For filled, mine subsidence and slip areas the Designer should refer to individual manufacturers and specify the type, length and manufacturer(s) of PVC pipe to be used.

8.8.2 Flanged

Flanged PVC pipes are not available. The preferred method of joining PVC pipes to a flanged valve or fitting is by means of a ductile iron flange/socket connector. (Note that a PVC socket should not be connected to a ductile iron spigot due to potential creep in the PVC socket).

8.9 CORROSION PROTECTION

8.9.1 Pipe

Not applicable for PVC-U pipes or fittings. PVC-U pipe is resistant to corrosion attack in naturally occurring soils and waters and is immune to stray current corrosion.

8.9.2 Fittings

Ductile iron fittings are coated and lined with a thermal bonded polymeric coating in accordance with AS/NZS 4158.

8.10 FITTINGS

Ductile iron fittings are compatible with Series 2 PVC pipes and are nominated as the default option for fittings. Series 1 pipes can also be accommodated for some sizes using adaptor seals in the fitting sockets. Long-radius post- formed bends (i.e. a pipe segment is bent over a mandrel to form a bend) are also available.

AS/NZS 2280 nominates the minimum depth of entry beyond the elastomeric seal for socketted fittings intended for use with plastics pipes. The minimum entry depths are proposed to accommodate axial movement of the pipe due to the combined effects of thermal contraction, Poisson contraction together with an allowance for joint angular deflection, spigot chamfer length, spigot end squareness and soil friction effects.

Guidelines for the use of plastics pipes with duction iron fittings are also given in the Water Services Association of Australia Information and Guideline Note WSA TN2 Guidelines for the use of ductile iron elastomeric joint fittings with plastics pipes, available from https://www.wsaa.asn.au.

Property services should be installed at the time of main laying, utilising pre-tapped connectors wherever possible. Where tapping bands are utilised, only Type F tapping bands incorporating a full circle design and positive stop should be used, particularly for pipes with low pipe stiffnesses such as PVC-O.

Only Type F repair and off-take clamps with a full circle design and positive stop should be used with PVC pipes, particularly for pipes with low pipe stiffnesses such as PVC-O.

8.11 STORAGE

PVC pipes are subject to surface degradation when exposed to UV radiation for extended periods. PVC pipes can be stored outside for 12 to 24 months depending upon location and longer if protected (e.g. warehouse or under hessian).

8.12 PIPELINE DESIGN AND INSTALLATION

Buried pipe structural design should be performed in accordance with AS/NZS 2566.1. The pressure class of pipe, which is based on the maximum operating pressure with appropriate de-rating for the effects of temperature, positive and negative surge and fatigue, should be nominated on the design drawings.

Buried pipes cannot be readily located unless tracer tapes or wires are installed over the pipe during installation.

Pipes can be easily cut to length and chamfered on site. Specialised equipment is available to cut the chamfers on site. Care should be taken to ensure the end of the pipes cut square and are not “scored” during this process. A witness mark indicating the insertion depth must be drawn on the spigot end of a cut pipe prior to assembly.

8.13 WATER INDUSTRY EXPERIENCE

PVC-U pressure pipe has been used by Australian Water Agencies since about 1970, albeit the major growth in the use of PVC-U occurred in the 1980s and 1990s. Overall the performance has generally been satisfactory, however some early failures were reported due to unsatisfactory design, particularly with respect to cyclic fatigue. The adoption of fracture toughness test in 1996 led to greater consistency in quality and performance.

PVC-M and PVC-O pipe has now been used successfully in Australia for multiple decades and have largely displaced PVC-U pipes for pressure applications.

8.14 RECOMMENDATIONS ON USE

PVC pipeline systems should not be used where there is a high likelihood that the ground is contaminated by chemicals that might soften the material e.g. ketones such as acetone and halogenated organic solvents such as dichloromethane. Even though PVC itself is not very permeable to many chemicals, consideration should be given to contamination of contents by chemicals entering the pipe via the joints. However, this is equally true of all pipe systems jointed with elastomeric seals.

Where PVC pipeline systems are intended to be used in pumped mains or where the temperature of the reticulated water exceeds 20°C, design analysis should be conducted to determine de-rating factors.

As with pipes of all materials, PVC pipelines should be installed in a manner that avoids point loading and mechanical surface damage. Pipes should be handled carefully and pipes containing scratches or scores deeper than 10 per cent (upper limit of 0.5 mm) should not be used.

8.15 FURTHER INFORMATION

Plastics Industry Pipe Association (PIPA) – download from http://www.pipa.com.au

POP201	1.1	May, 2013	Resistance of Plastics Pipes and Fittings to Water and Wastewater Chemicals
POP202	2.1	November 2016	PVC, PP and PE Pressure Pipe Installation on Curved Alignments
POP203	1.0	December, 2007	Identification Of Buried Pipe Systems
POP204	1.0	February, 2004	Expected Service Life Of Elastomeric Pipe Seals
POP207	1.0	June, 2012	Installation of Potable Watermains in Contaminated Ground
POP101	1.3	February, 2009	PVC Pressure Pipes Design for Dynamic Stresses
POP103	2.0	July, 2010	Depth of Engagement for PVC Pipes
TN002	1.0	Sep 2009	PVC Pressure Pipe System Maintenance Guide
TN003	1.0	Jan 2005	Temperature Derating of PVC Pipes for Pressure Applications
TN006	1.0	Apr 2010	Weathering of PVC Pipes and Fittings
TP006	1.0	Aug 2012	Long Term Performance of PVC Pressure Pipe

Water Services Association of Australia (WSAA) – download from http//www.:wsaa.asn.au

WSA –TN2	WSA-TN2 Guidelines for the use of non-metallic pipes with ductile iron elastomeric joint fittings and spread sheet calculation

PVC Pipe Association (USA) (http://www.uni-bell.org)

AWWA (USA) http://wwww.org/bookstore

9 MAINTENANCE HOLES

9.1 PRODUCT SPECIFICATION

WSA PS – 323 (Precast), WSA PS – 334[1] (VC), WSA PS – 339[1] (PE), WSA PS – 340[1] (PP) and WSA PS – 342[1] (GRP).

9.2 DESCRIPTION

Subject to Water Agency approval and design constraints, a maintenance hole (also known as an access chamber or manhole) may be either cast in-situ from special class concrete or constructed from pre-cast concrete components. Pre-cast concrete MHs are limited to 6 m maximum depth. Some Agencies allow MHs manufactured from polymeric materials such as polyethylene, polypropylene or glass reinforced plastic.

The use of precast or pre-formed bases may cause difficulty during installation since there is generally a limited range of off the shelf channel configurations.

A critical issue influencing the likelihood of infiltration is the integrity of the joint between the MH base and the MH walls and at through-wall connections of upstream and downstream pipes.

Covers for MH are available in various materials. Heavy weight concrete covers (cast iron frame with concrete infill) are not permitted by some Agencies due to the likelihood of back injury if incorrectly lifted by maintenance personnel. Alternative, light-weight and lockable covers manufactured from ductile iron, thermoplastic or composite materials may reduce the occurrence of injury but in the event of a surcharge, may result in damage to the upper precast MH segments to which the cover is connected.

9.3 CAST IN-SITU MH

Because of the elimination of joints, a principal advantage of an impermeable, cast in-situ MH is the prevention of groundwater infiltration and tree-root ingress. Related to this is the reduction of repair of MH which fail acceptance testing. Reinforced cast in-situ MHs are required for deep sewers and water-charged ground.

A disadvantage of cast in-situ MHs is the potential for poor quality concrete structure arising from poor concrete mix design, extended delays or deficiencies in placing the concrete, thereby reducing density and durability.

9.4 PRE-CAST MH

Joint seals between precast components are either elastomeric material complying with AS/NZS 1646 and AS 681.1 or butyl rubber mastic complying with ASTM C990-91A, in both cases to the manufacturers design.

1 WSA PS – 334 (VC), WSA PS – 339 (PE), WSA PS – 340 (PP) and WSA PS – 342 (GRP) all under Review

10 MAINTENANCE CHAMBERS

10.1 PRODUCT SPECIFICATION

WSA PS – 338 (PE) and WSA PS – 337 (PP), WSA PS – 331 (Con), WSA PS – 334 (VC)

10.2 DESCRIPTION

Maintenance chambers are non-man entry structures used in lieu of MHs to provide access to a sewer from the surface for maintenance and inspection purposes. Most modern mechanical cleaning and CCTV equipment can be used with MCs.

MCs have a minimum internal diameter of 450 mm ranging up to and including 800 mm minimum with or without tapering to 300 mm minimum diameter to terminate at FSL with a DN 300 access frame and cover. MCs incorporate a moulded and channelled base. Base configurations include in-line, bend and junction. MCs are generally available for sewers ≤DN 375 and depths up to 5 m subject to manufacturers certifying their products meet design requirements associated with a water table to full depth.

Only PP MCs are currently available. MCs require careful installation, particularly in regard to ensuring full support from a high modulus embedment. The WSAA appraisal process will assign limitations on the maximum permissible depth of installation of various designs. Installation in non-supportive soils requires specialist design.

11 MAINTENANCE SHAFTS

11.1 PRODUCT SPECIFICATION

WSA PS – 321 (PVC), WSA PS – 322 (PE), WSA PS – 341 (PP) and WSA PS – 334 (VC)

11.2 DESCRIPTION

Maintenance shafts are non-man entry structures used in lieu of MHs to provide access to a sewer from the surface for maintenance and inspection purposes. Most modern mechanical cleaning and CCTV equipment can be used with MSs. MSs have a minimum internal diameter of 225 mm ranging up to and including 425 mm with or without tapering to 225 mm minimum diameter to terminate with a sealed cap accessed through a DN 300 access frame and cover at FSL. MSs may incorporate a moulded and channelled or moulded spherical base. Base configurations include in-line, bend, junction and terminating. MSs are generally available for sewers ≤DN 300 and depths up to 4 m subject to manufacturers certifying their products meet design requirements associated with a water table to full depth.

MSs are available in various materials such as PVC-U, PE, PP and GRP either moulded or fabricated or a combination of both. MSs manufactured from such flexible materials require careful installation, particularly in regard to ensuring full support from a high modulus embedment. The WSAA appraisal process will assign limitations on the maximum permissible depth of installation of various designs. Installation in non-supportive soils requires specialist design.

Maintenance shafts and variable bends placed on the upstream side can accommodate changes of horizontal and vertical direction.

11.3 WATER INDUSTRY EXPERIENCE

Installations of PE MSs rotationally moulded from LDPE have suffered excessive deformation, leading to collapse in some instances, in poor ground conditions and at depths generally in excess of 2 m.

Recent installations of PVC-U, PE and PP MSs on the other hand have performed well in a variety of ground conditions and installation depths.

12 LADDERS AND STEP IRONS

12.1 PRODUCT SPECIFICATION

WSA PS – 314, WSA PS – 315

12.2 DESCRIPTION

Step iron and ladders are used to provide access into service reservoirs, tanks, sewer MHs and below ground chambers and pits. While many Water Agencies actively discourage access into sewers for OH&S reasons, there is often a need to gain access. These components are all suitable in their own right but some have additional advantages. Hot dipped galvanised steel is the least durable of all the products commonly used, especially in sewers that may have high levels of hydrogen sulphide.

13 VENT SHAFTS

13.1 PRODUCT SPECIFICATION

WSA PS – 325 (Educt)

WSA PS – 326 (Induct).

13.2 DESCRIPTION

Vent shafts provide a passive method of allowing fresh air to be drawn into the sewer system and in doing so allow foul air to be expelled. The foul air can in some situations cause odour complaints but the main reason for the use of vent shafts is to reduce the corrosivity of the environment within the sewer. Vent shafts vary considerably from Water Agency to Water Agency and includes a wide variety of material types and methods of construction.

14 VALVES

14.1 SEWAGE AIR RELEASE AND VACUUM BREAK VALVES

14.1.1 Product Specification

WSA PS – 275.

14.1.2 Purpose

Sewage air release and vacuum break valves may be installed on pressure sewers (rising mains).

Sewage air release and vacuum break valves provide the functions of:

(i) During normal operation of a pipeline, continually releases small amounts of accumulated air.

(j) During filling of a pipeline, releases air displaced by the incoming water.

(k) During draining of a pipeline, allows air to enter a pipeline.

Progressively releasing accumulated air is necessary to maintain pumping and flow efficiencies and avoid adverse hydraulic and dynamic effects (water hammer).

Releasing air during filling the pipeline is necessary to prevent restriction of the filling rate.

Ingress of air during draining a pipeline is necessary to avoid the generation of negative pressures (vacuum) within the pipeline.

14.1.3 Description

14.1.3.1 *General*

Design features of sewer air valves differ greatly from those of waterworks air valves. Some of the design features of sewer air valves are:

(l) Long body. That prevents the sewage from reaching the orifice thus keeping the orifice clean for reliable operation.

(m) Unlike free moving float of a waterworks air valve, the float of a sewer air valve is suspended from a stem or a stem and linkage arrangement.

(n) Like air valves in waterworks, air valves for sewer applications can be of air release type or air and vacuum type or double orifice type incorporating air release and air and vacuum valves in the same valve.

During charging the sewer mains, air is released through the large orifice to atmosphere at high velocity until the fluid level reaches the bottom of the large float. As the liquid level tends to rise inside the valve body, the buoyancy force on the float pushes it upward with its stem. This action forces both the large and small orifices to close. The entrapped air is then compressed by the rising sewage and continues to be compressed until the sewage pressure inside valve body equals the pressure of the entrapped air. In that situation, the sewage level cannot rise any more leaving a pressurised air column in between the orifice and sewage level inside the valve body, thus preventing the approaching liquid reaching the orifice. The orifice thus remains free of sewage and allows long-term trouble free operation.

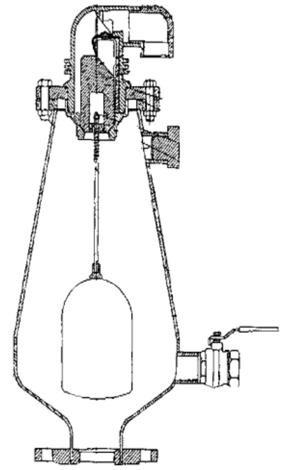
During operation, more air enters into the valve body forcing the liquid level inside the body to fall with the float. This action opens the small orifice and allows the release of some air until liquid pressure equals the entrapped air pressure and closes the valve again.

During draining, as the liquid level falls, the floats also come down with the liquid and open the valve fully. This allows the free entry of outside air into the pipeline preventing the formation of large vacuum and draining of the pipeline.

The orifice shape is generally long cylindrical unlike round or U-shaped, generally used for waterworks air valves. The orifice could be of non-corrosive metallic or non-metallic.

The sewer air valves should be provided with cleaning facilities both at the bottom and at the top of the body to clean or clear any blockages of the orifice. Some valves are provided with self cleansing mechanism.

14.1.3.2 *Combination sewage air release valve*



Combination Sewage Air Release Valve (Double Air Valve)

A combination valve specifically designed for sewerage combines the large orifice and small orifice functions in one valve.

The small orifice air valve releases accumulated air during normal operation of a pressure pipeline. The large orifice air valve ventilates the pipeline during emptying and filling.

14.2 KNIFE GATE VALVES

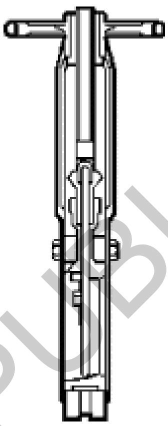
14.2.1 Product Specification

WSA PS – 266.

14.2.2 Purpose

Knife gate valves are generally used for on/off control of raw and treated sewage at pumping stations and treatment plants.

14.2.3 Description



Knife gate is one of the few application specific designs among industrial valves. It basically features a design that ensures minimum contact between moving parts of the valve. This is achieved by having a gate that is practically held between layers of gland packing without touching the body parts during most of its travel.

The seating itself is accomplished with a non-sliding motion aided by jams locate in the body. Avoiding sliding contact between gate and body permits this valve to handle floating material and abrasive particles present in the fluid much better than conventional designs.

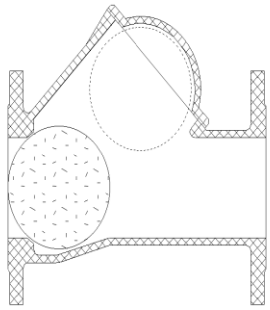
Another feature is the bevelled bottom edge of the gate, from which it derives the term “knife”, which allows positive closure of the gate even when the solid particles settle at the bottom of the body. Knife gate valves are generally unidirectional valves. However, modified designs are also available to handle bi-directional shut- off requirements. End styles are flanged, lugged or wafer with threaded holes in the chest area and threaded through holes in the lugs.

14.3 NON-RETURN (BALL CHECK) VALVES

14.3.1 Product Specification

WSA PS –TBA

14.3.2 Description



Non-return (ball check) valves consist of a rubber coated aluminium alloy ball held in a fusion bonded polymeric coated ductile iron valve that acts as a simple non-return valve for low-pressure applications where a recharge is potentially a problem

BALL CHECK VALVE

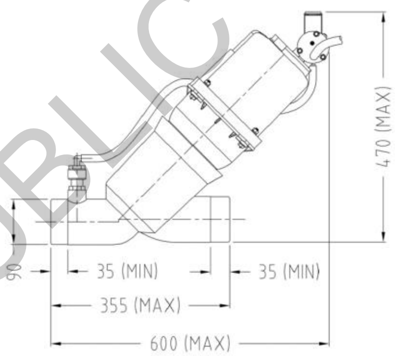
14.4 VACUUM INTERFACE VALVE

14.4.1 Product Specification

WSA PS – 273

14.4.2 Description

A vacuum interface valve is a device that acts as the interface between the vacuum of the service connections and the atmospheric pressure of the collection chambers. The interface valve is designed to automatically open when a predetermined volume of sewage has collected in the collection chamber and to close after the sewage has been removed



VACUUM INTERFACE VALVE

The valves are installed in the collection chamber using demountable, re-useable flexible couplings suitable for vacuum service and complying with WSA PS–235.

15 SURFACE FITTINGS

15.1 PRODUCT SPECIFICATION

WSA PS – 290 (cast ductile iron to AS 3996), WS PS – 291 (cast ductile iron to EN 124-2), WSA PS – 292 (Polymeric to AS 3996)

15.2 DESCRIPTION

Access covers and frames provide access to below-ground maintenance shafts and holes. Three classes of cover and frame are available having both watertight and gas tight capability. Class B is used for installation in very light trafficable areas such as private driveways, Class C is used in residential roads and Class D is used for installation in major roads (excluding freeways).

Bolt-down covers are also used to mitigate flow relief in environmentally sensitive areas and to increase security of sewers from unauthorised access.

15.2.1.1 *Cast iron access covers and frames*

Cast iron access covers and frames conforming to European Standard EN 124-2:2015 together with the additional requirements specified in WSA PS – 291 (which includes water and gas tightness), are deemed functionally comparable to those conforming to WSA PS – 290 (which is based on AS 3996-2019 but with additional requirements). There are significant differences in the cover load classifications between EN 124 and AS 3996 and their equivalence is detailed in WSA PS – 291.

Cover and frames are manufactured from ductile cast iron for manual handling benefits (lighter weight) and ductile behaviour (as opposed to brittle behaviour).

Covers may be solid-top or an infill design. Note that in-situ structural infill covers are required to meet all the requirements of AS 3996:2019 prior to application of the infill.

15.2.1.2 *Polymeric access covers and frames*

The term “Polymeric” replaces the terms “Macro-composite”, “Thermoplastic” and “Composite” that were previously used. Polymeric materials are defined in AS 3996-2019 as materials that have a structural polymeric component. Such materials comprise both thermoplastic (e.g. polyethylene, polypropylene, etc.) and thermosetting materials (e.g. epoxy, polyester, etc.), as well as composite materials that contain a polymeric component, such as fibre reinforced plastic (FRP), sheet moulding (SMC) and bulk moulding compounds (BMC) that can contain any reinforcing material (e.g. glass, or plastic fibres).

Polymeric covers are deemed to be functionally the same as cast iron covers. They are typically of lower weight than cast iron covers. This can improve WHS outcomes during cover installation and removal.

Polymeric lightweight covers can currently be economically manufactured for Class B applications.

15.3 SIZE AND CONFIGURATION

Access covers and frames are available to suit a variety of MH opening shapes and sizes:

(a) circular access covers and frames;

(b) square and rectangular access covers and frames;

(c) two-part, three-part and multi-part covers and frames; and

(d) concrete encased covers and frames.

The industry convention is to identify the size of access covers by specifying the internal clear opening dimensions of the frame. For circular covers, this dimension is a diameter.

For square and rectangular covers, the normal convention is width x length. For single part covers, the width is taken as the frame dimension parallel to the side of the cover with two keyholes. For single row, multi-row and trench grates, the width is taken as the span of the trench.

The multi-part system has been designed for rectangular openings too large to be covered by two-part or three-part covers or by a single row of trench covers.

Typical applications for multi-part covers and frames are for pit and floor openings over sewage pumping stations and valve chambers. Covers within a unit can be removed individually to allow localised access to the pit or floor opening, the remaining covers providing a stable, safe working platform over the opening. Complete access to the pit or floor opening can be obtained by removal of all covers and beam supports.

16 JOINTING COMPONENTS

16.1 JOINT SEALS

The long-term performance of joint seals is vital. Seals must retain their dimensional and physical properties, resist microbiological attack and resist degradation by chemically contaminated ground. The WSAA Codes require elastomeric seals to comply with AS 1646 which in turn references AS 681.1 - vulcanised seals, AS 681.2 – thermoplastic elastomer seals and AS681.3 – cellular rubber seals. The selection of the elastomer type is generally the responsibility of the pipe manufacturer but SBR or EPDM to AS 681.1 are now the preferred options. Natural rubber is no longer supplied is Australia for sewer seals and thermoplastic elastomers have not yet gained acceptance for sewer applications. AS 1646 specifies chemical and physical properties as well as methods of test to verify conformance to the Standard. For applications where increased oil resistance is required, polychloroprene (neoprene) or nitrile elastomers might be preferred.

The design (dimensions, shape, hardness) of the seal is also the pipe or fitting manufacturer's responsibility, subject to the joint conforming with the performance requirements of the product (pipe, valve etc.) standard.

Joint seals are usually supplied with the individual pipeline components and as such do not have a separate product specification. Notwithstanding, individual product certification of these critical components is encouraged. The Water Agency has the option to specify specific types of elastomeric compounds in the product specifications for the various pipe materials.

16.2 JOINTING LUBRICANT

Jointing lubricant is required to provide sufficient lubrication to reduce jointing forces and to prevent damage to joint seals or surfaces on jointing. There is no specific standard for a jointing lubricant but it is required to have the following characteristics:

(o) Not affect the elastomer or pipe or fitting materials.
(p) Remain an effective lubricant under wet conditions.
(q) Not be hazardous to handle and be able to be applied by hand.
(r) Be completely soluble in water.

Jointing lubricants are also supplied with the pipe and pipe seals and are nominated as a specific requirement in the pipeline product specifications.

Jointing lubricants should be used by the nominated use-by dates and stored in accordance with the manufacturer's instructions.

16.3 SOLVENT CEMENT FOR PVC-U

16.3.1 Description

Solvent cement for jointing PVC-U components consists of one or more solvents and a sufficient quantity of base PVC material dissolved in the solvent/s to give the cement the body and consistency required for proper application. Small amounts of inert fillers are sometimes added to control shrinkage during drying.

A priming fluid is initially used to clean the joint mating surfaces of dirt, oil and other contamination prior to application of the solvent cement, as well as removing the surface sheen on the PVC to aid action of the solvent cement. The solvent in the cement softens and swells a layer of the PVC on the spigot and socket mating surfaces and these layers combine with the PVC already in the solvent cement to create a bond on drying of the solvent. For sewer applications, solvent cement designated N shall be used.

There are two types of joint configurations for solvent cement joints:

(s) Tapered sockets—these socket designs are common in most of the locally manufactured product and are designed so that the pipe spigot physically engages the socket to form a tight fit.

(t) Parallel sockets—these socket designs are becoming more prevalent with some of the larger imported fittings. There is no or minimal interference between the pipe spigot and socket and, to ensure a satisfactory joint is produced, specifically formulated gap-filling solvent cements are required to be used in jointing these fittings. Fittings with parallel sockets are marked to highlight the need to use these gap-filling solvent cements.

16.4 FLANGE GASKETS AND O-RINGS

16.4.1 Product Specification

WSA PS – 312.

16.4.2 Description

Elastomeric flange gaskets and O-rings should comply with WSA 109.

WSA 109 provides gasket material options together with minimum property requirements and dimensions for both PN16 and PN35 flange gaskets and O-rings. Guidelines for flange assembly are also included.

Appendix C of AS/NZS 4087 Metallic Flanges for Waterworks Purposes provides guidance for the selection of correct jointing requirements for flanges including flange face type, gasket type, gasket thickness and minimum property class of fasteners.

Recommended torques should be sourced from the component manufacturer.

The industry predominantly specifies 3mm thick EPDM flange gaskets for PN16 applications.

Grey cast iron flat face flanges should only be jointed to another flat face flange. When jointing to a raised-faced flange the introduction of bending stress into the grey cast iron flange could result in over stressing and brittle fracture

17 COUPLINGS

17.1 UNRESTRAINED MECHANICAL COUPLINGS

17.1.1 Product Specification

WSA PS – 270

17.1.2 Description

A typical unrestrained coupling for variable pipe materials and diameters of the same nominal size rating refer to Figure 1. For a typical traditional unrestrained "Gibault" type coupling refer to Figure 2.

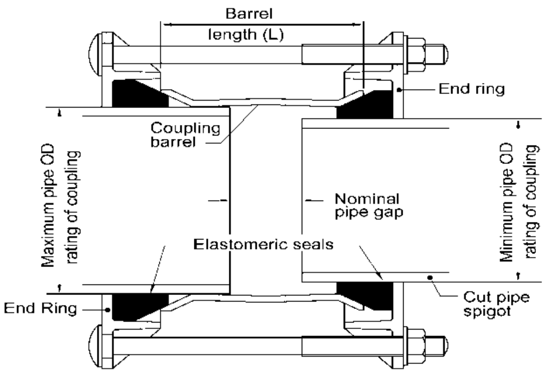


FIGURE 1

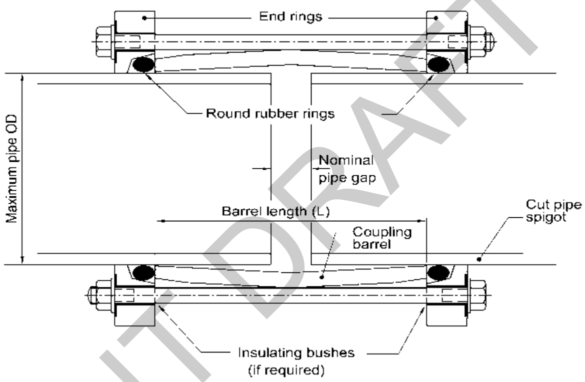


FIGURE 2

A typical bolted unrestrained stepped coupling for same or variable pipe materials of different nominal sizes is shown in Figure 3. A typical bolted unrestrained flange adaptor is shown in Figure 4.

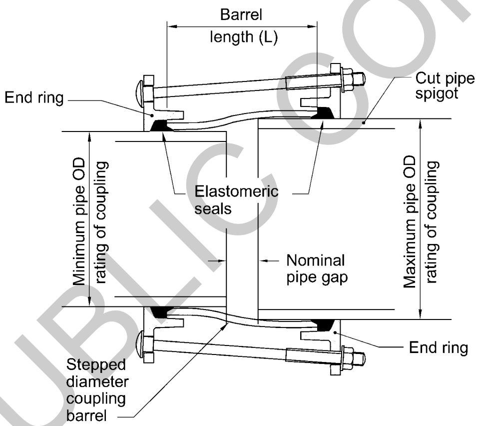


FIGURE 3

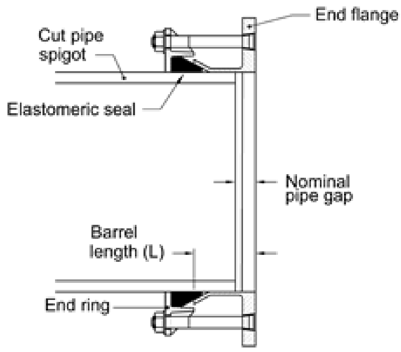


FIGURE 4

Mechanical couplings should conform to AS/NZS 4998 and may be made from a variety of materials but most commonly thermal bonded polymeric coated ductile cast iron or stainless steel with stainless steel bolts. Elastomeric seals are generally EPDM to meet the requirements of AS 1646 in conjunction with AS 681.1 (equivalent to EN 681.1).

Mechanical couplings are generally available for operating pressures up to 1.6 MPa and 3.5MPa. Unrestrained mechanical couplings should not be used where joint restraint is required. Some stepped couplings can also induce longitudinal forces on the fitting, which can facilitate movement along the pipe

17.2 RECOMMENDATIONS ON USE

Mechanical couplings are used to join spigot ends of pipes and/or fittings, typically for repair purposes but sometimes in new installations. The traditional "gibault' type coupling was very widely used and designed primarily for one pipe diameter size. These fittings have now essentially been replaced by a selection of mechanical couplings that are adaptable to a range of pipe diameters. These "variable" couplings are more versatile and can be used to join pipes with pipe diameter differences up to 22 mm.

17.3 METAL-BANDED FLEXIBLE COUPLINGS

17.3.1 Product Specification

WSA PS – 235.

17.3.2 Description

Metal-banded flexible couplings are designed for jointing pipeline components of similar diameter of either the same or differing materials for low-pressure applications. In some cases, with the use of an adaptor bush, pipes of larger diameter may also be jointed to pipes of smaller diameter.

Flexible couplings with stainless steel shear rings are preferred for applications subjected to the effect of soil and other superimposed loads, including repairs and post construction connections to existing pipelines.

17.4 RECOMMENDATIONS ON USE

Couplings having metal shear rings are to be used unless otherwise specified by the Water Agency. Coupling to be type B unless otherwise specified.

Not to be used as an expansion joint.

Usually, they are used in maintenance type applications but are used in some new installations.

18 CORROSION PROTECTION

18.1 LOOSE FIT POLYETHYLENE SLEEVING

18.1.1 Product Specification

WSA PS – 320.

18.1.2 Description

Polyethylene film was first used as a corrosion protection device for buried cast iron pipes in the USA in the early 1950s; it has proved to be an effective method of controlling corrosion in aggressive soils. The purpose of loose polyethylene sleeving is to prevent contact between the pipeline and adjacent soils, thus providing a non-aggressive environment for the pipeline and minimising corrosion. Moisture may form between the sleeving and the pipe and the free flow of ground water within sleeving is not acceptable. The effectiveness of the sleeving is not impaired by the presence of condensate or small amounts of water that may be trapped within the sleeve.

Polyethylene sleeving is supplied as a “layflat tube” i.e. a tubular form of polyethylene film which has been flattened for handling and storage. Nominal sizing of the layflat tube (DN) relates to the size of pipe for which it will be used. The sleeving is coloured green so as to provide good contrast relative to the (black) external surface of ductile iron so as to facilitate the detection of tears or other damage to in sleeving applied to a pipe or fitting. The specification for polyethylene requires a minimum film thickness of 200 micrometres and covers UV resistance and tear resistance. However, it should not be stored in direct sunlight and requires care during installation to avoid damage. Sleeving should be applied in accordance with AS 3681.

18.1.3 Application

The need for polyethylene sleeving depends on the type of soil, class and diameter of ductile iron pipe, and the required service life of a pipeline. In soils that are aggressive and where either the time or the cost of soil assessment is prohibitive, polyethylene sleeving is the quick and cost effective solution, giving assurance of long term performance. Use of the Linear Polarisation Resistance (LPR) method – a special electro-chemical soil testing technique, quickly determines the aggressivity of the soil by measuring its polarisation resistance.

18.2 TAPE WRAP SYSTEMS

18.2.1 Product Specification

WSA PS – 335

WSA PS – 336

18.2.2 Description

There is a wide range of tape wrap systems available for the external corrosion protection of metallic components.

The use of tape systems is generally not recommended in conjunction with stainless steel fittings.

Polymeric tapes are typically shop applied to steel pipe fittings and are used for steel pipeline field joints. Petrolatum tapes are typically applied to valves and appurtenances. may be field or shop applied.

Heat-shrinkable coatings are typically applied to steel pipeline field joints or are shop applied to steel pipe fittings.

18.2.3 Reference Standards

These reference Standards apply equally to pipework used in pressure sewers, pumping stations and buried applications in treatment works.

AS 4822 External field joint coatings for steel pipelines

Type 1A Petrolatum tapes for valves and Type 1B Polymeric tapes for field joints).

Type 1B for Polymeric tapes includes tests for indentation, impact strength, lap shear strength and adhesion between layers

Type 2A-1 Heat-shrinkable, cross-linked coatings

http://www.awwa.org/bookstore

18.2.4 Petrolatum tape systems

Petrolatum tape systems consist of a primer, the petrolatum tape and an over wrap. A mastic filler is also often required to obtain a smooth profile to enable optimum wrapping. These systems when applied correctly provide good protection where limited surface preparation is possible and where complex shapes are involved as it is readily moulded in to the desired configuration.

Petrolatum tape systems are not recommended where cathodic protection is to applied due to their limited dielectric properties when compared to pipe coating materials.

18.2.5 Synthetic tape systems

Synthetic tape systems consist of a wide range of materials form bitumen mastics to butyl mastic with various backing materials. These tape systems require a high level of surface preparation prior to the application of a primer. Profiling mastic or tape is also required to provide a regular surface profile prior to wrapping.

Synthetic tape systems are recommended for pipe joint reinstatement rather than more complex fittings and are suitable for use on cathodically protected pipelines.

18.2.6 Heat shrink sleeves

Heat shrink sleeves are used to provide corrosion protection to pipe joints. They have limited scope to accommodate any changes in geometry and are limited to use on welded steel pipe joints. A high level of surface preparation followed by preheating and priming is required for optimum performance.

The use of any tape systems is generally not recommended in conjunction with stainless steel fittings.

18.3 FURTHER INFORMATION

AWWA M11 Steel Pipe—A Guide for Design and Installation

AWWA M27 External Corrosion—Introduction to Chemistry and Control

AWWA M41 Ductile-Iron Pipe and Fittings

http://www.awwa.org/bookstore

19 CASING SPACERS

19.1 PRODUCT SPECIFICATION

WSA PS – 324

19.2 DESCRIPTION

Casing spacers, sometimes called slippers, centralizers, or thinsulators, are used to make it easier to insert and protect pipes when they are installed inside a sleeve or duct (casings). They are typically used in both above-ground and below-ground installations where a pipe is installed through a casing.

Casing spacers can be used for medium to heavy weight pipe materials including steel, ductile iron, GRP, FRP, concrete, PVC and PE and is suitable for both pressure and non-pressure pipelines in grouted and un-grouted installations.

The casing spacers utilise a segmented design that allows the system to be used on a range of carrier pipes from 100mm OD to 3000mm OD. The components of the spacer are manufactured from injection moulded inert engineering thermoplastics that incorporate low friction high abrasion resistant wear pads, attached to load sharing runners. The number of segments required for each spacer is determined by the outside diameter of the carrier pipe.

When a cased gravity sewer crossings is grouted ensure casing spacers are placed no more than 1 meter apart to maintain proper grade.

Casing spacers are frequently used in graded sewer lines to adjust the grade and alignment. To facilitate this process, it is preferable to have a casing spacer that features runners of different heights at the top and bottom of the spacer.

To account for potential upward forces on the casing spacer and upward deflection of the pipe between spacers due to flotation during the grouting process, it may be necessary to increase the interval between spacers. For specific technical advice regarding spacing intervals, it is recommended to consult the manufacturer of the casing spacers and pipe.

The OD of the casing spacers should be at least 10 mm less than the smallest ID of the encasement casing to minimise the potential for jamming. Internal protrusions such as weld beads should also be taken into account.

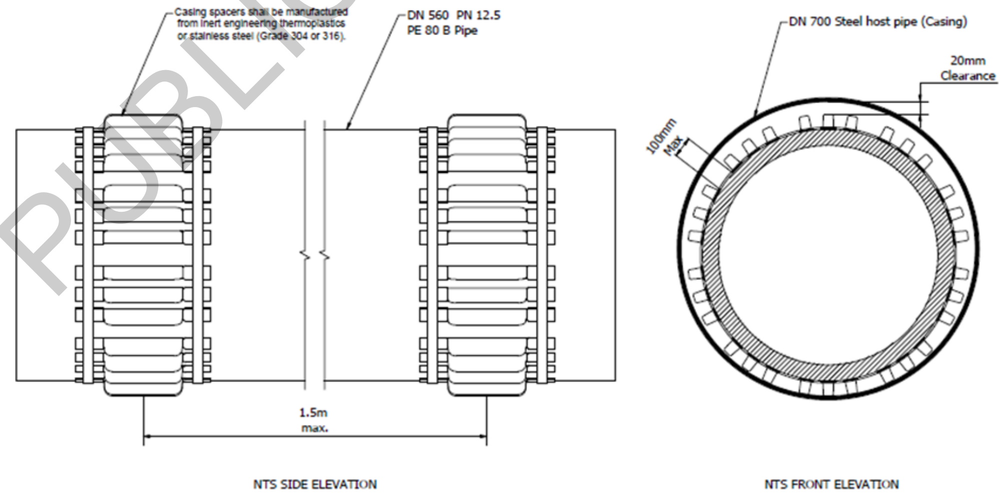


Figure X.1 Typical Installation of DN 560 PE pipes in a host pipe (Casing)

WATER SERVICES
ASSOCIATION OF AUSTRALIA

PART: 2 CONFORMITY ASSESSMENT OF PRODUCTS – OPTIONS AND SELECTION FOR THE WATER INDUSTRY

Product and Materials Information and Guidance Supplement to the Gravity Sewerage Code of Australia WSA 02—2014

CONTENTS

20 STANDARDS AND CONFORMITY ASSESSMENT

20.1 PURPOSE

The purpose of this Part is to

(a) provide additional information on product standards and specifications for products and materials.

(b) provide information regarding.

20.2 PRODUCT AND MATERIAL STANDARDS AND SPECIFICATIONS

20.2.1 Product Standard

A product Standard is a document prepared nationally, or internationally by a recognised Standards body (e.g Standards Australia, International Organisation for Standardisation (ISO), European Committee for Standardisation (CEN) or a recognised water industry body such as PIPA, WRc (UK) or AWWA (USA)). A product standard typically specifies attributes such as dimensions, materials of construction, performance requirements, production and factory quality control and testing requirements and serves as the basis for the manufacture and third-party certification of a product.

The long-term performance of pipeline systems is critical to the operating efficiency of water agencies. Product Standards play a crucial role in helping water agencies to ensure that assets are appropriately designed, constructed, maintained and rehabilitated in accordance with good risk management practices.

Most products used in the water industry are covered by an appropriate Standard. Standards may be purchased from a variety of sources including Standards Australia, Techstreet or SAI Global.

Where a suitable product standard is not available for a particular product WSAA may prepare and publish a WSAA Water Industry Standard pending publication of a suitable Australian Standard. Water Industry product standards are available from the WSAA website.

In some cases, more than one product Standard may be available for a particular product type. It is the responsibility of the Water Agency to nominate the appropriate and acceptable Standard for all products..

20.2.2 Product specifications

The purpose of product specifications is to allow purchasers to define their requirements to suppliers. A product specification generally references the applicable product Standard together with quality assurance, conformance requirements and options provided by the product standard e.g. protective coatings, pressure class, stiffness class, joint type etc.

WSAA maintains a suite of product specifications for water industry strategic products that are freely available from the WSAA website.

As specifications are subject to change, WSAA product specifications contain a document history section to allow users to ensure that the status of the specification is current before use.

In some cases, more than one WSAA product specification is available for a particular product type. e.g. Australian Standard vs ISO ductile iron pipes. It is the responsibility of the Water Agency to nominate the appropriate and acceptable product specification.

WSAA product standards and product specifications are published by the Water Services Association of Australia Inc. on the understanding that:

The Water Services Association of Australia Inc. and individual contributors are not responsible for the results of any action taken on the basis of information in the WSAA product standards and/or purchase specifications, nor any errors or omissions.

The Water Services Association of Australia Inc. and individual contributors disclaim all and any liability to any person in respect of anything, and the consequences of anything, done or omitted to be done by a person in reliance upon the whole or any part of a WSAA Water Industry Standard or Product Specification.

It should also be noted that WSAA Product Specifications have no reference to any contractual requirements or general terms and conditions that may be required by purchasers. Such contract details are the responsibility of the individual purchaser.

20.3 CONFORMITY ASSESSMENT

Conformity assessment is the process undertaken to demonstrate conformance to a product Standard. The means for demonstrating conformance involves completion of type tests and adherence to an ongoing minimum sampling and testing frequency plan. These requirements are defined in the Standard.

Assessment methods include ISO 9001 Quality Management System Certification, Product Certification, Second Party Verification, Supplier Declaration of Conformance and WSAA Appraisal. One or more of these methods may be selected.

The objective of conformity assessment is to reduce the consequences and associated costs of non-conforming product. However, the cost of conformity assessment should be balanced against the tangible and other benefits arising from its adoption.

Historically, Australian Standards included an Appendix that specified the use of a product certification scheme to demonstrate conformity with the Standard. Standards Australia has now determined that the choice of using product certification rests with the purchaser and revised Standards no longer include those requirements. Accordingly, it is now imperative that water agencies product specifications and procurement contracts clearly specify how product conformity is to be demonstrated.

20.3.1 Assessment Methods

There are a number of methods to undertake conformity assessment:

20.3.1.1 *Quality Management System certification*

ISO 9001 sets out the criteria for a manufacturer to maintain a Quality Management System. To enable the system to be certified a Conformity Assessment Body (CAB) audits the manufacturers quality systems on an annual basis to ensure compliance.

ISO 9001 certification is intended to provide confidence in a manufacturers quality system in relation to its specific manufacturing capability however does provide assurance of conformity of a particular product to a Standard.

ISO 9001 certification is generally specified by purchasers as a pre-requisite for product manufacturers.

20.3.1.2 *Product Certification*

Product certification is an impartial third-party attestation (See Clause 20.3.1.3) of product conformance to nominated Standard(s).

There are different levels of product certification from Type 1 to Type 6 defined in ISO IEC 17067. Type 5 is the most specified product certification requirement for the Australian water industry, although Type 1 and Type 3 is also sometimes specified, depending on the assessed risk of product non-conformance. Risk = consequence of failure x likelihood of failure

Type 1 requires type testing only. Type 3 requires type testing followed by periodic testing of samples from the factory. Type 5 requires type testing followed by periodic testing of samples from the factory and annual factory surveillance audits of the manufacturing process and management system.

Product certification is undertaken by a Conformity Assessment Body (CAB) accredited by a signatory member of the International Accreditation Forum (IAF) Multilateral Arrangement (MLA). In Australia, the appropriate signatory member of the IAF MLA is the Joint Accreditation System of Australia and New Zealand (JAS-ANZ).

See WSAA Technical Note WSA TN-08 for more details relating to product certification requirements. WSA TN-08 may be referenced by water agencies in regulatory and contractual agreements that involve the supply of products.

20.3.1.3 *Third-party Verification*

Third-party verification means that an independent organisation (CAB) has reviewed the manufacturing process of a product and has independently determined that the final product complies with specific standards.

20.3.1.4 *Second Party Verification*

Second party verification involves the purchaser, or its agent, auditing the supplier's manufacturing operations or inspecting finished product prior to release. For complex products, a hold point in manufacture may be specified whereby the purchaser audits or inspects the product prior to authorising continuation.

20.3.1.5 *Supplier's Declaration of Conformance*

A supplier's declaration of conformance states that the product or material complies with the specification quoted in the order or alternatively document any variations. The "supplier" may be the manufacturer or retailer of the product, depending on the distribution chain and purchasing transaction.

The Competition and Consumer Act 201 provides that a manufacturer's promotion or response to a purchaser's enquiry must not give false or misleading information.

Product certification does not permit a manufacturer or supplier to abrogate those obligations.

20.3.1.6 *WSAA Appraisal*

The WSAA Product Appraisal program is a voluntary scheme that provides a single coordinated appraisal of a product's conformity to the relevant specification. The Appraisal includes an assessment of design, attributes, performance and suitability of a product and verifies compliance with product certification and quality assurance requirements.

A WSAA Appraisal is not a product approval. Each water agency is responsible for authorisation of products for use within their area.

20.3.2 Testing Laboratories

Where tests are completed to demonstrate product conformity testing and calibration laboratories are required to be accredited to AS/NZS ISO/IEC 17025 by a signatory member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). The scope of the laboratory accreditation shall include the competencies and capabilities required to execute the product testing and calibration work to be undertaken. In Australia, the appropriate signatory member of ILAC MRA is the National Association of Testing Authorities (NATA).

APPENDIX A

ADDITIONAL INFORMATION AND DEFINITIONS

(INFORMATIVE)

A1 BEST ENVIRONMENTAL PRACTICE FOR PVC PIPES AND FITTINGS

In 2010, following an extensive review by an Expert Reference Panel, the Green Building Council of Australia (GBCA) published Green Star PVC materials credits in the Green Star rating tool. This established the criteria defining BEP PVC manufacturing from raw materials and production through use to end-of-life, recycling, and disposal.

At the time, the BEP requirements were included in the relevant Australian and New Zealand PVC product Standards. This allowed for both product certification and consistent BEP identification marking on PVC pipe and fittings products.

The requirements for BEP PVC have been consolidated in AS/NZS 5395, which can be referenced by the Australian Standards for PVC pipes and fittings.

Product/manufacturer declarations are necessary elements of the compliance process for BEP PVC. Whilst some requirements can be met by testing, there are others that are supported by supplier statements of compliance - for example, confirming the type of chlorine or vinyl chloride monomer manufacturing process employed.

Some organisations may require BEP PVC certification by an accredited third-party Conformity Assessment Body (CAB) registered with and accredited by the Joint Accreditation System of Australia and New Zealand.

AS/NZS 5395 may be used for demonstrating conformity to enable this certification.

NOTE : The background of the development of the Best Practice Guidelines for Life Cycle of PVC Building Products is given in PIPA POP106 Verification Guidance for Best Environmental Practice PVC Pipe and Fittings.

A2 FACTORS INFLUENCING SELECTION OF CONFORMITY ASSESSMENT OPTIONS

In determining the default conformity assessment requirement for a specific product, the following issues are relevant:

(a) Likelihood of manufacturing process causing a product non-conformance.

(b) Likelihood of failure of the pipeline system from a product non-conformance.

(c) Consequences of product failure.

(d) The product specification.

(e) Project magnitude / management.

(f) Innovation

RISK = CONSEQUENCE OF FAILURE x LIKELIHOOD OF FAILURE

A2.1 Likelihood of manufacturing non-conformance

Variability of product quality and the reliability of conformity assessment options are influenced by the means of production.

Where the volume of production is high, sampling plans to AS 1199 or AS 2490 may be used. Statistical sampling may not be applicable to low volume production processes or jobbing fabrications, in which case focus on process and /or personnel qualification, together with type testing, may be appropriate.

A2.2 Likelihood of failure of pipeline system from a product non-conformance

The likelihood of failure of a pipeline system from a product non-conformance depends on the nature of the non-conformance. A non-conformance of a pipe to a specified internal diameter would have little likelihood of causing to failure of a pipeline system. A non-conformance to a strength or stiffness requirement of a pipe could cause failure with low to high consequence depending on how close the particular loading was to the failure limit for the pipe / support selection i.e. standard stiffness small diameter PVC would have excess loading capacity for most installations. A non-conformance to a specified external diameter could affect joint sealing and may have a moderate to high likelihood of causing failure.

A2.3 Consequences of failure

A higher level of assurance of product compliance is required where the expected detrimental consequences of failure resulting from any non-conformance are high. The objective of conformity assessment is to reduce the likelihood of non-conformance and subsequent failure due to product design and/or manufacturing deficiency.

A2.4 Product specification

The product specification must be written such that it clearly specifies essential performance requirements, attributes and test methods. These must be specified in a manner that can be measured and objectively verified by the manufacturer and certification body.

A2.5 Project magnitude / management

For contractual and other reasons, a major or special project may require specific quality assurance provisions in lieu of the default conformity assessment options stipulated in this WSA 02 and WSAA product specifications.

A2.6 Innovative products

This WSA 02 does not nominate specifications for innovative products, even though they may have existing certification to a national or industry standard. For products undergoing trial evaluations, a Water Agency may be prepared to accept or manage a (temporary) higher level of risk.

Each agency should be responsible for stating its own conformity assessment requirements for innovative products.

A3 SELECTING THE CONFORMITY ASSESSMENT OPTION

Selection of the appropriate conformity assessment option for products is made after considering the factors outlined above.

A3.1 Type 1

Type 1 product certification should be nominated where:

(a) the likelihood of the manufacturing process causing a non-conformance is low, e.g. fully automated manufacturing and control, and manufacturing quantity is small; and/or

(b) the consequences of failure are low; and/or

(c) the likelihood of failure is low.

Examples of products for which Type 1 product certification is applicable are non-detectable marking tapes and maintenance hole covers in non-trafficable areas.

For a product normally used in situations where failure would result in moderate consequences of failure or where the likelihood of failure is moderate, Type 1 may be specified in conjunction with an ISO 9001 quality management system certification if Type 3 is not practicable.

A3.2 Type 3

Type 3 product certification should be nominated where:

(a) the likelihood of manufacturing processes causing a non-conformance is moderate to high and statistical sampling plans are not practicable e.g. a minor degree of manual input to manufacturing; and/or

(b) the consequences of failure are moderate; and/or

(c) the likelihood of failure is moderate.

Examples of products for which Type 3 product certification is applicable are valve chambers and maintenance hole covers in trafficable areas.

The frequency of CAB surveillance audits should be increased to match an increase in the likelihood of manufacturing non-conformances or increased risk of failure. Type 3 may be specified in conjunction with an ISO 9001 quality management system certification if Type 5 is not practicable.

A3.3 Type 5

Type 5 product certification should be nominated where:

(a) the likelihood of manufacturing processes causing non-conformance on a large scale and with consistent repetition is high, i.e. mass produced product; and /or

(b) the consequences of failure are high; and/or

(c) the likelihood of failure is high.

Examples of products for which Type 5 product certification is applicable are certain flow control valves and buried pipes and fittings (excepting special low volume products).

For pipes made by batch processes or complex or speciality products, Types 1 or 3 plus ISO 9001 quality management system certification may alternatively be specified.

Type 5 is specified where the risk of failure is high. It is commonly adopted for mass-produced, critical products such as pipes, fittings and valves. However, it may not be practicable for batch processes or complex or speciality products; for these, Types 1 or 3 plus ISO 9001 quality management system certification may be more appropriate.

A3.4 ISO 9001 quality management system certification

ISO 9001 quality management system certification is generally nominated where the expected consequence and likelihood of non-conformance is moderate or, for high risk products, where product certification is not practicable. This is typically where there may be many design changes (e.g. concrete) or for low volume, speciality products (e.g. fabricated GRP fittings) or where the specification does not adequately specify objective performance criteria.

Where WSAA Product Specifications mandates an ISO 9001 quality management system certification as a means of assuring product quality, the scope of the certification is required to be focused and relevant to the product. Typically this requires the certificate issued by the CAB to specifically state the product type or process by which the product is produced (e.g. manufacture and supply of concrete, to AS 1379.)

An ISO 9001 management system certification generally does not reference a product standard or specification; however, for the above example, reference to AS 1379 in the scope is appropriate since AS 1379 is process oriented.

A3.5 Supplier's declaration of conformance

A supplier's declaration of conformance should be required for all products.

Purchasers are expected to seek the supplier's declaration that product supplied against a purchase order complies with the nominated specification.

A3.6 Second party verification

A salient objective of third party (CABs) system or product certification is to minimise the intervention of second parties (purchasers) in the supplier's production operations. Second party auditing at the suppliers works may, however, be appropriate for low volume fabricated items and may be used in conjunction with ISO 9001 management system certification. This option may be an overriding option for the purchaser should product quality problems be identified during the supply. The Water Agency or Designer may determine the need for second party verification and specify this in the project contract documentation.

A4 THE STANDARDS AND CONFORMANCE INFRASTRUCTURE OF AUSTRALIA

In Australia, the following bodies make up the standards and conformance infrastructure:

(a) The National Measurement Institute (NMI), which maintains and disseminates the national standard of physical measurement, and ensures Australia's measurement standards are at a level comparable to those of its major trading partners.

(b) Standards Australia, an independent, not-for-profit national standards development body.

(c) The National Association of Testing Authorities (NATA), an independent, not-for-profit national accreditor of laboratories and testing facilities and inspection bodies.

(d) The Joint Accreditation System of Australia and New Zealand (JAS-ANZ), a bi-national government accreditation authority for certification and inspection bodies and other related bodies.

Each component of Australia's standards and conformance infrastructure has a key role to play, and the resulting enhancement will contribute to greater economic prosperity for Australia and the health, safety, and wellbeing of all Australians.

For further information on Australian standards an conformance infrastructure in the regional and international framework refer to https://www.industry.gov.au/trade/australias-standards-and-conformance-infrastructure.

A4.2 National Measurement Institute

The NMI is responsible for Australia's national infrastructure in terms of physical, chemical, biological, and legal measurements. Under the National Measurement Act 1960, the NMI is responsible for coordinating Australia's national measurement system and for establishing, maintaining, and realising Australia's units and standards of measurement which, in turn, provide measurement traceability.

More information about the NMI is available on the following website: www.measurement.gov.au

A4.3 Standards Australia

Standards Australia is recognised by governments as Australia's peak voluntary standards body. It coordinates standards development activities (referred to as 'standardisation'), develops internationally – aligned Australian Standards for public benefit and in the national interest, and facilitates the accreditation of other standards development organisations.

From the perspective of the construction industry, conformity assessment and the standards and conformance infrastructure bodies that underpin it – provide a high degree of confidence in the products used and the services delivered.

More information about SA is available on the following website: www.standards.org.au

A4.4 Joint Accreditation System of Australia and New Zealand

JAS–ANZ is the government–appointed accreditation body for Australia and New Zealand, which is responsible and inspections. JAS–ANZ accreditation is built upon a competency-based assessment process and provides confidence in CAB's capability to deliver reliable certification and inspection services.

More information about JAS-ANZ is available on the following website: www.jas–anz.org

A4.5 National Association of Testing Authorities

NATA is recognised by governments as Australia's national authority for the accreditation of laboratories and reference material producers. NATA is also recognised as a peak body for the accreditation of inspection bodies and proficiency testing scheme providers. NATA accreditation is based on a process for peer assessment of a facility's competence and its capability to produce reliable data from tests, measurements, inspections and related services.

NATA provides specific guidance on working with NATA accredited building product laboratories in the form of Industry User Guide No 4 for building products

More information about NATA is available on the following website: www.nata.com.au

A5 INNOVATIVE PRODUCTS AND MATERIALS

Innovative products are deemed to be those for which a recorded history of successful performance under a range of Australian installation and operating conditions is not available and for which a default or alternative specification is not included in WSAA Codes.

A6 RESPONSIBILITIES

A6.1 Water Agency

Each Water Agency should be responsible for nominating variations to the default product specifications and conformity assessment requirements.

A6.2 Designer

Except where a project or Agency agreement or specification states otherwise, the Designer should be deemed responsible for selecting the most appropriate / suitable products. In some cases, products may have to be authorised by the Water Agency.

Product requirements, including attributes such as protective coating, pressure and/or stiffness class, joint type etc should be stated in the Design Drawings and/or Specification.

A6.3 Constructor

Constructors should use only such products that are nominated in the Specification and Design Drawings.

A6.4 Purchaser

Unless otherwise specified by the Water Agency, the default product specifications listed on the WSAA website should be used for specifying product requirements.

The purchaser should be responsible for obtaining the supplier's declaration that products conform to purchase specifications.

> The Constructor is frequently the "purchaser" of products.
>
> Where third party certification is specified, the conformity assessment body is deemed to be responsible for licensing the manufacturer (or the Licensee) to use the certification body's mark and ensuring correct use of the mark.
>
> The supplier may or may not be the manufacturer of the product.

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