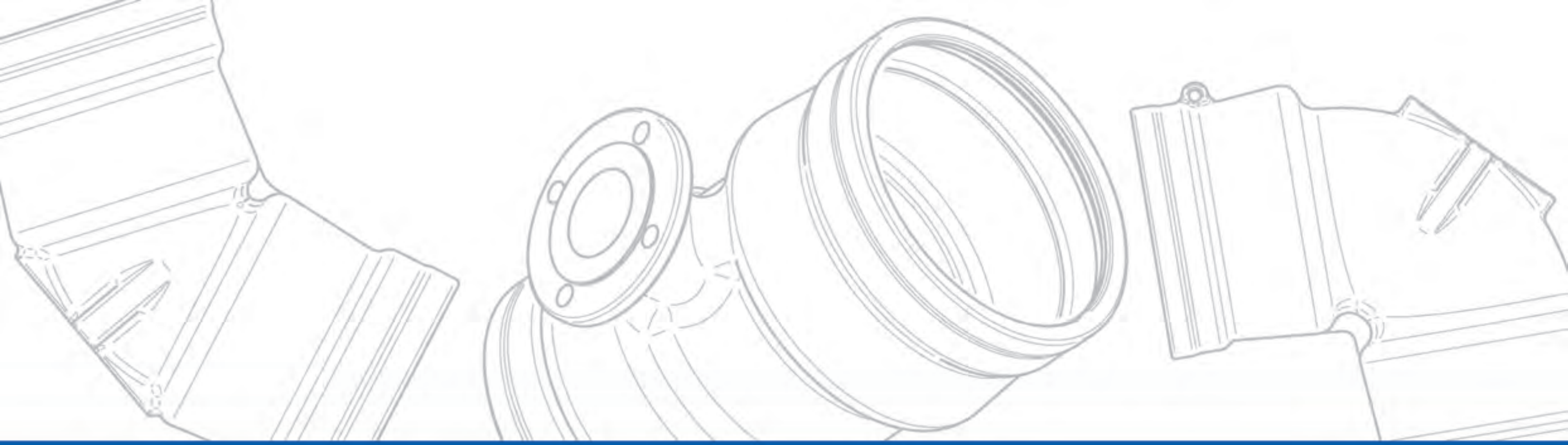
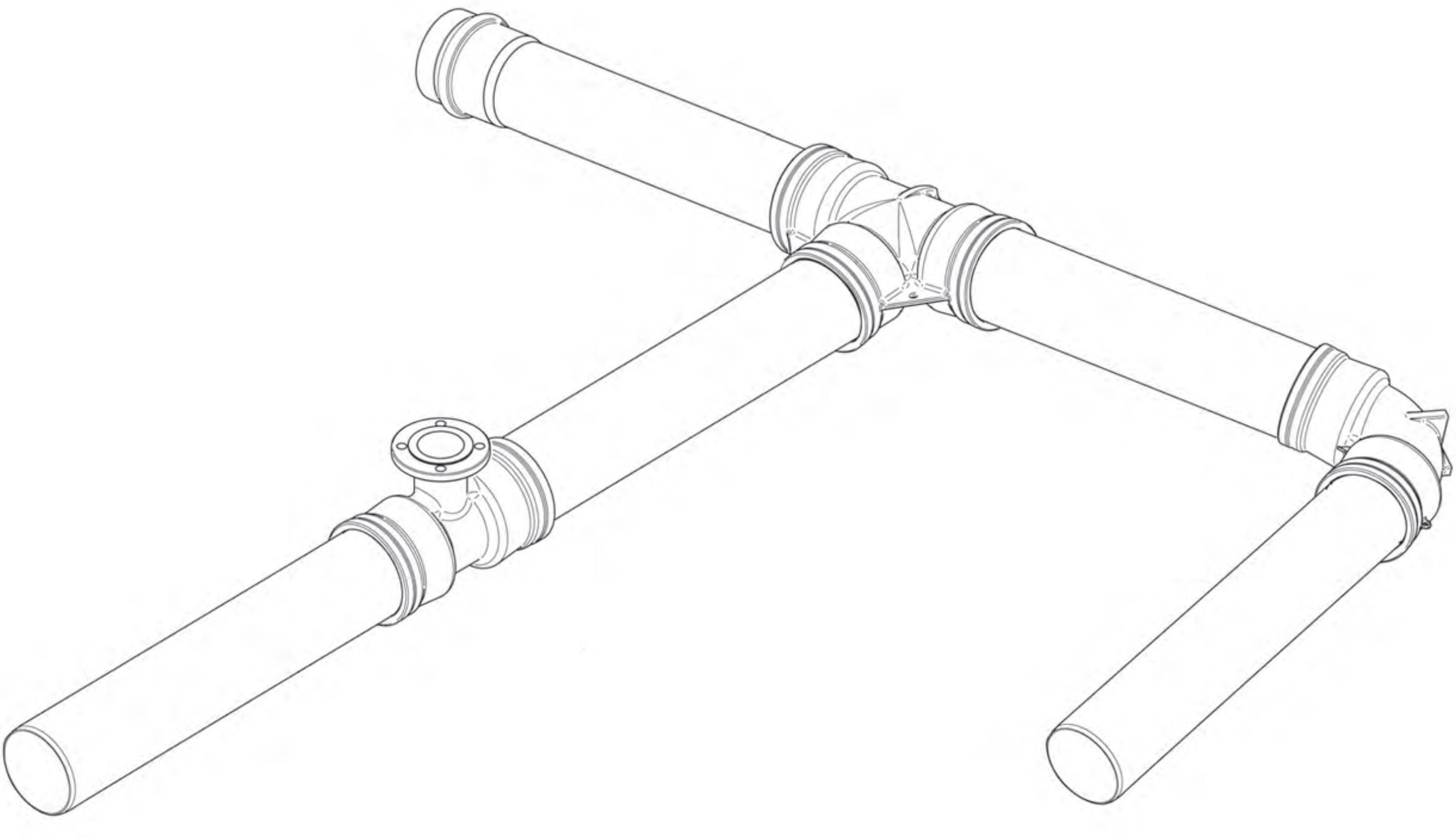


ENGINEERING DESIGN AND INSTALLATION GUIDE

ApolloBLUE™ PREMIUM
Bi-axially Oriented PVC (PVC-O) Pressure Pipes



iPLEX Pipelines

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1.1 Introduction

Iplex ApolloBLUE™ Premium is a bi-axially oriented PVC pressure pipe for use in water supply infrastructure. Iplex manufactures the pipe using two new processes known as Biax Extrusion and Super Socketing, both of which are patented. This method of production, results in an exceptionally tough, high performance thermoplastic pipe with greatly enhanced physical characteristics, including greater impact resistance, higher ductility, improved fatigue resistance and reduced weight when compared with other PVC pipes. ApolloBLUE™ also provides increased hydraulic capacity due to its exceptionally smooth and enlarged bore.

1.2 Origin of ApolloBLUE™ Premium

Yorkshire Imperial Plastics in the United Kingdom, first developed oriented PVC pipe manufacture during the 1970s. It was found that by orienting the molecular structure of an extruded PVC material in the circumferential direction in a pipe wall, at elevated temperatures, there was a marked improvement in its physical properties, especially hoop strength.

Over the last seven years Wavin UK has carried out further developments. Their latest process uses biaxial orientation, which is a combination of radial and longitudinal expansion to enhance the overall pipe performance. Due to a technology sharing arrangement, Iplex is now in a position to introduce this more advanced technology to the Australian market.

1.3 Applications

ApolloBLUE™, ApolloCREAM and ApolloPURPLE pressure pipes are suitable for a range of buried applications including: -

- Major potable water supply trunk and reticulation mains
- Industrial process pipelines
- Recycled water pipelines
- Effluent pipelines for pumped sewage, industrial and rural wastes
- Slurry pipelines carrying corrosive mine waste water
- Irrigation and turf watering systems

1.4 Processing for molecular orientation

PVC polymer molecules are extremely long, resembling long intertwined woolen threads with their shape comparable to balls of wool. They form the building blocks of the pipe.

Figure 1.1: Short piece of a polymer molecule.

Figure 1.1 shows a model of a polymer molecule, which on stretching would start to straighten but ultimately further stretching would result in rupture. When a polymeric pipe is extruded in the traditional way a more or less spherical shaped molecular structure results. If the pressure capability is to be increased the pipe wall has to contain more building blocks (i.e. molecules) in the direction of the principle stress. Normally for higher design pressures, the wall of the pipe is made thicker to incorporate these additional building blocks.

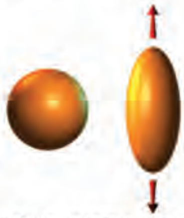


Figure 1.2: The diameter of the sphere decreases when stretched.

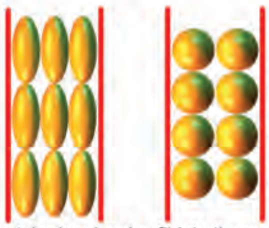


Figure 1.3: More stretched molecules fit into the same wall thickness of the pipe.

By stretching the pipe in the correct way, the spherical polymer molecules are reshaped or oriented in the longitudinal direction. Because the cross section has become smaller, more molecules fit into the same pipe wall (Figure 1.3) and are able to withstand a greater stress.

Figure 1.4: Iplex uses the latest technology for the manufacture of ApolloBLUE™ Premium pipe

1.5 Biaxial orientation

Biaxially oriented or drawn pipe is where both pipe circumference and length are extended after extrusion. In practice the "pre-form" pipe diameter is increased from 25 to 100% and its length from 0 to 30% with corresponding reductions in wall thickness. Strength enhancement is achieved by drawing to elongate the PVC molecules, realigning them into the preferred directions.

If pipe stretching were done immediately behind the die-head where the temperature is approximately 190°C there would be no beneficial effect. The stretching process must take place at a temperature level where the PVC molecules can be distorted, but still low enough to freeze them immediately, so as to keep their oriented shape. In other words drawing takes place at the lowest temperature possible, just above the molecular freezing point of about 85°C for PVC, to ensure the orientation remains permanent.

An additional benefit of this process is the exceptionally smooth pipe bore which results from the "finishing" of the pipe bore as it is pulled over the polished steel expansion cone.

Figure 1.5: Wall cross-section of " pre-form" pipe with a small diameter and a large wall thickness being stretched circumferentially and axially into a pipe with larger diameter and a thinner wall.

1.6 Advantages of ApolloBLUE™ Premium

The increase in strength, toughness and ductility of biaxially oriented PVC permits the use of higher design stresses with improved overall performance.

The resulting larger bore reduces pumping costs. Alternatively, for the same head there is a greater flow carrying capacity than would be the case for the equivalent PVC-U or PVC-M pipe.

Some of the advantages are summarised in Table 1.1.

Table 1.1: Features and benefits of ApolloBLUE™ Premium

Features	Benefits
A full range of Series 2 diameters.	Outside diameters are compatible with the majority of installed water mains such as AC, CI, DI, GRP and PVC.
Increased internal diameter and smooth bore.	Lower flow resistances compared with traditional pipe systems giving the possibility of lower pumping costs.
Increased pipe stiffness.	Pipe stiffness has been optimised to withstand both diametral and axial loadings together with internal vacuum and full field service tapping capability.
Exceptional toughness and ductility.	Resists accidental impact during handling and installation.
Resistance to crack propagation.	Provides extended fatigue resistance.
Excellent internal and external resistance to corrosion.	No corrosion protection, such as poly sleeving is required. Ensures a service life in excess of 100 years.
A factory fitted, EPDM jointing gasket with a blue coloured polypropylene-retaining ring.	Eliminates potential installation errors due to insertion of the wrong ring and requires minimal jointing force when making the joint.
Light weight.	For ease of handling and laying.

2.1 Materials properties

The general physical properties of ApolloBLUE™ Premium are given in Table 2.1.

Table 2.1: Physical properties

Property	Value
Physical and mechanical	
Specific gravity	1.42
PVC resin minimum K value (ISO 1628-2)	64
Effect on potable water - AS/NZS 4020	Complies
Overall service (design) coefficient 'C'	1.6
Pipe class 'PN'	12.5 or 16
Material type (AS/NZS 4441)	355 or 450
Minimum required strength 'MRS' at 20°C extrapolated to 50 years representing the 97.5% lower predicted limit	35.5 or 45 MPa
Pipe series (Refer ISO 3)	18
Standard dimension ratio 'SDR'	37.0
Hydrostatic design stress 'σ_s'	22 or 28 MPa
Flexural ring modulus, initial (refer ISO 9969 test)	4200 MPa
Creep ratio, 2 year (refer ISO 9967 test)	2.38
Flexural ring modulus (2 year)	1700 MPa
Flexural ring modulus (50 year)	1400 MPa
Poisson's ratio	0. 45
Thermal	
Coefficient of linear thermal expansion	70 x 10^{-6} per degree celsius
Thermal conductivity	0.138 W/m.K
Specific heat	1045 J/kg.K
Maximum working temperature	50°C
Fire resistance (using data from tests on PVC-U of similar composition)	
Flammability	Will not support combustion
Ignitability - AS 1530.3*	7
Smoke development - AS 1530.3*	9
Spread of flame - AS 1530.3*	0
Heat evolved - AS 1530.3*	2
* AWTA TEST REPORT 7-558803-CV	
Electrical	
Volume resistivity	10^{16} ohm.cm (60% RH)
Surface resistivity	10^{13} - 10^{14} ohm
Power factor	0.015 - 0.020 at 20°C
Dielectric constant	3.4 - 3.6 at 25°C (60 Hz)

2.2 Sustainability

ApolloBLUE™ pipe is a sustainable infrastructure pressure pipeline. It has low embodied energy, can utilize re-processible PVC from its manufacture and is fully recyclable at the end of its service life.

ApolloBLUE™ pipes are lightweight and as result require less non-renewable energy (e.g.diesel) during transportation. The lightweight ApolloBLUE™ pipes also allows the production of more length of pipe per tonne of raw material, compared with almost any other pressure pipe of similar diameter and pressure class.

Iplex ApolloBLUE™ pipes do not contain any compounds based on lead, cadmium or mercury. This actively prevents more of these compounds from entering the environment and positively reduces industry demand for these compounds upstream of the manufacturing process.

ApolloBLUE™ is chemically inert. There is no corrosion or chemical or gas emissions during its normal service life as a public water main or sewer.

ApolloBLUE™ pipe does not require any further application of protective coatings or sealing compounds, which are known to liberate volatile organic compounds to atmosphere.

ApolloBLUE™ is also very durable enabling a one off energy consumption in the manufacture of the pipe asset. This is only required once in its anticipated 100 year service life, if installed and operated to the relevant codes and standards.

For further information refer to the PIPA website, www.pipa.com.au/environment.

2.3 Temperature effect

ApolloBLUE™ pipes are suitable for service temperatures ranging from 0°C and 50°C. For temperatures above 20°C provision must be made for pressure re-rating in accordance with Table 2.2. These re-rating factors are the same used for PVC-M or PVC-U.

*Table 2.2: Thermal re-rating factors**

Maximum service temperature (°C)	Multiplication factor for pressure re-rating
20	1.00
25	0.94
30	0.87
35	0.78
40	0.70
45	0.64
50	0.58

*Based on ISO 4422-2 Pipes and fittings made of un-plasticized polyvinyl chloride (PVC-U) for water supply Part 2: Pipes (with or without integral sockets)

2.4 Chemical resistance

Resistance of PVC-O pipe and elastomeric seals to reaction with or attack by the chemical agents listed in the "Chemical Resistance Guide" has been determined by research, investigation and reference to data from international and local sources.

Information provided is intended as a guide only. Due to the complexity of some organochemical reactions, it is suggested that in critical applications, additional long-term testing be performed.

Data provided should not necessarily be regarded as applicable to all exposure durations, concentrations and working conditions likely to be encountered.

PVC has exceptional resistance to attack from high concentrations of alkalis and acids, except for strong oxidising agents at maximum or near maximum concentrations. The material is not recommended for use with aromatic and chlorinated hydrocarbons, ketones, esters and ethers.

For further information and chemical resistance charts refer to the Chemical Resistance Guide on the Iplex Website www.iplex.com.au in design tools.

3.1 Standards and testing

ApolloBLUE™ Premium pipes and associated materials are manufactured to relevant Australian Standards under third party accredited quality assurance programs complying with AS/NZS ISO 9001.

3.2 Pipe

ApolloBLUE™ Premium pipes and associated materials are manufactured to AS/NZS 4441 "Oriented PVC (PVC-O) pipe for pressure applications" under third party accredited quality assurance programs complying with AS/NZS ISO 9001.

The StandardsMark Certification Number is SMKP20188.

3.3 Colour and Markings

To readily distinguish between pipeline applications, ApolloBLUE™ pipes are colour coded.

ApolloBLUE™ pipes for drinking water applications are blue in colour. Alternative colours such as purple for recycled water and cream for sewerage rising mains can be supplied.

Figure 3.1: A combined trench installation using blue DN100 and purple DN150 ApolloBLUE™ for a dual water supply at Bamera, South Australia

3.4 BLUEseal gaskets

The BLUEseal joint is a spigot and socket joint comprising of the Forsheda EPDM rubber gasket moulded onto a distinctive blue polypropylene-retaining ring. These gaskets are normally supplied factory fitted in the pipe sockets but are also designed for field installation where necessary.

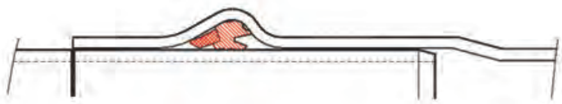


Figure 3.2: Cross section of the BLUEseal Joint

The gaskets comply with, BS EN 681 and have a UK Kitemark.

Parts 1 and 3 of AS/NZS 1646 "Elastomeric seals for waterworks purposes" takes cognizance of BS EN681.

Test regimes used to certify the BLUEseal joint include those of ISO 13846 for pressure, ISO 13844 for vacuum performance and AS/NZS 4020 for drinking water applications.

Figure 3.3: ApolloBLUE™ pipes are supplied with factory fitted elastomeric seals. (However in the event of damage it is possible to insert a replacement)

3.5 Product codes

The product computer identification codes used by Iplex Pipelines for ApolloBLUE™ are given in the following Table 3.1 and are of the form;

"AAAA(A)BBCCC(D)"

The brackets indicate the symbol is used only where required.

Table 3.1 Pipe product codes

Product description and code AAAA(A)		Pressure class		Nominal diameter		Pipe effective length	
		PN	Code "BB"	DN	Code "CCC"	(m)	Code "(D)"
Blue ApolloBLUE™	PDRA	12.5	12	100	100	3	C
				150	150		
Purple ApolloPURPLE	PDRAL	16	16	200	200	6	-
				225	225		
Cream ApolloCREAM	PDRAC			250	250		
				300	300		

Examples:

The code for a DN200 ApolloBLUE™ pressure pipe with BLUEseal joint and in (non stock standard) 3 m nominal lengths is:

"PDRA16200C"

The code for a DN150 ApolloBLUE™ "Purple" recycled water pressure pipe with BLUEseal joint and in standard 6 m nominal lengths is:

"PDRAL16150"

Table 3.2 - Product codes for lubricants

Container size (grams)	Product code	
	Iplex standard lubricant	Iplex Plus* (Bactericidal)
500	JLO10500	JLB10500
1000	JLO11000	JLB11000
4000	JLO14000	JLB14000

* This product is accredited under the WaterMark Scheme to technical specification ATS 5200.014, licence No: WMKA00103.

4.1 Pipe dimensions

The ApolloBLUE™ range of pipes are available in Series 2 only with either material type 355 or 450 which relates to PN 12.5 or PN 16 respectively.

Pipes are manufactured in accordance with AS/NZS 4441 and design coefficient C=1.6.

Table 4.1 – ApolloBLUE™ Premium pipe dimensions

Nominal diameter DN	Nominal outside diameter dn	Nominal thickness en	Nominal internal diameter ID	Distance for witness mark from pipe end	Chamfer length (10 -15 degree angle)
100	121.7	3.4	114.9	146	6
150	177.1	4.9	167.9	165	9
200	231.9	6.4	219.1	186	12
225	258.9	7.1	244.7	200	13
250	285.8	7.9	270.0	208	14
300	344.9	9.5	325.9	218	17

Note:
1. *All dimensions are in millimeters*
2. *Outside diameter is also the minimum mean*
3. *Nominal internal diameter ID = dn – 2 x en*
4. *The standard length of all pipes is 6 m + 15, -0 mm*

4.2 Ductile iron fittings

Conventional socketed fittings complying with AS/NZS 2280 – "Ductile Iron Pressure Pipes and Fittings" and WSAA TN2 are recommended for use with ApolloBLUE™ Series 2 pressure pipes.

A complete range of bends, tees, reducers and flange-spigot pieces are available from Iplex with rubber ring sockets in sizes DN100 to DN300.

Ductile iron fittings can be protected from corrosion with the following:-

- Polymeric coating (preferred)
- Cement lining and polyethylene wrap
- Epoxy coating

All standard ductile iron fittings supplied by Iplex have both an internal and external polymeric coating.

4.3 Ductile iron fittings dimension table

Ductile iron fittings used with ApolloBLUE™ pipes should be manufactured with socket lengths equal to or greater than the dimensions given in Table 4.2.

These dimensions are necessary to allow for Poisson's contraction when fully pressurised to class head.

Where a flange connection is required a flange-socket adaptor may be used.

Table 4.2 - Ductile iron sockets – joint configuration (AS/NZS 2280)

Nominal diameter DN	Minimum insertion depth (mm)	Typical chamfer length (mm)	Allowable joint deflection (degrees)
100	42	10	3.5
150	50	10	3.5
200	58	10	3.5
225	62	10	3.5
250	66	10	3.5
300	71	10	2.5

Reference: WSAA TN2 Issue 2 "Guidelines for the use of ductile iron elastomeric joint fittings with plastic pipes"

Figure 4.1: Typical polymeric coated ductile iron socketed bend

Figure 4.2: Polymeric coated DI hydrant tee – note witness mark on the ApolloBLUE™ pipe spigot to ensure full insertion is achieved when joining.

5.1 Flow capacity

The capacity of a pipeline can vary due to various factors, which include:

- Growth of slime, which will vary with the age of the pipeline and available nutrient in the water.
- Roughening, due to the wear by abrasive solids.
- Siltation or settlement of suspended particulate matter.
- Joint imperfections/fitting types and configurations

To assist the designer in selecting the appropriate diameter, a flow resistance chart covering both PN12.5 and PN16 pressure classes has been provided in Figure 5.2. The flow resistance chart relates friction loss to discharge and velocity for pipes running full and has been calculated using the Colebrook-White transition equation.

$$V = -2\sqrt{2gdS}\log\left(\frac{k}{3.7d}+\frac{2.51\nu}{d\sqrt{2gdS}}\right)$$

where:

V = mean velocity (m/s)
g = acceleration due to gravity (m/s^2)
d = pipe internal diameter (m)
S = hydraulic gradient (m/m)
k = equivalent hydraulic roughness (m)
ν = kinematic viscosity (m^2/s)

The Colebrook-White transition equation takes into account the variation of viscosity with temperature and pipe roughness and is recognized as being the most accurate in general use, but requires iterative solutions.

The flow resistance chart in Figure 5.2 has been prepared based on a temperature of 20° C which corresponds to a kinematic viscosity for water ν = 1.01 x 10^{-6} m^2/s and equivalent pipe wall roughness co-efficient, k = 0.003 x 10^{-3} m.

This value of the equivalent roughness coefficient "k" assumes the ApolloBLUE™ pipeline is straight, clean and concentrically jointed without fittings. Possible values ranging between 0.003 to 0.015 mm are given in AS 2200 "Design Charts for Water Supply and Sewerage" for PVC. An approximate allowance for the effect of variation in water temperature can be made by increasing the chart value of the head loss by 1% for each 3° C below 20° C and decreasing it by 1% for each 3° C in excess of 20°.

The hydraulic performance of a pipeline may be adversely affected if combined air release and anti-vacuum valves are not installed at local high points in each section of a pipeline, with a maximum spacing not exceeding 500m. These are required to maintain full bore flow and limit the occurrence of sub atmospheric conditions.

The Iplex web site www.iplex.com.au also has a flow calculator, which provides a quick means of determining the flow for other conduits.

5.2 Pressure class selection

The *nominal* pressure rating of ApolloBLUE™ pressure pipe is either 1250 kPa or 1600 kPa. The rated pressure should not be exceeded at any location in the pipeline by the maximum operating pressure including water hammer pressure surcharges. Where the pipeline will be operating at elevated temperatures that are higher than 20°C, the nominal rating should be multiplied by the re-rating factor for that temperature as provided in Table 2.2.

Fatigue and structural considerations should also be considered when selecting the pipe class. For example surge pressures commonly known as 'water hammer' must be considered when selecting the pipe class.

ApolloBLUE™ pipes are manufactured with a minimum pipe stiffness of not less than 9000 N/m.m, which is greater than the recommended minimum for pipelines under full vacuum conditions without external soil support. The factor of safety for buried pipelines, fully embedded in a properly compacted non-cohesive material (such as sand or gravel) will therefore be even greater.

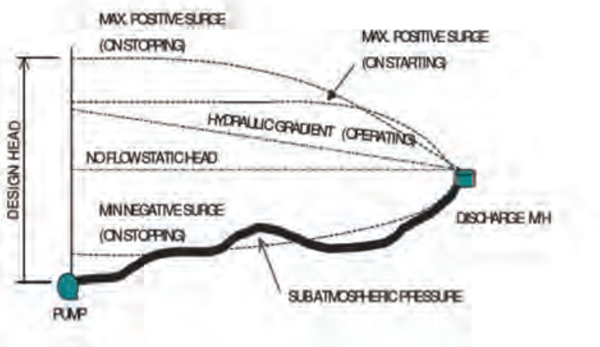
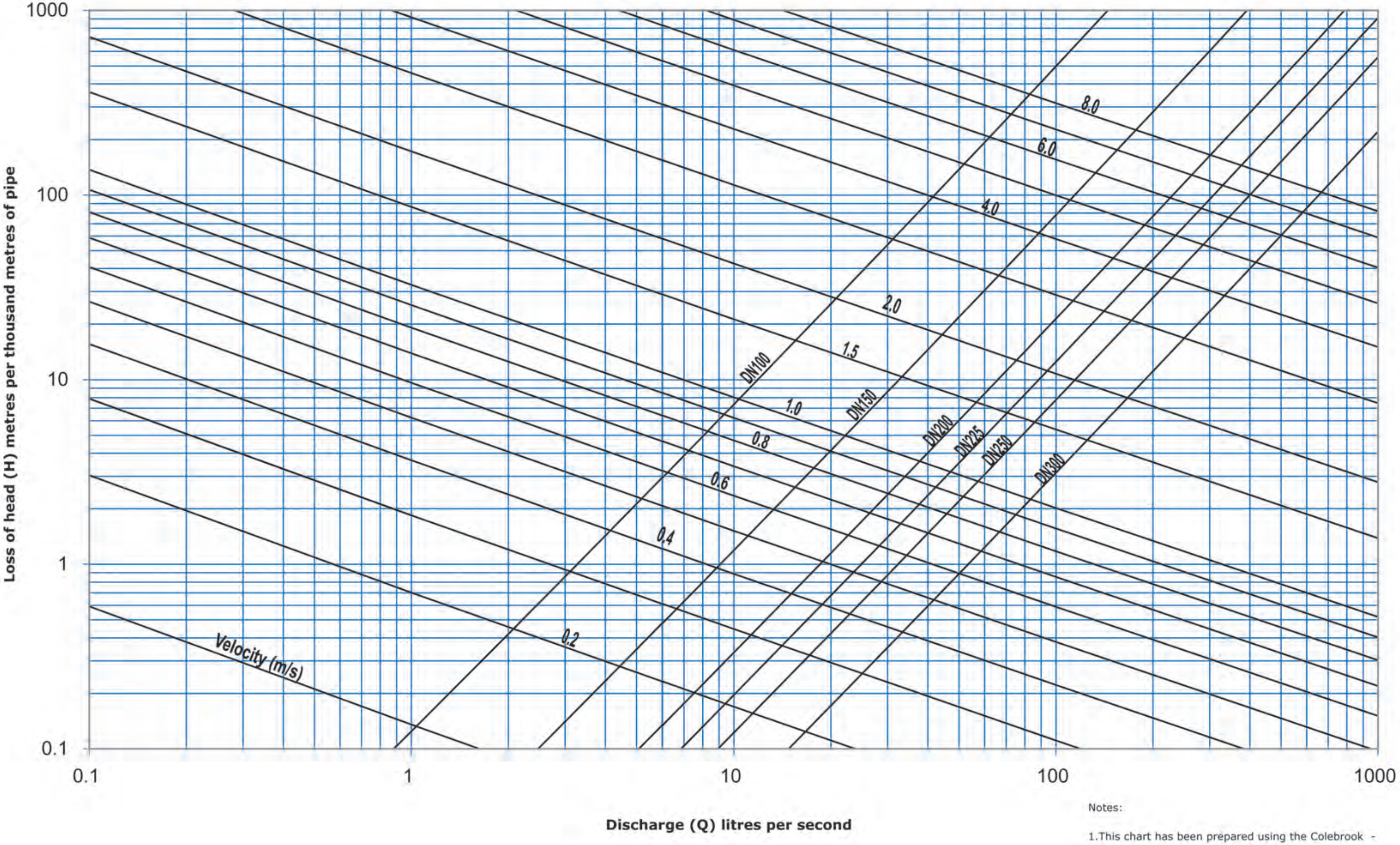


Figure 5.1 - Typical hydraulic grades and surge envelopes required for design

Figure 5.2: Flow resistance chart – ApolloBLUE Premium PVC-O (Series 2)



Notes:

1.This chart has been prepared using the Colebrook - White Formula with a roughness co-efficient k=0.003mm

2.This chart has been calculated for the viscosity of water at 20 C

5.3 Water hammer surges and cyclical effects

Water hammer effects in thermoplastic materials are considerably reduced compared with iron, steel and concrete due to the much lower modulus of elasticity. Typical values for celerity for ApolloBLUE™ and DI are shown in Table 5.1.

Table 5.1 - Water hammer celerity comparison (at 20 degrees C)

Material	Approximate celerity (m/s)
PVC-O	340
DI	1150

ApolloBLUE™ has predictable characteristics with respect to fatigue under cyclical pressures. To eliminate risk of fatigue failure the designer should take into account the frequency of pressure fluctuations during the service life of the pipeline, which may be in excess of 100 years. This can be achieved by ensuring that the amplitude of the surge (i.e. the difference between the maximum and minimum steady state operating pressures including persistent water hammer effects, when divided by the load factor given in Table 5.2, does not exceed the nominal pressure rating of the pipe.

In practice the pressure changes in water reticulation systems are seldom of sufficient amplitude and frequency for fatigue to affect pipe class selection, but they can be an important consideration for sewer rising mains. The amplitude will be the difference in the hydraulic gradients, when the pump is running and when the pump is stopped.

The frequency is defined as the number of combined pump start and stop cycles. If an allowance is considered necessary to allow for attenuation of water hammer oscillations the frequency can then be taken as being twice the number of start/ stop cycles. (It can be shown mathematically that this is appropriate for the exponential decay typical of pressure surge oscillations).

The dynamic fatigue consideration requires a pipe to be selected with a pressure rating which, when multiplied by the fatigue factor, will give a value greater than the pressure range.

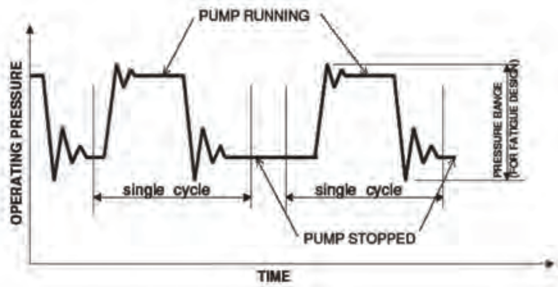


Figure 5.3 - Inputs for fatigue design – pressure range ("amplitude") and frequency

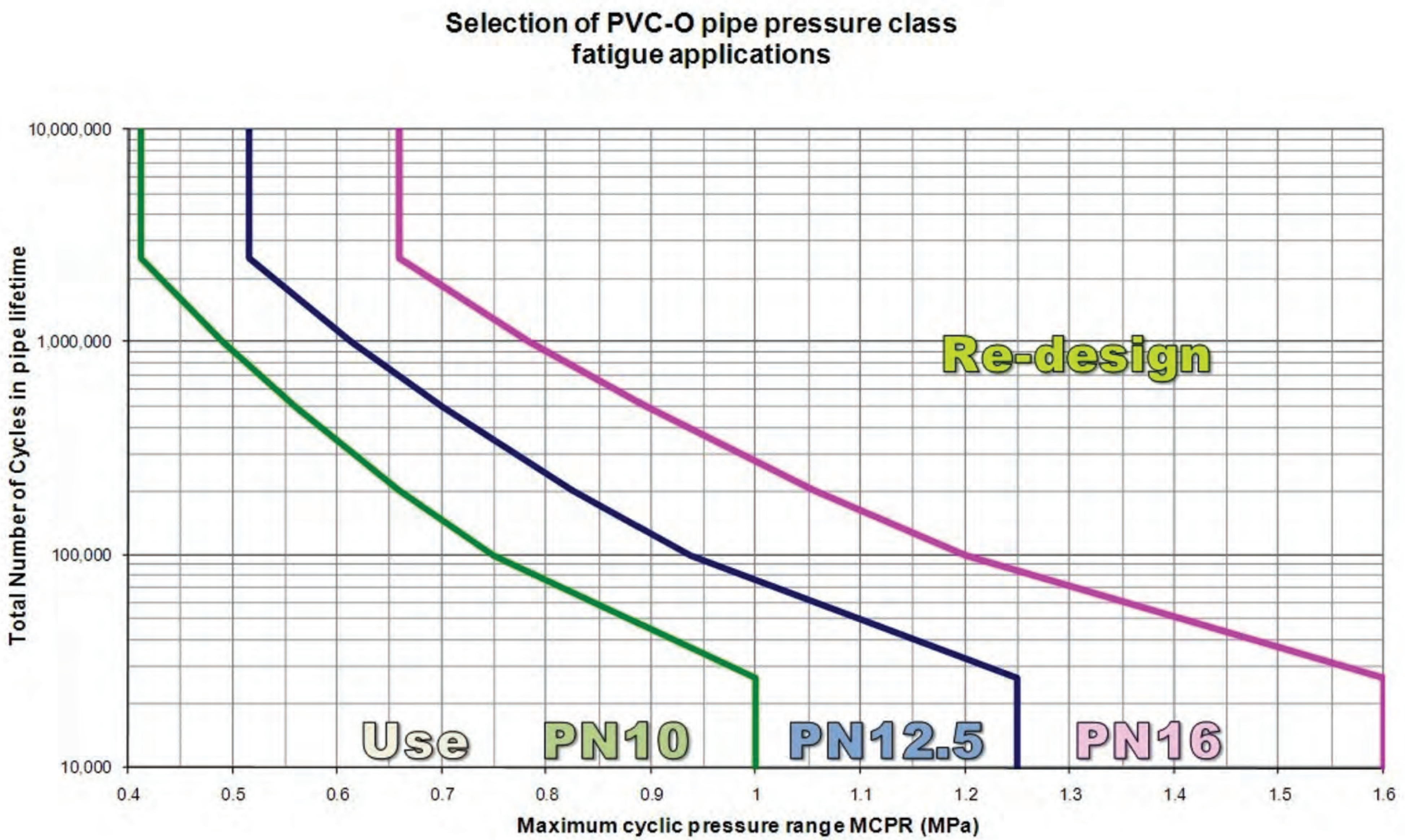
ApolloBLUE™ PN16 has a pressure rating of 160 metres. If a pipeline is proposed which is estimated to be subject to say 2.5 million cycles over its entire service life, Table 5.2 gives a fatigue load factor of 0.41. Therefore an ApolloBLUE™ PN16 pipeline is suitable for a fluctuating pressure range of up to 160 x 0.41 = 65.6 metres. (Alternatively Figure 5.4 could be used to directly determine the appropriate class)

Table 5.2 - Fatigue load factors for different PVC materials

Total number of cycles over 100 years	Approx. no. cycles per day for 100y life	Fatigue cycle load factors		
		PVC-U	PVC-M	ApolloBLUE™ PVC-O
26,400	1	1.00	1.00	1.00
100,000	3	1.00	0.67	0.75
200,000	5.5	0.81	0.54	0.66
500,000	14	0.62	0.41	0.56
1,000,000	27	0.50	0.33	0.49
2,500,000	82	0.38	0.25	0.41
5,000,000	137	0.38	0.25	0.41
10,000,000	274	0.38	0.25	0.41

Reference: PIPA Industry Guidelines "PVC Pressure Pipes, Design for Dynamic Stresses" Issue 1.3 POP101

Figure 5.4 Fatigue loading



6.1 Allowable cover heights

In engineering terminology, ApolloBLUE™ pipes are considered to be "flexible" pipes, therefore when buried they are designed to deform or deflect diametrically within specified limits without structural damage.

The external soil and live loadings above flexible pipes may cause a decrease in the vertical diameter and an increase in the horizontal diameter of the pipe. The horizontal movement of the pipe walls in the soil material at the sides develops a passive resistance within the soil to support the external load. That is, the pipeline performance is influenced by the soil type, density and height of water table. The higher the effective soil modulus at pipe depth, the less the pipe will deflect. Long-term deflections of up to 7.5% are permissible and will not affect the pressure rating of the pipe or the leak tightness of the BLUEseal rubber ring joint.

A complete design procedure is available for ApolloBLUE™ pipes. Consult Iplex for further details or refer to AS/NZS 2566.1 "Buried flexible pipelines Part 1 Structural design".

Iplex has developed a computer software program, which is available for download free of charge. It is based on AS/NZS2566.1 and in addition to ApolloBLUE™, covers all Iplex pipeline materials.

6.2 Minimum cover height – (Ref AS/NZS 2566.2)

For areas with no traffic loading a minimum cover height of 450mm to the top of the pipe should be adopted. Under carriageways, the minimum cover height is 600mm for sealed pavements and 750mm for unsealed pavements. In these installations the pipe embedment material in the bedding and side support zones should have a minimum compaction Density Index of 65% or Standard Dry Density Compaction of 90%.

After pipes are laid and centred in the trench, the embedment material should be compacted in 80-100mm layers to the specified density. The embedment should continue 80mm to 150mm above the pipe to provide protection from the backfill.

6.3 Thrust block design for fittings

For rubber ring jointed pipeline systems, provision must be made for potentially unrestrained forces at changes of size or direction. For e.g., bends, tees, reducers, valves and closed ends.

In buried installations, fittings are usually restrained by blocks of concrete cast in-situ. These thrust blocks are formed and sized to distribute the applied force from the fitting to a safe soil pressure / concrete interface. The resistance provided will depend on the soil type and depth.

Where bends are in the vertical plane, convex and close to the surface, the mass of a concrete anchor block alone may have to be the restraining force.

AS/NZS 2566.2 and AS/NZS 2032 specify the use of thrust blocks for all in-line gate valves. Although no longer allowed, Water Agencies have in the past omitted valve restraints for small diameter (≤ DN200) reticulation pipelines.

Where there is risk of axial thrust, it is strongly recommended that only those DI fittings with full circle bearing surfaces at the base of the socket should be used. It is also beneficial if the ApolloBLUE™ spigots are trimmed back and the chamfer reduced to DI chamfer lengths. This serves to increase the effective end bearing area for the PVC spigot inside the DI socket.

Installers should be alerted to the potential for catastrophic failure where there is insufficient buried pipe downstream of an unanchored valve to provide enough soil friction to resist the hydrostatic thrust when the valve is closed.

Concrete thrust blocks should be correctly oriented to transfer the hydraulic thrust to the specially trimmed undisturbed soil of the vertical trench walls perpendicular to the load.

Figure 6.1: ApolloBLUE™ should be installed in the same way as other PVC pipes that are fully surrounded and embedded in a compacted granular material with "bell holes" for the sockets.

Figure 6.2 - Typical thrust block arrangements (Reference: AS/NZS 2566)

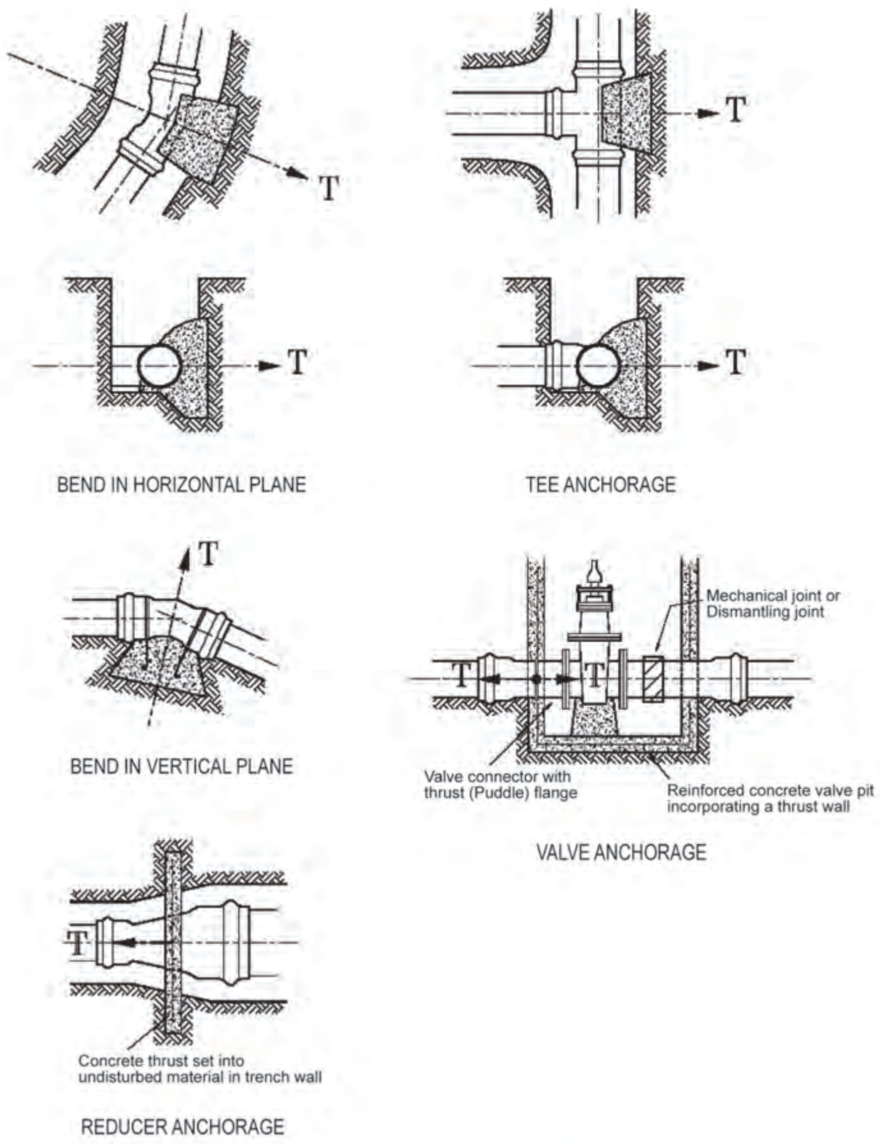


Table 6.1 - Hydrostatic forces (kN) on rubber ring jointed fittings per ten (10) metres hydrostatic head

Pipe DN	Pipe OD	Bend 90°	Bend 45°	Bend 22½°	Bend 11¼°	Tee/ Closed end/ valve
100	122	1.62	0.88	0.45	0.22	1.15
150	177	3.41	1.85	0.94	0.47	2.41
200	232	5.86	3.18	1.61	0.81	4.14
225	259	7.31	3.96	2.01	1.01	5.17
250	286	8.91	4.83	2.45	1.23	6.30
300	345	12.96	7.02	3.57	1.79	9.16

Note:
For concentric reducers the resultant thrust will be the difference between the "closed end" forces for the two pipe sizes.

Table 6.2 - Soil bearing capacities (kPa) – apply minimum factor of safety of 1.1

Soil group description as per AS1786	Minimum soil cover above centre line of thrust block in metres			
	0.75	1.0	1.25	1.5
GW,SW	57	76	95	114
GP,SP	48	64	80	97
GM,SM	48	64	80	96
GC,SC	79	92	105	119
CL	74	85	95	106
ML	69	81	93	106
OH	0	0	0	0

Thrust blocks must be configured to distribute the hydrostatic force to a 'wall' of undisturbed soil, which is approximately perpendicular to the imposed load.

The equation for this calculation is:

$A = (T/ b) \times f$

Where,

A = area perpendicular to force (m^2)
T = hydrostatic thrust (kN)
b = soil bearing capacity (kPa)
f = factor of safety (generally 1.1 to 1.5)

Example

A DN300 ApolloBLUE™ pipeline has a maximum operating head (including field test heads) of 150 metres. What is the minimum area for a thrust block for a 90° ductile iron bend buried with 1 metre of cover to the centre-line in a type SC soil?

Solution

From Table 6.1 - the hydrostatic thrust "T" is 12.96 x 15 = 194.4 kN.

From Table 6.2 - "b" = 92 kPa.

Therefore: A = (194.4 / 92) x 1.1 = **2.32 m^2**

7.1 Handling and storage

While ApolloBLUE™ pipes are light and easy to handle, careless handling can cause unnecessary damage. Pipes and fittings should not be dropped or thrown onto hard surfaces or allowed to come into contact with sharp objects or slide across sharp edges, which could inflict deep scratches. During construction storage areas should be selected which are free from surface irregularities such as stones, branches or other sharp projections.

Where gouging or heavy scratching to a depth of more than 10% of the pipe wall has occurred the pipes must be rejected for pressure applications.

Figure 7.1: Standard crates for storing and transporting ApolloBLUE™ Premium

ApolloBLUE™ pipes may be subject to distortion under high loads, particularly at elevated temperatures and bowing as a result of uneven heating. They should therefore be protected from direct sunlight, or other heat sources.

If ApolloBLUE™ pipes are stored for extended periods (> 12 months) they should be protected from direct sunlight by using hessian covers or similar which will allow adequate air circulation. Black plastic covers must not be used owing to the high temperatures developed when stored in the sun.

Socketed pipes should be stacked in layers with sockets placed at alternative ends of the rack and protruding, to avoid uneven stacks and distortion. The sockets should not be allowed to carry loads.

If mechanical handling equipment such as forklifts or cranes is to be used on bundles, adequate spreader and lifting bars should be provided. Wire slings must be kept clear of the pipes. When unloading alongside excavated trenches, it is recommended that pipes should be placed on the opposite side of the trench from excavated material.

Figure 7.2: ApolloBLUE™ pipes are easily handled on site

Figure 7.3: Faster installation is possible especially on congested sites owing to the pipes light- weight nature and minimal jointing force required when using ApolloBLUE™

7.2 Trenching

Trenches should be excavated in accordance with the plans and specifications and should allow adequate space for compaction of the embedment material in the side support zone.

Trenches should be straight and as narrow as practicable at the top of the pipe. The minimum trench width should be as shown in Table 7.1.

Table 7.1 - Minimum embedment zone dimensions – AS/NZS 2566.

DN	h	B*	k
100	75	350	100
150	75	400	100
200	100	550	150
225	100	550	150
250	100	600	150
300	100	650	150

** Note: The tabulated values may provide insufficient clearances for installation purposes in certain circumstances.*

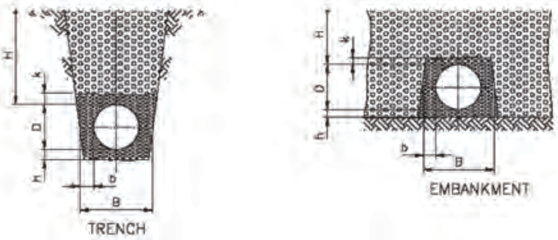


Figure 7.4 - Embedment, clearance and cover dimensions

7.3 Embedment and backfilling

The quality of the embedment material and its compaction, combined with the type and density of the native soil are all relevant to the ultimate performance of ApolloBLUE™ pipes once installed.

The trench bottom should be as smooth as possible and to grade. Embedment material, used in the bedding, side support and overlay are generally non-cohesive granular materials. Pipes should not be buried in contact with soil particle sizes larger than 5% of its diameter, with 20 mm maximum.

Soil clods must be excluded from the pipe embedment zone and under no circumstances should temporary supports such as bricks or timber be left under or in contact with pipes. If the excavated material is not granular or friable, or does not comply with the project specification, then suitable embedment must be imported.

Jointing or "clearance holes" should be excavated in the bedding for pipe sockets to ensure the pipes are evenly supported along their full length. It is important that only non-cohesive or granular embedment be used. Careful attention to the placement of embedment material to the specified relative compaction with an absence of voids is important.

Mechanical joints, especially flanged joints, should be left exposed if possible until the line is tested. Pipes should not be left uncovered. The possibility of pipe flotation in the event of rain and water in trench will occur unless it is backfilled to a height of at least one and a half diameters above the pipe.

The method of placing the remainder of the trench backfill will depend on whether the pipeline is located in an area with no traffic loading or under a roadway. In a roadway it is normal practice to continue backfilling and compacting with good quality embedment material up to pavement level. Heavy compaction of backfill should not commence without at least 300mm of material covering the pipeline.

Figure 7.5: A granular embedment material should surround pipes and be adequately compacted in the side support zone before excavated material is placed into the trench.

7.4 Joining instructions

ApolloBLUE™ pipes are supplied with the BLUE-seal rubber ring spigot and socket joint. The gasket is factory fitted and subsequently MUST NOT BE REMOVED. If the ring is tampered with or damaged in any way after leaving the factory then the seal can be removed. Contact Iplex Pipelines for specific instructions.

Joining to compatible ductile iron socketed fittings with rubber rings requires a similar procedure but with appropriate changes to the position of the witness mark and chamfer length.

The recommended jointing procedure is as follows:

Step 1: Cutting pipes

If required, pipes can be cut to length on site using either a hand saw or powered cutting disc. Ensure that the cut end is then chamfered with an appropriate field-lathing tool. Removal of 25 % of the wall thickness at an angle of 10 to 15 degrees will give satisfactory results. The size of the chamfer may be less where joining to ductile iron fittings.

A new witness mark should be made on the pipe spigot to match the socket depth. *Note: this may be shorter for a DI socket.*

Figure 7.6: Powered disc cutter is being used to cut ApolloBLUE™ to length on site

Step 2: Clean the spigot and socket prior to jointing

Remove all dust and dirt from the pipe spigot and socket paying particular attention to the insitu BLUEseal gasket and the surrounding housing. If the gasket is damaged or missing, a new one should be installed.

Step 3: Installation of replacement gasket

Although this is rarely needed, if a replacement BLUEseal gasket has to be inserted, it should be forced into a "heart shape". This will be assisted by choosing the point of maximum flexure of the retaining ring so as to coincide with a group of closely spaced "drill holes" in the ring perimeter. The gasket should then be placed in the socket ring groove with the blue retaining ring to the outside.

Step 4: Apply lubricant

Apply lubricant to the spigot, fully covering the circumference up to the witness mark. Ensure the lubricant is also applied to the pipe chamfer.

Step 5: Assembly

Insert the leading edge of the spigot into the socket mouth. It is essential that the pipes are aligned in a straight line before attempting to make the joint.

Figure 7.7: Chamfering the cut end of an ApolloBLUE™pipe by hand.

Step 6: Push spigot into socket

A small, longitudinal force applied to the socket end of the pipe is sufficient to insert the spigot into the adjacent pipe socket. For larger diameter pipes requiring a crowbar for jointing, protect the pipe socket with a wooden block.

Care must be taken to ensure that the pipe is not under-inserted as this may result in a leaking joint as the pipe contracts as a result of Poisson's and/or thermal effects. Under-insertion is signified by the witness mark not being pushed up to the end of the socket. *Note: When pressurised, Poisson contraction will cause a shortening of the pipes and this might re-expose the witness mark. This is acceptable.*

If simple insertion past the witness mark has occurred there is no significant risk to the performance of the joint. Only if the spigot has been forced so hard that it has stressed the transition region at the back of the socket to the barrel of the pipe is there a cause for concern. This is generally only a risk with uncontrolled insertion using mechanical equipment like the bucket of a back hoe.

Figure 7.8: A DN150 ApolloBLUE™ pipe is being joined by pushing with a crow bar. Note: the pipe socket is protected from possible damage with a block of timber.

7.5 Ductile iron socket joints

ApolloBLUE™ pipes can be used with ductile iron socketed fittings complying with AS/NZS 2280.

Note: The witness marks and chamfers to suit these particular sockets should be used.

Figure 7.9: A new witness mark is being stencilled to take into account the ductile iron fitting socket depth.

7.6 Mechanical jointing systems

Where cut-ins or repairs are needed in an existing ApolloBLUE™ pressure main, Iplex recommends fittings complying with WSA 105 and AS/NZS 4998 'Unrestrained mechanical couplings', should be used. E.g. the AVK coupling.

7.7 Jointing fluids (lubricants)

It is essential to use *Iplex Standard or Iplex Plus* bactericidal jointing fluid with ApolloBLUE™ pipes and ductile iron rubber ring sockets. Other lubricants especially MINERAL BASED GREASES MUST NOT BE USED.

Iplex Plus bactericidal jointing fluid is recommended for potable water supplies as it contains a bactericide designed to limit the growth of bacteria by disinfection at its source. During installation bacteria can enter the system and form a colony in the joint area, which is highly resistant, (even to high levels of chlorine) and can cause continuing infection of the line. Being water-soluble, the fluid is quickly removed from potable water systems when flushing commences.

Iplex Plus is safe and has no detrimental effect on the rubbers used in gasket materials and because of its properties, can also lower jointing forces. Keep the container closed when not in use to avoid spillage or contamination by dust or dirt.

As a safety precaution, avoid contact with eyes. If contact does occur, flush with copious amounts water. If ingested drink copious amounts water.

7.8 Expansion and contraction

Distortion can occur when laying pipes in direct sunlight. When one side of the pipe is hotter than the other it may develop a slightly bent shape, which may make jointing difficult. Common practice is to rotate pipes or place pipes in the shade to offset any uneven temperatures within the pipe.

Plastic pipe will contract as it cools, after laying in hot weather. A 6-metre length of ApolloBLUE™ pipe will expand or contract approximately 5mm for each 10ºC rise or fall in temperature.

The following precautions should be taken to ensure that the joints do not pull apart:

1. Laying is best done in the cooler parts of the day.
2. Rubber ring systems will allow for thermal movement of the pipeline after having been layed. In both cases, backfill each length, at least partially, as laying proceeds.

7.9 Installing on a curved alignment

The tolerances on the ApolloBLUE™ spigot and socket rubber ring will generally allow up to a 1° deflection, which corresponds to a 105 mm offset per 6m pipe length.

In addition ApolloBLUE™ pipes are flexible enough to be curved to the required effective centre line radii. The minimum radius of curvature is 300 x DN as shown in Table 7.2.

Pipes should be curved evenly along their length controlling the pipe displacement with sand bags or embedment material to prevent excessive point loadings. Pipes should always be joined in a straight line before changing to the construction alignment required.

Some authorities may not allow tightly curved ApolloBLUE™ pipes to be drilled or tapped. However where the typical displacement of a water main is within the minimum radius of curvature shown in the table below, tapping bands are normally accepted. Alternatively tapped DI couplings may be used.

Table 7.2 – ApolloBLUE™ - alignment criteria

Nominal Diameter DN	Min allowable radius of curvature (m)	Maximum offset per 6 metre length (mm)
100	30	600
150	45	400
200	60	300
225	67	260
250	75	240
300	90	200

Figure 7.10: Curved pipeline installed ready for backfilling.

7.10 Concrete encasement

Where concrete encasement is required, PVC-O pipes shall be set to line and level on either bags of natural fibre filled with sand and cement mix or on concrete blocks or saddles cast to the outside diameter of the barrel and located near the socket. Precautions shall be taken to prevent movement, flotation or deformation of the pipe while pouring concrete.

Where damage to pressure pipe surfaces could occur as a result of differential movement of the encased pipe, the pipe and fittings shall be protected by wrapping the pipe in a compressible membrane made of polyethylene, PVC, Petrolatum tape or felt.

For further information refer to AS/NZS 2032 ' Installation of PVC pipe systems' and AS/NZS 2566.2 'Buried flexible pipelines Part 2: Installation'.

7.11 Tapped service connections

ApolloBLUE™ pipes can be tapped using approved tapping bands and hole cutters. Fine toothed 'shell cutters' or hole saws are recommended to avoid any risk of spalling of the internal pipe surface. Spade bit cutters should not be used.

Several proprietary bands including Crevet Taptite DI and Milnes gunmetal bands have been tested when installed on ApolloBLUE™ pipes in accordance with AS/NZS 4793 "Mechanical Tapping Bands for Waterworks Purposes". These tests include short and long term hydrostatic testing, vacuum testing, bending, rotation and sliding.

Iplex can advise on tapping bands, which comply with AS/NZS 4793 when used on ApolloBLUE™.

Figure 7.11: Taptite polymeric coated DI tapping band installed on an ApolloBLUE™ water main. Shown here is a brace and bit fitted with a hole saw being used for a "dry"' tapping.

Figure 7.12: Most tapping bands providing full circle support to the pipe are suitable for ApolloBLUE™. A Milnes gunmetal band is shown here.

Figure 7.13: Tapped DI couplings can be used for service connections.

7.12 Under pressure connections

There has been development work on large diameter cut-ins with ApolloBLUE™ pipes. Initial tests using the Crevet stainless steel DN 150 x 150-flanged branch tapping band have met the testing requirements of WSA 03 Supplement for 'Under-pressure cut-ins'.

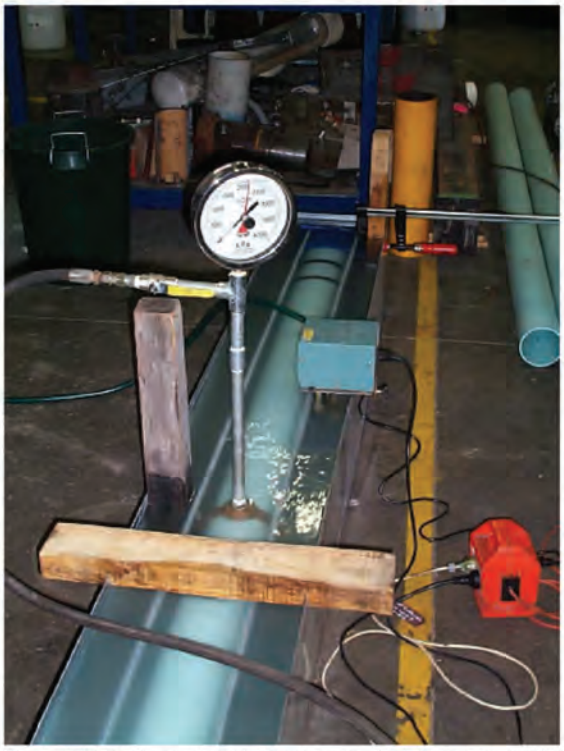


Figure 7.14: Testing a gunmetal tapping band installed on ApolloBLUE™ as part of a comprehensive evaluation in accordance with AS/NZS 4793.

Figure 7.15: Live tapping of a DN150 ApolloBLUE™ pipe with a DN150 branch connection using a Crevet stainless steel flanged branch and flanged AVK gate valve.

Figure 7.16: Use of a hole-saw cutter in the tapping machine results in a cleanly cut coupon

7.13 Repairs and cut-ins

Where a section of pipe has been removed to cut-in another fitting or replace a damaged pipe, the normal range of mechanical joints can be used on ApolloBLUE™ pipes. E.g. AVK couplings.

Where wrapper or banded types of jointing collars are used, care should be taken to avoid excessive bolt torques as these may result in distortion of the pipe wall.

7.14 Above ground installation

ApolloBLUE™ pressure pipes can be used above ground provided that long-term exposure to ultra violet radiation is provided. In direct sunlight acrylic paint may be a suitable barrier.

ApolloBLUE™ pipes should be supported as specified in AS/NZS 2032. Full circle supports should surround the pipes and "padded" with compressible material such as 3mm thick insertion rubber. This protects the exterior surface of the pipe from abrasion. Special structural supports will be necessary for fittings to resist hydrostatic thrust.

Table 7.3 indicates the maximum support spacing for pipes filled with water where aesthetic considerations require long-term deflections to be limited by the span distance divided by 500.

Table 7.3 - Span between supports (for long term deflections less than L/500)

Pipe designation	Span (metre)
DN 100 & DN 150	2
DN 200 to DN 375	3

8.1 Field testing

The test procedures of Clause 6.3.3 of AS/NZS 2566.2 "Buried flexible pipelines, Part 2: Installation" are recommended for ApolloBLUE™. The recommended test pressure should not be less than the maximum design pressure and at the same time not exceed 1.25 times the pressure rating at any point along the pipeline.

Before carrying out the test, ensure the pipe installation, including, backfilling and curing of concrete thrust and anchor blocks is completed. Pipes should also be substantially backfilled to ensure they cannot move. Where joints are exposed some movement of the witness mark away from the socket will be apparent due to "Poisson's effect", that is the shortening of the pipes under circumferential working stress.

It is recommended that mechanical joints and flanged connections remain exposed so that they can be visually checked for leaks. When testing against closed valves, arrangements should also be made for checking these for leaks. Appendix M4 of AS/NZS 2566.2 describes the test procedure and the figure 8.2 illustrates the usual test equipment arrangement.

Figure 8.1 provides an example of how variations in the elevation of the pipeline and the maximum design pressure envelope, can be accommodated when setting the location of the test section and magnitude of the hydrostatic test pressure. If thrust restraints are part of the installation they should be designed for the full test pressure to be applied.

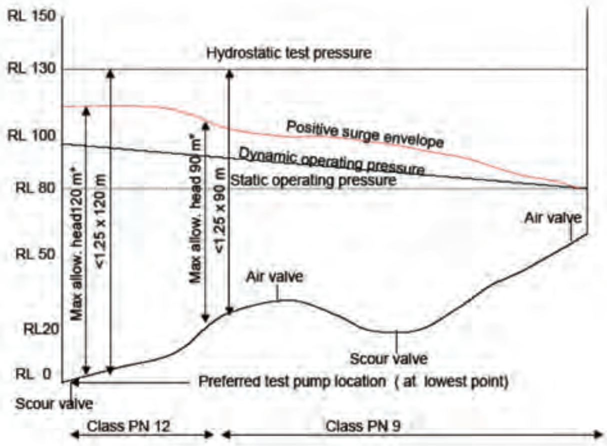


Figure 8.1 - Using longitudinal section of pipeline for determining appropriate hydrostatic test pressures

If no make-up water is required to maintain pressure after one hour at test pressure, or after the time needed to inspect the whole pipeline, it can be considered that the test has passed. The need for make up water may not indicate a leak if it is within certain limits. Clause 6.3.4.1 of AS/NZS 2566.2 gives the following equation for calculating the allowable make – up necessary to maintain the test pressure

$$Q < 0.14 \times L \times D \times H$$

Where

Q = allowable make-up water, litres per hour
D = nominal diameter, in metres
L = test length, in kilometres
H = average test head over length of pipeline under test, in metres

This allowance is intended to compensate for the apparent loss due to entrapped air being forced into solution.

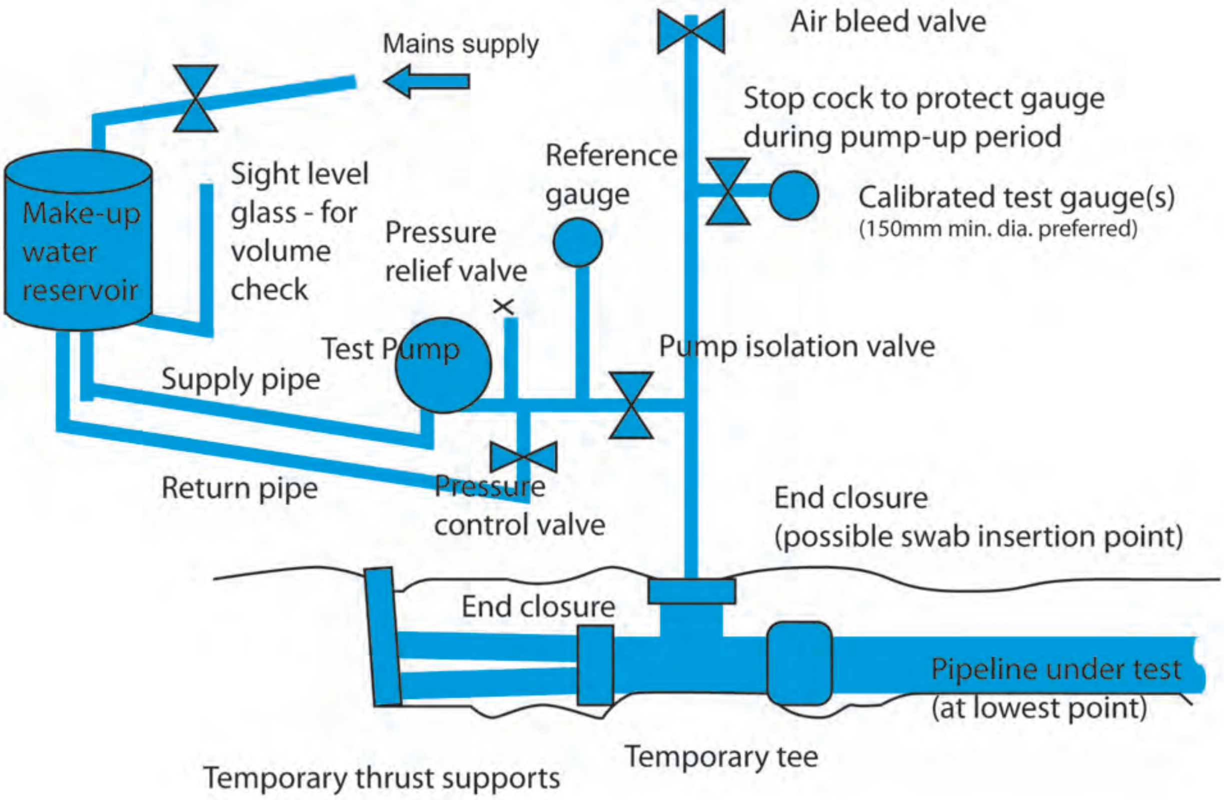


Figure 8.2 - Typical arrangement of testing equipment

WARNING:
High pressure (i.e. >30kPa) air testing is not recommended for safety reasons as the energy stored by compressed air or other gas in a pipeline can be extremely destructive and life threatening if released accidentally.

1. What is ApolloBLUE™?

ApolloBLUE™ is a biaxially oriented PVC pressure pipe suitable for water distribution mains, rising sewer mains and irrigation supply. It provides the latest advancements in PVC pipe technology.

2. What is so unique about it?

The oriented PVC material is significantly stronger and tougher than PVC-U and therefore provides better performance overall. For example PVC-O is approximately twice the strength and ten times more impact resistant than PVC-U!

3. Isn't ApolloBLUE™ relatively new?

No. Biaxially oriented PVC is not a new process. Yorkshire Imperial Plastics in the United Kingdom first developed it in the early 1970's. So this technology has been available for nearly 40 years and is well established and quite sound.

4. Iplex has modified PVC (PVC-M). Why does Iplex also have oriented PVC (PVC-O)?

PVC-M and PVC-O are both advances on the old PVC-U. PVC-O has a higher design stress than 'M' and therefore, for a given pressure class, has a larger bore and hence a higher hydraulic capacity. Pipelines installed and operated correctly in either material have an expected service life in excess of 100 years.

5. We have heard about deformation failures in PVC-O pipe from repair clamps and gibault joints. Will yours be any different?

PVC-O pipes have adequate stiffness for the intended applications and if installed and operated correctly will not fail. However, the resistance to deformation is inversely proportional to the SDR and so pipes with a lower SDR will be inherently stiffer than those with a higher SDR. If deformation is a concern then consideration could be given to selecting a product with a lower SDR.

6. What sizes are available?

ApolloBLUE™ is manufactured in sizes DN100, DN150, DN200, DN225, DN250 and DN300 in Series 2 diameters, which covers all of the main sizes required in Australia and are compatible with the majority of installed water mains such as DI and PVC.

7. What pressure classes are available?

ApolloBLUE™ is available in two standard pressure classes. PN12.5 & PN16 pipe rated to 1250kPa or 1600 kPa at 20° C

8. Is ApolloBLUE™ a certified product?

Yes. ApolloBLUE™ has StandardsMark certification to AS/NZS 4441 'Oriented PVC (PVC-O) pipes for pressure applications.

9. Has ApolloBLUE™ been appraised by WSAA?

Yes, ApolloBLUE™ has been appraised by WSAA and the appraisal is available on their website.

10. Does ApolloBLUE™ need to be re-rated for increased temperature?

ApolloBLUE™ pipes are suitable for service temperatures between 0° and 50°C. For temperatures above 20°C provision must be made for pressure re-rating. Refer to Table 2.2 for recommended thermal de-rating factors.

11. Does ApolloBLUE™ pipe require special embedment material and compaction?

No. The embedment material and compaction is the same as what is required for Blue Rhino (PVC-M).

No special embedment material or extra compactive effort is required.

Note: Embedment material and compaction is specified by the consultant engineer in accordance with water authority requirements and/or WSAA specifications.

12. What is the maximum allowable deflection at the joint for the ApolloBLUE™ pipe?

The maximum allowable deflection for the ApolloBLUE™ pipe is 1°.

However ApolloBLUE™ pipes can be curved to a minimum radius of 300 x the nominal diameter.

For example,

DN100 ApolloBLUE™ pipe – 300 x 100 = 30m radius
DN150 ApolloBLUE™ pipe – 300 x 150 = 45m radius
DN200 ApolloBLUE™ pipe – 300 x 200 = 60m radius
DN225 ApolloBLUE™ pipe – 300 x 225 = 67m radius
DN250 ApolloBLUE™ pipe – 300 x 250 = 75m radius
DN300 ApolloBLUE™ pipe – 300 x 300 = 90m radius

Note: Use sand bags or fill to support pipe during curvature. Do not use stakes! The curvature must be uniform along its entire length.

WSAA also recommend pre-tapped connectors for service connections as each end has a deflection joint.

13. When I cut an ApolloBLUE™ pipe to make a length adjustment, what is the recommendation for chamfering the end?

Cut the pipe square to the axis. Use a file to remove 25% of the wall thickness at an angle of 10° to 15°.

Note: A file is much easier to manage than a quick cut saw.

14. How do I join the pipes?

ApolloBLUE™ pipes have a rubber ring that is fixed in the pipe socket. Do not remove the ring!

Apply lubricant on the ring and pipe spigot and align the spigot in the socket in a straight line. (Refer to Section 7 for installation details)

Note: Use a bar with a block and fork. Don't use the bar alone as it can damage the pipe end. No backhoe is required to make the joint!

15. What fittings are recommended?

The same fittings used for Blue Rhino PVC-M. Ductile Iron fittings manufactured to AS/NZS 2280.

Note: Do not insert DI spigots in ApolloBLUE™ socket.

16. What is the recommendation for on site storage?

Like all PVC pipes, ApolloBLUE™ pipes should be left in their timber packaging and stored on level ground.

ApolloBLUE™ pipes can be stored for up to 12 months. For longer periods, cover pipes with hessian to allow for ventilation.

Like all PVC pipes, do not cover ApolloBLUE™ pipes with black plastic!

17. Can tapping saddles be used?

Always use tapping saddles that are designed for plastic pipes! For example, Milnes gunmetal bands or Taptite bands are both acceptable and are commonly used for side connections.

Another acceptable alternative is the pre-tapped connector.

18. What cutters or drill bits do you recommend?

As with all PVC pressure pipes use a hole saw. Don't use a 'speed bore', 'masonry' or 'spade' bits

Note: Tapping saddles must have a positive stop and be full circle.

19. Can I tap into a curved pipe?

Yes. Tapping a curved ApolloBLUE™ pipe is OK provided the radius is not less than 300 x DN. (See answer to FAQ No 12)

Note: Tapping saddles must be at least 450mm apart from each other and at least 300mm from a spigot end.

20. What about mechanical couplings for repairs?

Practically all approved Gibault type couplings are suitable e.g. AVK SUPA COUPLING PN16

Follow the installation instructions, which are attached to the couplings and use a torque wrench!

Note: Do not use a stainless steel repair clamp to join cut pipes on any pipe system! They are not designed for this application.

21. What about stainless steel repair clamps?

Stainless steel repair clamps were originally designed to fix a small hole in cast iron pipes, however they can also be used to repair ApolloBLUE™ pipes.

Apply lubricant to the rubber seal to prevent seal bunching and tighten bolts evenly to the maximum recommended torque.

Follow the installation instructions, which are attached to the couplings and use a torque wrench!

By the start of 2009 approximately 2,700 km's of ApolloBLUE™ pressure pipe has been installed in Australia since its introduction in 2005.

10.1 Major case study – Darling Anabranch Pipeline

Name of the project:	Darling Anabranch Pipeline Project
Principal:	Department of Commerce, NSW
Designer:	W3 Plus Consulting
Installer:	Mitchell Water
Principal's project value $:	$30M
Iplex supply value $:	$10M
Supplied by (Iplex/Crevet):	Iplex Pipelines
Pipeline sizes:	DN100 PN16, DN150 PN16, DN200 PN16, DN300 PN16
Length of pipeline:	218km's total – The longest PVC-O pipeline in the world to date.
Why was the pipeline being constructed?	The Darling Anabranch stock and domestic open channel system in south-western NSW supplies some 72 customers, who have an annual demand of about 1.5GL. Due to extremely high seepage, leakage and evaporation losses, it was necessary to release 48.5 GL per annum to supply the 1.5 GL stock and domestic demand. The piping of the entire system returned water savings of 47 GL per annum to the ailing Darling and Anabranch rivers within the greater Murray Darling Basin.
What needed to be achieved?	Design and construction of the entire system in less than 12 months.
How was the pipeline being constructed?	Trenching using Cleveland's. All pipe was laid to grade using automatic levelling equipment installed on each Cleveland.
What were the timelines for completion of the pipeline?	The client required the project to be completed in less than 12 months.
Other factors (difficult conditions, timeframes, Environmental issues / areas etc.)	The project area was in a very remote part of NSW that was not easily accessible and required remote camps to be established. Mitchell Water employed up to 6 No. Aboriginal heritage monitors and all cultural heritage issues were successfully negotiated.

Location of the Pipeline	
Start location:	Curlwa, near Mildura.
Finish location	Menindee Lakes
What was the terrain?	Flat
What were the soil types?	Sandy clay

Time frames	
Project timing:	March 2006 to March 2007
Construction of pipeline (start / finish):	March 2006 to December 2006 (3 months ahead of schedule)
Lay rate:	Up to 4km / day
Supply rate:	Up to 4km per day.
Pipe material:	PVC-O, Class 450 ApolloBLUE™ Pipe.
Pressure class:	PN16 (16 bar)
Stiffness:	Minimum SN 10
Pipe length:	218km's in total
Special requirements:	Nil
Fittings / valves / ancillary products supplied:	Iplex supplied all fittings and valves.
Did Iplex provide any design input / engineering services / problem solving?	W3 Plus consulting undertook the hydraulic optimisation and detailed design of all pipelines, river intake structures, pumping stations and storages.
Why were our products used over alternative / competitor products?	The use of PVC-O allowed substantial capital cost savings to be realised as it was possible to reduce pipeline diameters yet maintain the same pump heads.
How did our products provide a solution to meet the design factors and any special requirements for the project?	PVC-O allowed the lengths of the various pipe diameters to be reduced without compromising required levels of service (flow / pressure) at customer off take points.
What benefits did our products provide?	Substantial capital cost savings.

The result	
How successful was the project?	Project delivered 3 months ahead of program and under budget.
How well did construction proceed?	Iplex's significant production capacity meant supply of product could be kept up to all laying crews.
How did our products perform?	Very well.
Iplex's performance (technical advice / sales support / logistics):	Excellent from the commercial negotiations, to demand planning to logistics. Iplex Water provided a full time Site Interface Manager in Mildura for the duration of the project, which greatly assisted Mitchell Water and Iplex.
Overall customer satisfaction:	Very high

iPLEX
Pipelines

ABN 56 079 613 308

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