IPLEX APOLLO®

PVC-O PRESSURE PIPE

SPECIFICATION AND INSTALLATION GUIDE

SEPTEMBER 2023


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The Iplex® vision is to be the leading manufacturer and supplier of plastic building materials in New Zealand.

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IPLEX APOLLO® PVC-O
INTRODUCTION AND ORIGIN

Iplex Apollo® PVC-O is a biaxially orientated PVC pressure pipe, for use in water and waste water infrastructure pipelines.

Iplex production processes used for Iplex Apollo® PVC-O pipe result in improved mechanical performance, higher flow capacity, and reduced unit weight, compared with Iplex PVC-U and PVC-M pressure pipes of the same OD size and similar PN class.

Oriented PVC pipe manufacture was first developed by Yorkshire Imperial Plastics in the UK during the 1970s. It was found that by orienting the molecular structure of 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. Further development has been carried out by Wavin UK. Their latest process uses biaxial orientation, that is, a combination of radial and longitudinal expansion, to enhance the overall pipe performance. Arising from a technology sharing arrangement with Wavin, Iplex now manufactures this PVC-O pipe technology for Infrastructure Pipeline markets throughout New Zealand, Australia and the Pacific region.

Extrusion Equipment used for the manufacture of Iplex Apollo® PVC-O Pressure Pipe

IPLEX APOLLO® PVC-O APPLICATIONS

Iplex Apollo® PVC-O pressure pipes are suitable for a range of buried pressure pipeline applications including:

- Potable water supply mains for transmission,
- distribution and reticulation
- Principal pressure sewer mains
- Industrial process lines
- Effluent pipelines for industrial and rural wastewater
- Rural stock water, Irrigation and turf water systems

Colour Coding
To readily distinguish between pipeline applications, Iplex Apollo® PVC-O pipes is colour coded. For potable drinking water supply, Iplex Apollo® PVC-O Series 1 is usually coloured white and Iplex Apollo Blue® PVC-O Series 2 is coloured blue.

Other colours such as purple for non-potable recycled water, or cream for pressure sewage are available and must be specified at the time of ordering.

Note: White colour has also been accepted historically for PVC sewer rising mains in New Zealand, using Series 1 dimension pipes,when accompanied by appropriate identification tape marking above the pipe.

Figure 2.1 - Joint sockets on white DN 200 Series 1 PN 10 Iplex Apollo® PVC-O pipes with factory fitted, retained design, Anger-lock™ seal rings, Oamaru, Waitaki District

Figure 2.2 - Iplex Apollo® PVC-O Blue DN 250 Series 2 PN 16 PVC-O pipe, with factory fitted Anger-lock™ seal rings, as delivered to site in factory assembled bulk crates, Wanaka, Queenstown Lakes District

Figure 2.3 - Iplex Apollo® PVC-O DN 300 Series 2 PN 16 PVC-O pipe, coloured lilac for non potable recycled water application, Adelaide, South Australia

IPLEX APOLLO® PVC-O MOLECULAR ORIENTATION

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

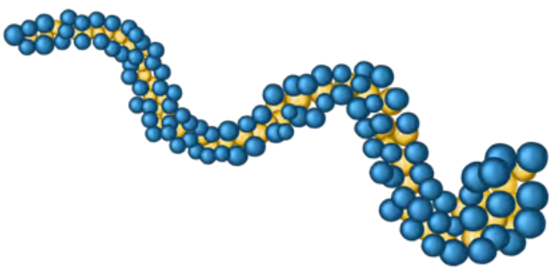


Figure 3.1 - Short piece of a polymer molecule

Figure 3.1 shows a model of a polymer molecule which upon initial stretching would start to straighten but ultimately further stretching would result in rupture.

When a PVC pipe is extruded without orientation, 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. For higher design pressures, the wall of the pipe is made thicker to incorporate these additional building blocks.

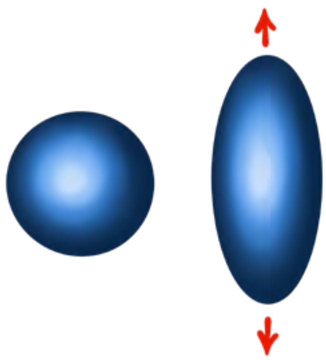


Figure 3.2 - The diameter of the sphere decreases when stretched

By stretching the pipe in the correct way the spherical polymer molecules are reshaped or oriented to the longitudinal direction. Because the cross section has become smaller, the oriented molecules now fit into a thinner wall section of pipe (Figure 3.3).

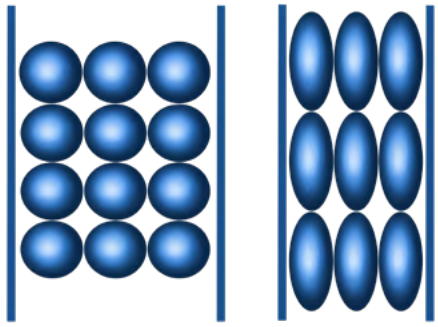


Figure 3.3 - The oriented molecules now fit into a thinner wall section of pipe

BIAXIAL ORIENTATION

Biaxially oriented PVC pipe is formed where both the pipe circumference and the pipe length are extended or "stretched" during extrusion. Strength enhancement is achieved by the stretching, (Figure 3.4) which elongates 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" their shape immediately, so as to retain their oriented shape. In other words stretching 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.

Figure 3.4 - 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

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

IPLEX APOLLO® PVC-O STANDARDS AND DESIGN MRS

Pipe Standards

Iplex Apollo® PVC-O pipe is manufactured in accordance with Australia/New Zealand Standard AS/NZS 4441 "Oriented PVC (PVC-O) pipes for pressure applications".

(Standards Mark Licence number SMKP20682)

Quality Endorsed Company

Australian Standard

Iplex Apollo® PVC-O pipe is manufactured using a Quality Management System accredited to AS/NZS ISO 9001, Licence No. QEC 4169.

Design Material Class MRS and Pressure Class (PN)

Iplex has chosen to manufacture Iplex Apollo® PVC-O using four *Design Material Classes*. These are 315, 355, 400 and 450.

The Design Material Class is related to the Minimum Required Strength (MRS) value (in accordance with AS/NZS4441) and to the maximum allowed working pressure (PN), as shown in the pipe specification chart below.

To simplify pipe selection, Iplex Apollo® PVC-O Series 1 and Iplex Apollo Blue® PVC-O Series 2 are each available in two PN classes.

These are either PN 12.5 or PN 10 for Iplex Apollo® PVC-O Series 1, and either PN 16 or PN 12.5 for Iplex Apollo Blue® PVC-O Series 2.

The resulting actual pipe stiffnesses for Iplex Apollo® PVC-O in these PN classes, are suitable for general munipipal water reticullation, urban or rural water applications, and installations where pipes are laid under roads.

Note: Refer also to Section 11 for installation guidelines.

Pipe dimension series & PN class		Design MRS (MPa)	Design Material Class	Maximum working pressure @ 20° C (m head)	Maximum working pressure @ 20°C (PN)
Iplex Apollo® PVC-O	**Series 1 PN 12.5**	40 MPa	400	125	12.5
	Series 1 PN 10	31.5 MPa	315	100	10
Iplex Apollo Blue® PVC-O	**Series 2 PN 16**	45 MPa	450	160	16
	Series 2 PN 12.5	40 MPa	355	125	12.5

Figure 4.1 - Site handling of Iplex Apollo® PVC-O DN 250 Series 2 PN 12.5 , for drinking water distribution, Nelson District

Figure 4.2 - Site handling and installation of Iplex Apollo® PVC-O DN 100 Series 1 PN 12.5, for water distribution in a residential subdivision near Martinborough

IPLEX APOLLO® PVC-O
PRODUCT DATA AND RANGE

Nominal Size (mm)	Nominal Pressure Class (PN) Bar	Mean Outside Diameter (Dn) mm	Mean Inside Diameter (mm)	Mean Wall Thickness (en) mm	Design MRS (MPa)
Iplex Apollo® PVC-O Series 1 Metric Pipe					
DN100	10	114.25	108.2	3.0	31.5
DN150	10	160.25	151.6	4.3	31.5
DN200	10	225.35	213.5	5.9	31.5
DN300	10	315.50	299.1	8.2	31.5
DN100	12.5	114.25	108.2	3.0	40.0
DN150	12.5	160.25	151.6	4.3	40.0
DN200	12.5	225.35	213.5	5.9	40.0
DN300	12.5	315.50	299.1	8.2	40.0
Iplex Apollo Blue® PVC-O Series 2 Imperial Ductile Iron OD					
DN100	12.5	121.90	114.5	3.7	35.5
DN150	12.5	177.40	166.8	5.3	35.5
DN200	12.5	232.25	218.4	6.9	35.5
***DN225**	**12.5**	**259.30**	**244.1**	**7.6**	**35.5**
DN250	12.5	286.25	269.4	8.4	35.5
***DN300**	**12.5**	**345.45**	**325.2**	**10.1**	**35.5**
DN100	16	121.90	114.5	3.7	45.0
DN150	16	177.40	166.8	5.3	45.0
DN200	16	232.25	218.4	6.9	45.0
***DN225**	**16**	**259.30**	**244.1**	**7.6**	**45.0**
DN250	16	286.25	269.4	8.4	45.0
***DN300**	**16**	**345.45**	**325.2**	**10.1**	**45.0**

Subject to minimum order quantity and availability.

Note 1: Mean Internal diameter ID = Dn – (2 x en)
Note 2: The effective length of all pipes is 6 m
Note 3: Design E modulus is 4200 MPa
Note 4: Design coefficient = 1.6

IPLEX APOLLO® PVC-O
ANGER-LOCK™ JOINT SYSTEM

Anger-lockTM is a factory fitted EPDM rubber ring, which provides improved security and ease of joint assembly, when compared with Iplex Z seal rings of the same OD size.

The Anger-lock™ seal is a combined lip and compression design, which is positioned and retained inside the socket, at the time of pipe manufacture. The seal comprises an EPDM rubber sealing element, bonded to a distinctive blue coloured polypropylene retaining ring, which holds the seal securely in position during transport and pipe joint assembly. Tool-assisted removal or installation in the field is only recommended in the field in case of seal damage.

The seals comply with BS EN 681 and have a UK Kitemark. Parts 1 and 3 of AS 1646 "Elastomeric seals for waterworks purposes" takes account of BS EN681. Test regimes used to certify the Anger-lock™ joint, include those of ISO 13846 for pressure, ISO 13844 for vacuum performance and AS/NZS 4020 for drinking water applications.

Figure 4.3 - Joint socket on white DN 300 Series 1 PN 12.5 Iplex Apollo® PVC-O pipe, with factory fitted, retained Anger-lock™ seal ring

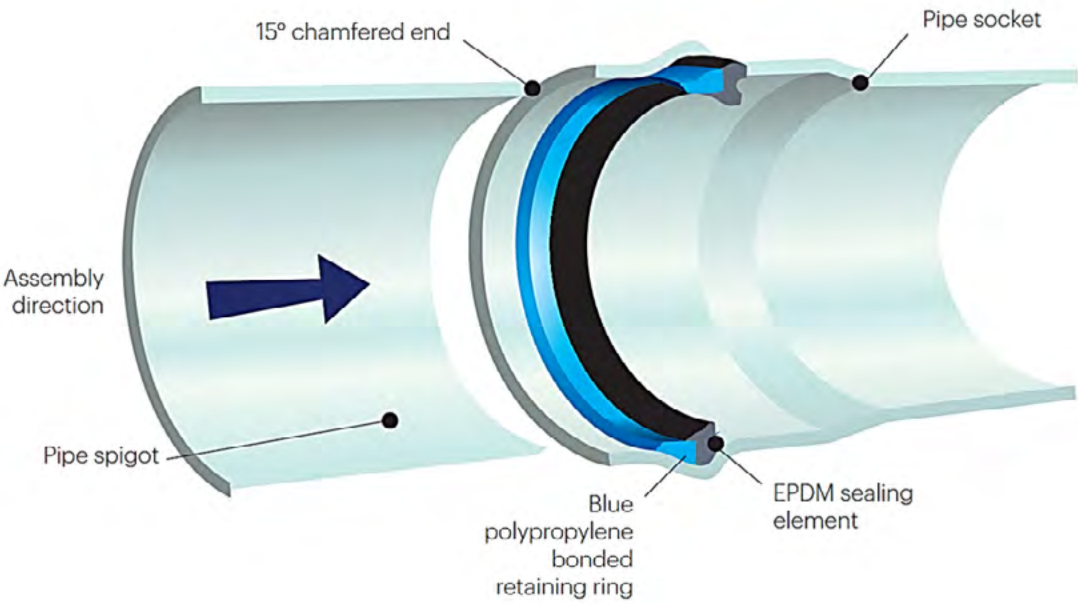


Figure 4.4 - Cross section of Anger-lock™ socket

IPLEX APOLLO® PVC-O
FEATURES & BENEFITS

Iplex Apollo® PVC-O pipe has greater impact resistance at low temperature, larger internal diameter, higher Long Term Hydrostatic Design Stress (Figure 8.3) and significantly reduced unit weight compared with Iplex PVC-U or PVC-M pressure pipes, of equivalent/similar PN class,

Iplex Apollo® PVC-O's larger internal diameter can reduce pumping costs or, for the same head there can be greater flow carrying capacity compared with the equivalent Iplex PVC-U or PVC-M pipe. Performance of Iplex Apollo® PVC-O is summarised as follows:

FEATURES	BENEFITS
1. LIGHTER WEIGHT PIPE Iplex Apollo® PVC-O is lighter weight compared to Iplex PVC-U or PVC-M of the same OD size & similar pressure class. (for further information contact Iplex Pipelines NZ)	The benefit of lighter weight pipes is the potential to reduce the impact from transportation, handling and lifting machinery onsite.
2. HIGHER IMPACT STRENGTH Iplex Apollo® PVC-O has a higher impact strength compared to Iplex PVC-U of the same OD size & similar pressure class. (for further information contact Iplex Pipelines NZ)	The benefit of higher impact strength pipe is improved resistance to accidental impact damage during handling & installation.
3. HIGHER FLOW CAPACITY Iplex Apollo® PVC-O has a increased ID compared with Iplex PVC-U or PVC-M of the same OD size & similar pressure class. Refer to page 20 of this manual for further information on flow rates.	The benefit of higher flow capacity comes from the increased ID of Iplex Apollo® PVC-O compared with PVC-U or PVC-M of the same OD size and similar pressure class giving the installed pipeline greater potential capacity.
4. RETAINED SEAL RINGS IN POSITION Iplex Apollo® PVC-O comes with factory fitted Anger-lock™ EPDM jointing seal rings 'Retained in the Socket' with bonded blue coloured polypropylene retaining element. Refer to page 12.	The benefit of the factory fitted Anger-lock™ seal ring is that it avoids potential displacement during joint assembly.
5. SERIES 1 AND SERIES 2 OPTIONS Iplex Apollo® PVC-O comes in both Series 1 and Series 2 making it compatible with existing watermains.	Series 1 provides compatible OD's with all Series 1 PVC-U and PVC-M watermains in current use. Series 2 provides compatible OD's with all Series 2 PVC-U and PVC-M watermains in current use & the majority of AC/ CI/ DI dimension watermains in use.

PIPE STIFFNESS	Iplex PVC-O pipe stiffness is suitable for underground installation including under road applications.
FATIGUE RESISTANCE	Iplex PVC-O provides resistance to dynamic stresses (fatigue) when designed according to PIPA Fatigue Guidelines, POP-101
DURABILITY	Iplex PVC-O is designed for an asset life of at least 100 years in accordance with NZS 4404:2010 when designed, installed & operated in accordance with the relevant Industry Codes & Standards.
CHEMICAL RESISTANCE	Iplex PVC-O pipe is not affected by corrosion when used in underground waste water or potable water pressure applications.

CHEMICAL RESISTANCE

Iplex Apollo® PVC-O pipe has excellent resistance to a wide range of chemical reagents, agressive natural ground conditions, and saline soils. Iplex Apollo® PVC-O has been used successfully for potable water mains in "brownfield" sites, and In ground contaminated with automotive hydrocarbons. Please contact the Technical Services Team on freephone: 0800 800 262 for specific information on chemical resistance performance.

Figure 5.1 - Installing a DN 200 S2 PN 12.5 Iplex Apollo® PVC-O Water Main in a main highway crossing, through hydrocarbon- contaminated ground, Manawatu District

IPLEX APOLLO® PVC-O
RECYCLING OF PVC-O PIPES

PVC compounds used in Iplex Apollo® PVC-O pipes are all recyclable thermoplastic materials. (Recycling Code 3)

Iplex utilises all re-processable PVC-O material from the Iplex Apollo® PVC-O pipe production process, in several other Iplex PVC pipe products for gravity or duct applications as permitted by the relevant manufacturing Standards.

PVC pipe materials from the production process are reprocessed by grinding into small chips (Figure 6.6). These are remelted and formed into new pipes, for a wide range of applications. Almost 100% content of recycled PVC pipe materials (Figure 6.7) can be used, delivering the same physical pipe perfomance as for virgin PVC.

Figure 6.6 - Mixed PVC pipe recyclate material in chipped form ready for reprocessing

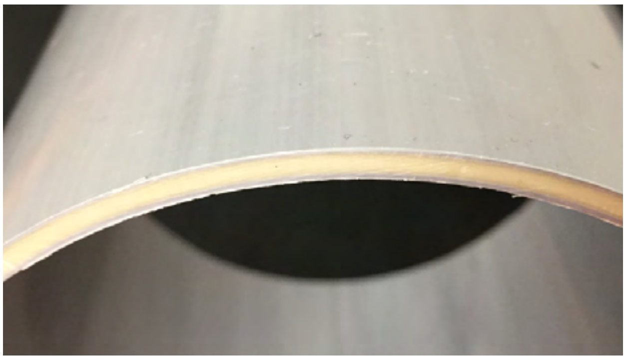


Figure 6.7 - Iplex PVC non pressure pipe, utilising solid wall "SC" technology, with randomly mixed recycled PVC material content within the pipe wall

SECTION 7
SEISMIC PERFORMANCE

IPLEX APOLLO® PVC-O SEISMIC PERFORMANCE

The major Canterbury area earthquake sequence of 2010 to 2012 severely tested buried pipes in the region. PVC pressure pipes and fittings systems with rubber ring joints were generally found to perform well when compared with other non plastic pipe materials, and continue as a solution for new development projects, in the Canterbury region.

Iplex Apollo PVC-O pipes with rubber ring joints have delivered resilient performance in New Zealand seismic events, including the Christchurch (2011,) and Kaikoura (2016) events.

Refer:

- Iplex NZ website - Resources / Case Studies
- Figure 7.1 and Figure 7.2

Contact Iplex Pipelines for more information on pipeline seismic performance.

Figure 7.1 - Iplex Apollo® PVC-O DN 200 PN 12.5, pressure sewer main, installed in Charles St, Kaiapoi, October 2010, which endured the February 2011 Christchurch Earthquake sequence, and all following aftershocks undamaged

Figure 7.2 - Iplex Apollo Blue® PVC-O PVC-O DN 150 PN 16 pressure watermain, installed in Kelburn Parade , Wellington City, in 2011, specifically to improve seismic resilience in the area, which endured the November 2016 Kaikoura/ Culverden Earthquake sequence, undamaged

IPLEX APOLLO® PVC-O FLOW CAPACITY

Flow capacity in PVC Pressure Pipelines

The flow capacity of a PVC pressure pipeline is influenced by various factors. (Figure 8.2)

Internal diameter (ID) of the pipe is the major influencing factor, and even small changes in ID have a significant effect on flow capacity.

- Flow design should always be based on the actual pipe ID, which does vary significantly, according to the PN pressure class and type of PVC used.

eg: in Iplex DN 150 Series 1, nominal PN 12 / 12.5, the actual mean pipe ID is

- **Iplex Apollo® PVC-O = 151.6mm**
- **Rhino PVC-M = 148.3mm**
- **Novakey PVC-U = 142.6mm**

(In this example, Iplex Apollo® PVC-O would deliver approximately 18% more flow capacity, from the larger ID, compared with Iplex Novakey PVC-U, and approximately 6% more flow capacity compared with Iplex Rhino PVC-M, for the same hydraulic gradient. Other factors may include:

- Surface roughness in service, such as in pressure wastewater pipelines, which may be influenced by flow velocity and available nutrient loading in the water
- Fitting and valve types, and radii of curvature at bends

To assist the designer in selecting the appropriate flow performance, flow charts for Iplex Apollo® PVC-O, pipes, in the available Series 1 or Series 2 sizes, and PN pressure classes, have been provided in Figure 8.6 & 8.7. The flow charts relate friction losses (head loss) and hydraulic gradient to flow discharge and flow velocity for pipes in new condition, carrying clean water, running full, and have been calculated using the Lamont Smooth Pipe Formulae (S3 for Reynolds Number *(3000<Re<300,000) or S4 for Reynolds Number* Re>300,000).

LAMONT FORMULA S3 (3000<Re<300000)

$$Q = \frac{d^{2.6935} i^{0.5645}}{2304}$$

$$V = 0.55254\, d^{0.6935} i^{0.5645}$$

$$i = \frac{905032\, Q^{1.772}}{d^{4.772}}$$

LAMONT FORMULA S4 (Re>300000)

$$Q = \frac{d^{2.629} i^{0.543}}{1791}$$

$$V = 0.711\, d^{0.629} i^{0.543}$$

$$i = \frac{979618\, Q^{1.842}}{d^{4.842}}$$

Explanation of Units
Re = Reynolds No.
Q = Flow rate (Litres per second)
i = Hydraulic Gradient
V = Flow Velocity (metres per second)
d = Mean Pipe Internal Diameter (mm)

*Figure 8.1 - (*Reynolds Number is defined as the ratio of the dynamic forces of mass flow to the shear resistance due to fluid viscosity)*

The Lamont Smooth Pipe Formulae are based on an operating temperature of 12.8°C (55°F) which corresponds to a kinematic viscosity for water v = 1.3 x 10^{-6} m^2/s and assumes an approximate equivalent Colebrook- White pipe wall roughness co-efficient, k = 0.003 mm.

This value of the equivalent roughness coefficient "k" assumes the PVC pipeline is straight, clean and concentrically jointed without fittings. Possible "k" service values for PVC ranging between 0.003 to 0.015 mm are given in AS 2200 "Design Charts for Water Supply and Sewerage" ,and in NZS 4404:2010 - Land Development and Subdivision Infrastructure. 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 12°C and decreasing it by 1% for each 3°C in excess of 12°C.

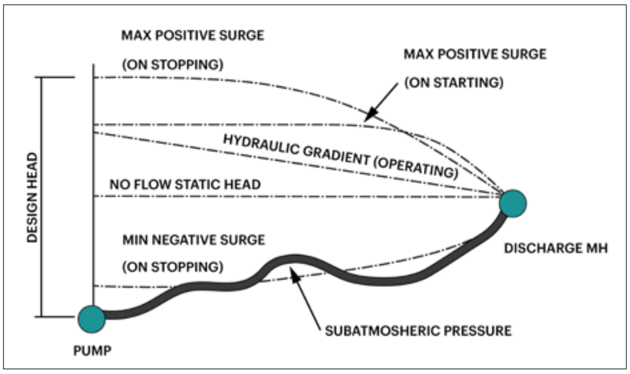


Figure 8.2 Typical hydraulic grades and surge envelopes required for design

IPLEX APOLLO® PVC-O HYDRAULIC DESIGN

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 0.5 kilometres. These are required to remove air, maintain full bore flow and limit the occurrence of sub atmospheric conditions.

Pressure class selection

The nominal pressure rating of PVC pressure pipe is the "PN" class, in Bar. For example, PN 12.5 = 12.5 bar = 1250 KPa = 125 m head = 181 psi. The nominal pressure rating (PN) should not be exceeded at any location in the pipeline by the maximum allowable operating pressure (MAOP), including water hammer pressure surcharges.

Factors which must be considered when selecting the pipe class and type of PVC type used, include: (but are not limited to)

- **Dynamic Stresses** (Fatigue) and surge pressures or "water hammer" , associated with frequency and magnitude of cyclic pressure variation, (Page 22) for example in Pressure Sewer applications. (Refer to PIPA Australia Technical Guideline POP101 - PVC Pressure Pipes Design for Dynamic Stresses.
- **Structural performance of the pipe in negative pressure (vacuum) conditions.** For example PN 6 PVC-U or PVC-M pipe should not be used in any negative pressure application. A minimum Class of PN 10 (PVC-O) must be used for any pipeline subject to any negative pressure.
- **Pressure Class Re-rating for Elevated Temperature** (Page 24)

Hydrostatic Design Stress

The long-term hydrostatic design stress of Iplex Apollo® PVC-O is higher than either Iplex PVC-M or Iplex PVC-U. This allows Iplex Apollo® PVC-O to be manufactured with a larger internal diameter, compared with Iplex PVC-M or Iplex PVC-U. for the same OD size and similar pressure class.

Stress Regression Lines - Iplex PVC–O, PVC-U, PVC–M

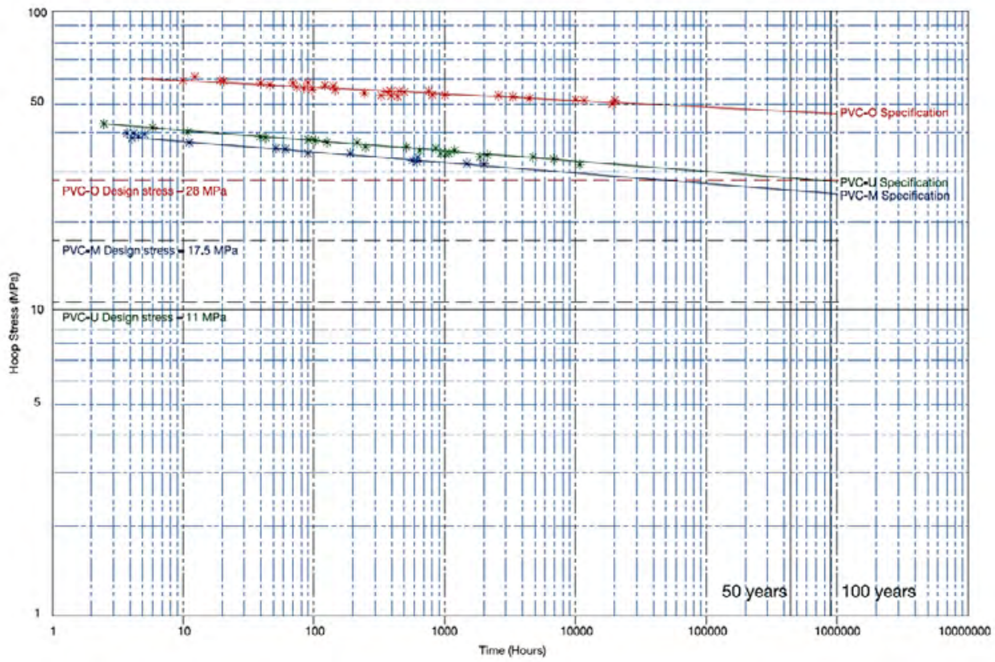


Figure 8.3 The long-term hydrostatic design stress of Iplex Apollo® PVC-O is derived from long-term stress regression analysis and using the design coefficient (1.6) nominated in AS/NZS 4441. The stress regression lines for Iplex Apollo® PVC-O compared with Iplex PVC-U and Iplex PVC-M are shown in the graph above.

IPLEX APOLLO® PVC-O FLOW COMPARISON

Iplex Apollo® PVC-O Flow Rate Comparison with Iplex PVC-U and PVC-M*

Figure 8.4 Iplex Apollo® PVC-O Series 1 (PN12.5/PN10) versus PVC-U (PN12) and PVC-M (PN12)

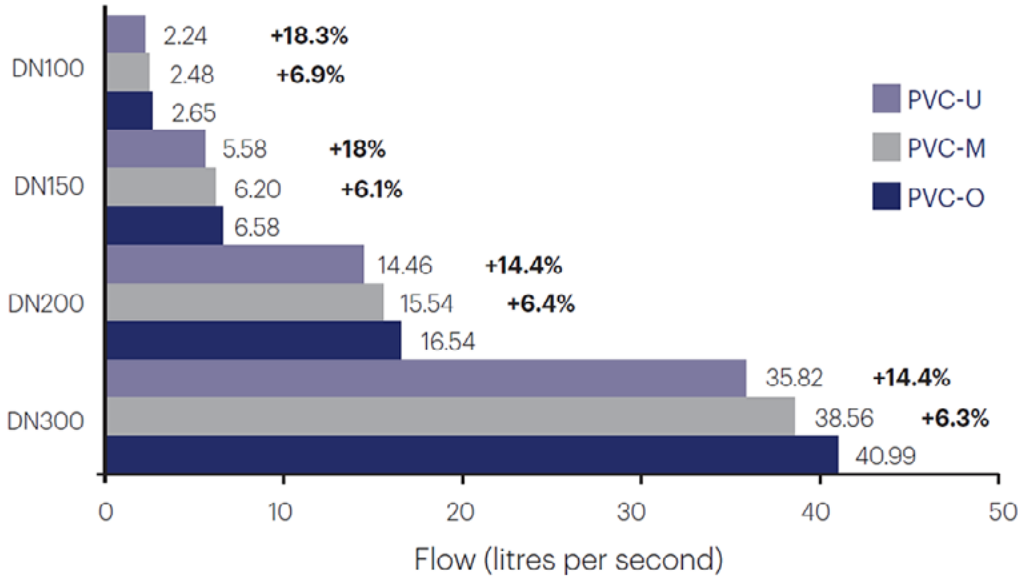
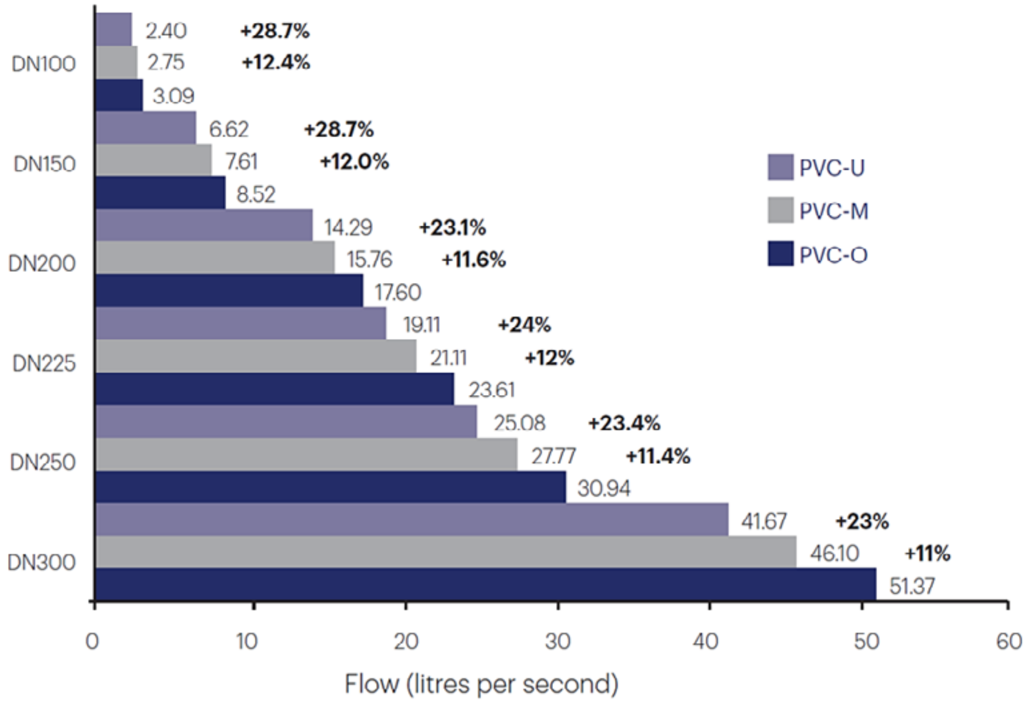


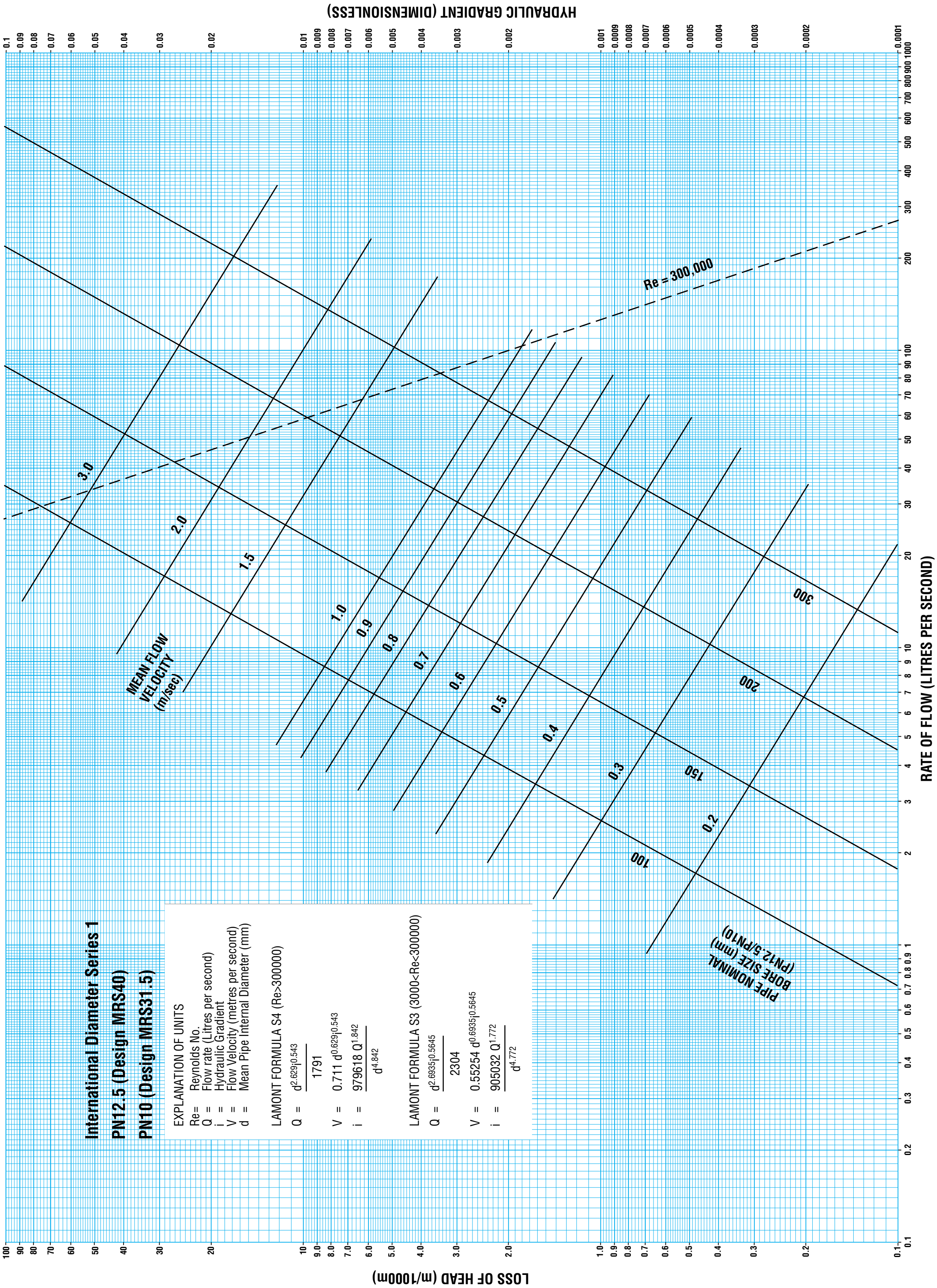
Figure 8.5 Iplex Apollo Blue® PVC-O Series 2 (PN16/PN12.5) versus PVC-U (PN16) and PVC-M (PN16)



**Based on mean pipe internal diameters and hydraulic gradient (i) - 0.001 Flow rate percentages compare Iplex PVC-U or PVC-M against Iplex Apollo® PVC-O*

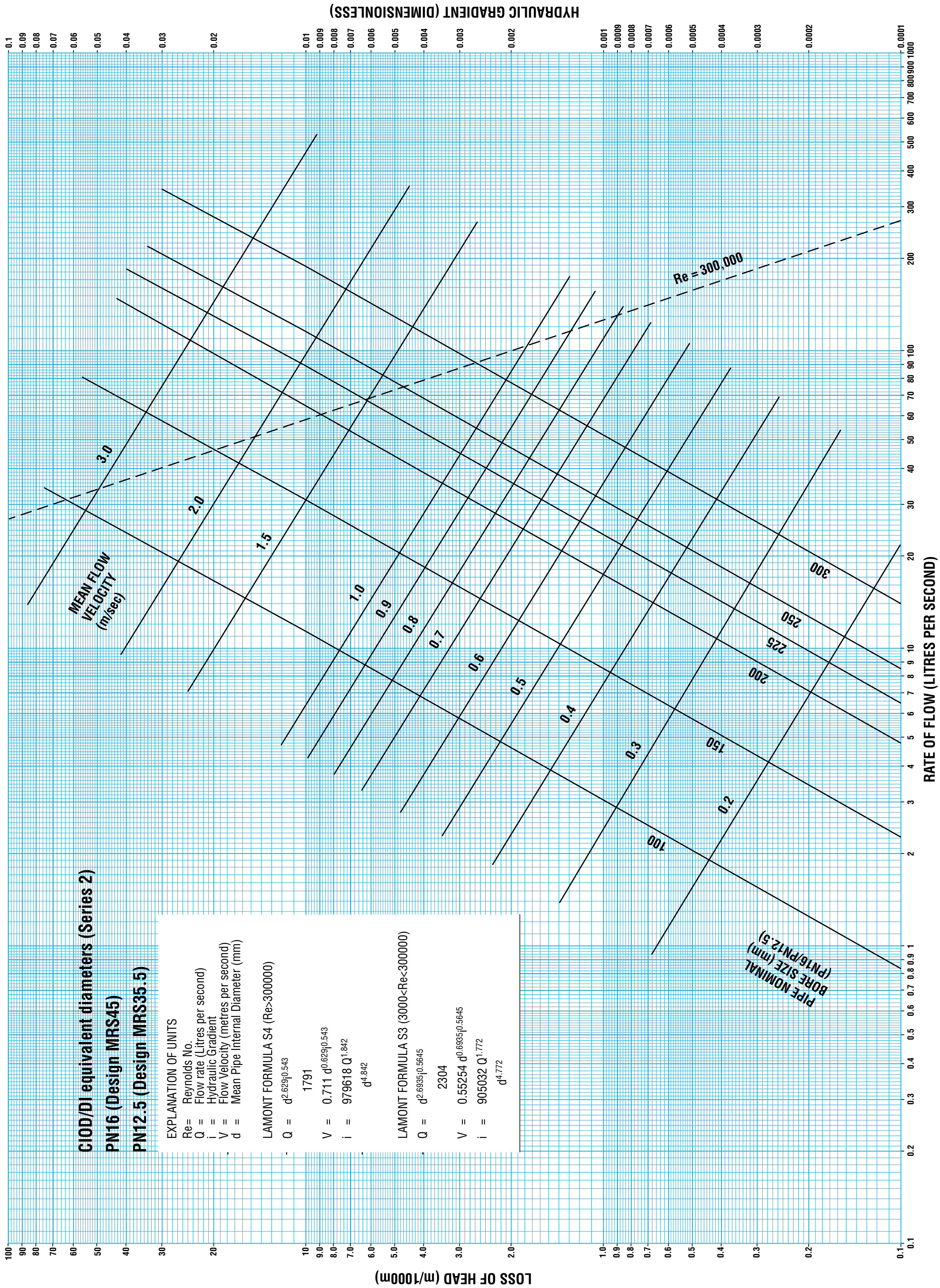
IPLEX APOLLO® PVC-O
FLOW CHART

Figure 8.6 Apollo Series 1 Flow Chart



IPLEX APOLLO® PVC-O
FLOW CHART

Figure 8.7 ApolloBlue Series 2 Flow Chart



IPLEX APOLLO® PVC-O DYNAMIC STRESSES (FATIGUE)

Surge and Fatigue design

Iplex Apollo® PVC-O pipelines can be designed to provide long term performance under dynamic stresses (fatigue) involving cyclic operating pressures. The designer should take account of the frequency of pressure fluctuations during the life of the pipeline, (ie: number of pressure cycles and the amplitude of each pressure variation). (Figure 8.8)

The amplitude of the pressure change between the maximum and minimum steady state operating pressures plus water hammer effects, when divided by the fatigue cycle factor given in the table below should not exceed the nominal class (PN) pressure rating of the pipe.

In practice the pressure changes in drinking water reticulation systems are seldom of sufficient amplitude and frequency for fatigue to affect pipe class selection, but these pressure changes can be an important consideration for sewer rising mains (Figure 8.9) where frequent pump starts/stops may occur.

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 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.)

Note: Designers are stongly recommended to refer to PIPA Industry Guideline POP101 - PVC Pressure Pipes Design for Dynamic Stresses for more complete information - www.pipa.com.au

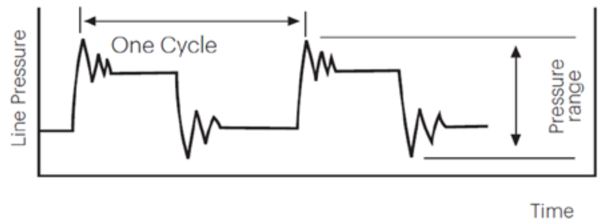


Figure 8.8 Pressure Cycle

Figure 8.9 - DN 150 S2 PN 16 Iplex Apollo® PVC-O pipe used for a pressure sewer rising main - New Plymouth City, Taranaki

Fatigue load factors for different PVC materials

Total Cycles	Approx. No. Cycles / day for 100y life	Fatigue Cycle Factors, *f*		
		PVC-U	PVC-M	PVC-O
26,400	1	1	1	1
100,000	3	1	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

IPLEX APOLLO® PVC-O FATIGUE APPLICATIONS

Selection of PVC-O Pipe Pressure Class and Water Hammer Effects

To select the appropriate pipe class for fatigue loading, the following procedure should be adopted:

1. Estimate the likely pressure range, P, i.e., the maximum pressure minus the minimum pressure.
2. Estimate the frequency or the number of cycles per day that are expected to occur.
3. Determine the required service life and calculate the total number of cycles which will occur in the pipe lifetime.
4. Using the fatigue load factors table on the previous page, find the fatigue cycle factor, ***f***, for PVC-O and the number of cycles.
5. Divide the pressure range by the fatigue cycle factor to obtain an equivalent operating pressure.
6. Use the equivalent operating pressure to determine the class of pipe required.
7. A graphical method for selecting pipe class is shown in Figure 8.10.
8. Refer also to PIPA POP 101 - PVC *Pressure Pipes Design for Dynamic Stresses.*

Water hammer surges and cyclical effects

Water hammer and pressure surge effects in pipes are directly influenced by the Celerity (the speed that the pressure waves travel in the pipe), and the short term Modulus of Elasticity (E) of the pipe material. Water hammer effects are considerably reduced in Iplex Apollo® PVC-O pipe when compared with ductile iron and steel pipe, owing to the much lower Modulus of Elasticity of PVC-O. Typical values of Celerities for PVC-O compared with Ductile iron are shown in the table below.

For more information please contact the Iplex Technical Services Team on freephone: 0800 800 262.

Water hammer celerity comparison (at 20°C)

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

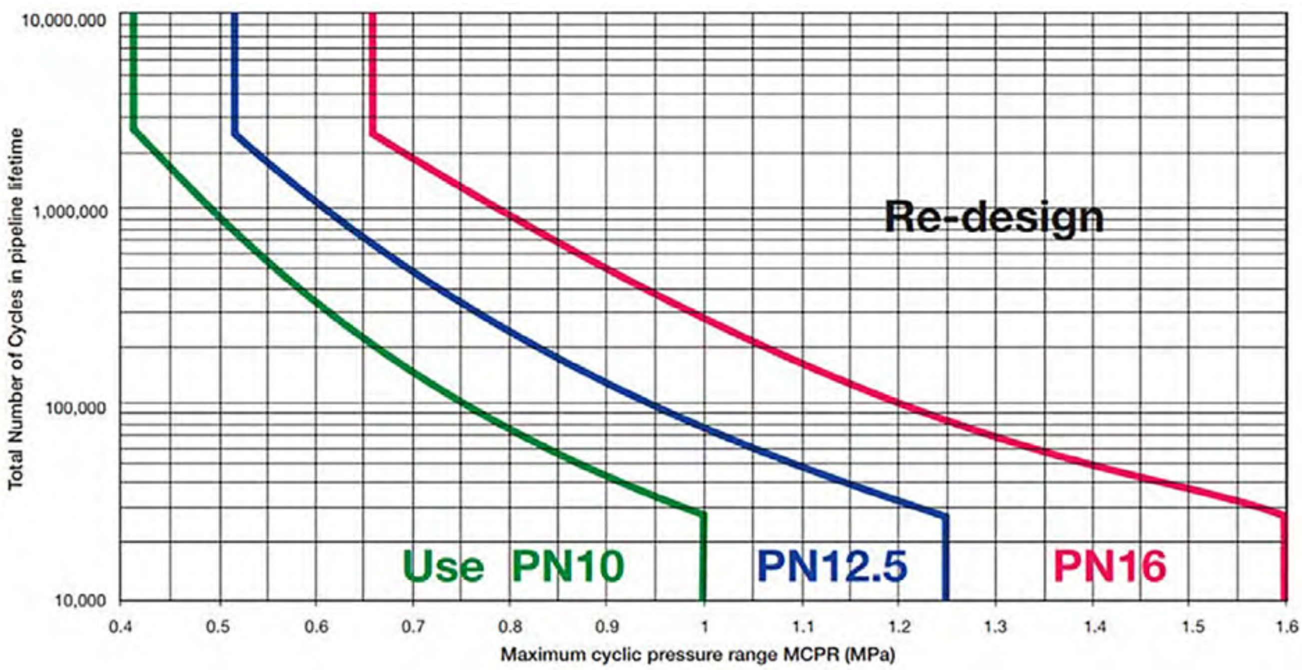


Figure 8.10 Selection of PVC-O Pressure Class Fatigue Applications

IPLEX APOLLO® PVC-O
TEMPERATURE CONDITIONS & THERMAL RE-RATING

Iplex Apollo® PVC-O pipes are suitable for service temperatures between 0°C and 50°C, subject to Pressure Rerating. For temperatures above 20°C, provision must be made for pressure re-rating in accordance with the table opposite. These rerating factors are the same as for PVC-M or PVC-U.

Low Temperature Applications

When compared with Iplex PVC-U or PVC-M pipe, Apollo PVC-O pipe has improved mechanical impact performance in low temperature applications, (Figure 8.11).

Negative Pressure Effects

Calculated using Timoshenko's relationship, and allowing

$$P_{CR} = \frac{2.E}{1-\upsilon^2} \times \left[\frac{t}{D-t}\right]^3$$

for Poisson's effect.

Where

P_{CR} = critical buckling pressure (MPa)

E = short term Flexural Ring Modulus = 4000 MPa

υ = Poissons Ratio = 0.38

D = Pipe Outside Diameter (mm)

t = Pipe wall section (mm)

Critial buckling Pressure, P_{CR}, (MPa), for Short term loading at 20°C				
IPLEX APOLLO® PVC-O DESIGN CLASS				
Design Class	315	355	400	450
P_{CR}	0.14	0.20	0.14	0.20

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

Figure 8.11 - Installing DN 100 S1 PN 12.5 Iplex Apollo® PVC-O pipes in sub-zero winter conditions, for a reticulation Water Main ,Wanaka, Queenstown Lakes District

SECTION 9
FITTINGS

IPLEX APOLLO® PVC-O
DUCTILE IRON SOCKETED PRESSURE PIPE FITTINGS

Iplex recommends the use of ductile iron socketed fittings manufactured to AS/NZS2280:2014 “Ductile Iron pipes and fittings”, (Figure 9.1 & 9.2) and compliant with Table 3.1 “of this Standard – “..ductile fittings with plastics pipes” , with compatible dimension Iplex Apollo® PVC-O, pressure pipes.

Appropriate Series 1 “metric” OD transition seal rings may be used with some sizes of PVC compatible Series 2 ductile iron fittings, to allow use with Series 1 pipe OD sizes. Socket spacers may be required in some fitting brands with DN 150 Series 1 pipe to centrally locate and support the pipe, in the socket. Iplex recommends consultation with the fitting supplier for specific advice on the need for socket spacers.

Ductile iron fittings require suitable corrosion protection. Iplex recommends all ductile iron fittings to be coated with a polymeric coating applied in accordance with AS/NZS4158 - “Thermal Bonded Polymeric Coatings” and fitted with stainless steel nuts, bolts and washers.

Figure 9.1 - Ductile iron bends, socketed or flanged

Figure 9.2 - Ductile iron flange adaptors, socketed or plain ended

Figure 9.3 - Socketed Ductile Iron fittings should have a full circle pipe stop in the Socket, to butt the PVC pipe end against, when installing, to prevent over- insertion

Figure 9.4 - Re position the insertion witness mark on the pipe spigot as needed, to allow for full depth socket insertion

Assembly of Ductile Iron Socketed Fittings on PVC Pressure Pipes

Figure 9.5 - If cutting a pipe on site, cut the pipe square and handchamfer the pipe spigot, similar to a factory produced chamfer

Figure 9.6 - Lubricate the chamfered PVC-O pipe spigot, and fitting seal ring, with Iplex Medlube

LH Image - Iplex ApolloBlue® PVC-O, DN 300 S2 PN 12.5 twin pipelines, installed under highway road berm, Whakamarama, Western Bay of Plenty District

IPLEX APOLLO® PVC-O
DUCTILE IRON SOCKETED PRESSURE PIPE FITTINGS

Figure 9.7 - Assemble the fitting onto the PVC-O pipe with a bar. Insert the pipe into the full length of the fitting socket

Figure 9.8 - Larger size ductile iron fittings may need extra mechanical help to assemble, such as here, with a lifting strop pulled by the excavator. DN 250 socketed bend being assembled onto a DN 250 Series 2 PN 16 Iplex Apollo® PVC-O watermain near Richmond, Tasman District

IPLEX APOLLO® PVC-O
MECHANICAL COUPLINGS & FLANGE ADAPTORS

Iplex recommends the use of unrestrained "universal" mechanical couplings manufactured to AS/NZS 4998 “Unrestrained Mechanical Couplings” for Water Works Purposes, with compatible dimension Iplex Apollo® PVC-O pressure pipe. Various fitting brands which fully comply with this Standard may be used.

These "Universal" couplers differ from traditional "gibault" style couplers, as they typically allow connection between pipes of differing OD sizes (eg: Series 1 to Series 2) and between differing pipe materials (eg PVC to Ductile Iron / cast iron / asbestos cement / steel etc). The seal gaskets and barrel design are designed to accommodate some "rotation" or angular change of direction across the joint, which will vary with fitting brand and design and may be in the range 4 to 8 degrees.

Recommended assembly procedure

- Ensure all sliding components, including the central "barrel" and the seal gaskets, are thoroughly clean and freshly lubricated, with Iplex Medlube pipe jointing lubricant, to ensure uniform compression during tightening.
- Apply witness marks to the pipe with a pencil or felt marker pen, to ensure correct "centralised" positioning of the coupler during tightening, and to allow for the required "end gap" of approximately 10mm between the pipe ends, which is taken up during tightening.
- Assemble the fitting onto the pipe, taking account of the fitting manufacturer's instructions for use specifically with PVC.
- Pre-tighten the bolts using a ratchet spanner.
- Then tighten the bolts using a torque-wrench, to the manufacturer’s recommended torque setting specifically for PVC pipe.
- The correct torque will vary with fitting brand and design and may be in the range 40 to 65 Nm **(do not overtighten)**

Figure 9.9 - "AVK" brand Series 603 PN 16 Universal Flange adapters suitable for Appolo PVC-O, pressure pipe. The pressure rating (PN 10 /16) and range of allowed compatible pipe OD sizes is moulded on the end cap

Figure 9.10 - "AVK" brand Series 601 PN 16 Universal Couplings for DN 100 PVC-O, pressure pipe. The range of allowed compatible pipe OD sizes is moulded on the end cap

Figure 9.11 - Use of a torque wrench during final tightening of the bolts on an "AVK" brand Universal Coupling, installed on DN 100 Series 1 Iplex Apollo® PVC-O pressure pipe

Figure 9.12 - Typical arrangement of "AVK" brand, Universal flange adapters, on a flange branched tee, with hydrant, and hydrant riser, installed onto DN 250 Iplex Apollo® PVC-O pipe, Tasman District

IPLEX APOLLO® PVC-O
SERVICE LATERAL CONNECTIONS

Iplex recommends the use of PVC-compatible, full circle supported tapping bands with Iplex Apollo® PVC-O, pressure pipes. These include Plasson Plassaddle Tapper mechanical tapping saddles, (Iplex 2536 - Series 2), "Milnes" brand Gunmetal, Crevet Taptite, or other tapping bands manufactured to AS/NZS 4793 “Mechanical Tapping Bands for Water Works Purposes”. Either O or V type tapping band seals are suitable for use with Iplex PVC pipes.

Note: Tapping band internal (ID) dimensions are always specific to either Series 1 (metric OD) pipe sizes or Series 2 (imperial CIOD pipe sizes), and are not interchangeable between the two Series. “Universal” tapping bands that use U-bolt support straps, without direct contact of the two halves when tightened, are not recommended for any type of Iplex PVC pipe.

Tapping bands must be installed centrally positioned over the drilled service hole. This hole should be drilled using a fine-tooth hole saw. Bolt tightening torque should not exceed 20Nm.

Figure 9.13 - Gunmetal tapping saddle with a Plasson "line 7" male threaded adapter,on white DN 100 Series 1 Iplex Apollo® PVC-O water main, connecting to a DN 50 Iplex Blueline PE service lateral, and valve box, near Wanaka, Queenstown Lakes District

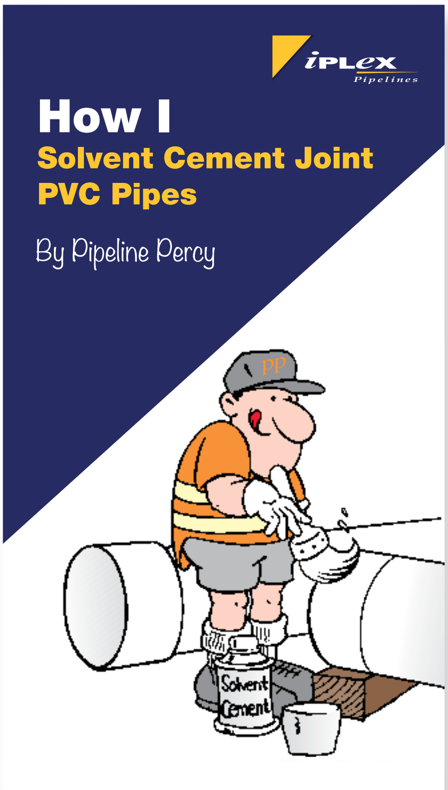
Figure 9.14 - Gunmetal tapping saddle and Under Pressure Tapping ferrule with a Plasson "line 7" male threaded adapter, for an air release point, on a twin, DN 150 Series 2 PN 16 Iplex Apollo® PVC-O pipe, near Oakura, Taranaki district

IPLEX APOLLO® PVC-U
PRESSURE FITTINGS FOR SOLVENT CEMENT JOINTING (SCJ)

Solvent Cement Joints (SCJ) can be used between Iplex Series 1 Iplex Apollo® PVC-O pipe, and Iplex Novakey Series 1 PVC-U fittings, using the Iplex SCJ procedure with Iplex 9100P series PVC Pressure Solvent Cement and 9101/9101C series PVC Cleaner Primer materials.

Note: Series 2 PVC pipes are not joined with solvent cement only because suitable Series 2 SCJ style PVC fittings are not commonly available.

Refer to the Iplex instruction guideline "Pipeline Percy - How I Solvent Cement Joint PVC pipes" visible on the Iplex NZ website at www.iplex.co.nz



Iplex Novakey 800 Series 1 PVC-U pressure fittings

Iplex Novakey 9100 Series PVC pressure solvent cement

Iplex Novakey 9101 / 9101C Series purple PVC cleaner primer

IPLEX APOLLO® PVC-O
ECOFITTOM® FITTINGS FOR SERIES 1 PVC PRESSURE PIPES

EcoFITTOM® is the world's first range of PVC-O pressure fittings for use in Rural, Irrigation and Civil pressure water reticulation networks. Rated to a single PN16 class, in Series 1 OD sizes and PVC-O bore sizes, means they can be used across a range of pressure ratings, and PVC types. They are compatible with:

- Iplex Apollo® PVC-O, Series 1 pressure pipe, PN 6.3, PN10, and PN12.5
- Iplex White Rhino PVC-M Series 1 pressure pipe, PN 6 / 7.5, PN9, PN12 or PN15
- Iplex Novakey PVC-U Series 1 pressure pipe, PN 6, PN 9, PN 12 and PN 15

Figure 9.15 - PVC-O pressure fittings range includes bends, couplings, slip repair couplers and reducers

Figure 9.16 - Site handling Lightweight PVC-O DN 375 PN 16 22.5O Bend

Quality assurance

Applied for compliance to prEN 17176 Part 3 piping systems for water supply and for buried and above ground drainage, sewerage, and irrigation under pressure - orientated unplasticized poly (vinyl chloride) (PVC-O).

RH Image - Iplex Apollo® PVC-O, DN 100 S1 PN 12.5 installed for dairy stock water supply, Murchison, Tasman District

SECTION 10
STRUCTURAL DESIGN & THRUST SUPPORT

IPLEX APOLLO® PVC-O
FLEXIBLE PIPE STRUCTURAL DESIGN

Iplex Apollo® PVC-O pressure pipes are "flexible" pipes, which means they are designed to de-form or deflect diametrically within small specified limits without structural damage. Iplex PVC-O pipes have been used for many underground applications under roads, such as Figure 10.1.

The external soil and live loadings above flexible pipes may cause a normal slight decrease in the vertical diameter and an associated slight 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 is influenced by the soil type, density of bedding and surrounding fill, and height of water table. The higher the effective soil modulus at pipe depth, the less the pipe will deflect.

Short term deflections of up to 5% and long term deflections of up to 7.5% are allowable (Ref AS/NZS 2566.2) and will not affect the performance or pressure rating of the pipe. Contact Iplex NZ for further details or refer to AS/NZS 2566.1 "Buried flexible pipelines Part 1 Structural design" . Iplex NZ has developed design software, based upon this Standard which covers all its PVC pipeline materials.

Figure 10.1 - Iplex Apollo® PVC-O, DN 150 S2 PN 12.5 installed under SH 54, Feilding Town Centre, Manawatu District

Minimum cover heights -AS/NZS 2566

For areas with no traffic loading, a minimum cover height of 450mm to the top of the pipe may be adopted. Under sealed roadways the minimum cover height should be 600mm and under unsealed roadways, 750mm.

Pipe embedment material 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 200-300mm layers (Figure 10.2) to the specified density. The embedment should continue 80mm to 150mm above the pipe to provide protection from the backfill.

Figure 10.2 - Trench with temporary red index marks on the trench wall to guide backfilling and compaction in 300mm layers

Figure 10.3 - Concrete thrust block with vertical tie bars, supporting an in-line flanged connection between Iplex Apollo® PVC-O and PE pressure pipe at a river crossing, Waitaki District

IPLEX APOLLO® PVC-O
THRUST BLOCK DESIGN FOR FITTINGS

For rubber ring jointed PVC pressure pipeline systems, provision must be made to support hydrostatic thrusting forces at changes of size or direction 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 against solid undisturbed ground, (Figure 10.3, 10.5 & 10.6) and sized to distribute the applied force from the fitting into a safe soil pressure I concrete interface. The support required to resist the hydrostatic forces will depend on the pipe diameter, peak operating pressure or test pressure, soil type, fitting type / configuration / angle, and depth. (Refer to Table 10.1 & 10.2)

Where bends are in the vertical plane, in convex position and close to the surface, the mass of a concrete anchor block alone may need 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.

Figure 10.4 - Concrete thrust block supporting a three-way valve assembly, on a PVC transmission water main, Timaru City

Figure 10.5 - Installing a concrete thrust block on a DN 100, 45 Deg Ductile iron bend, fitted to Iplex Apollo® PVC-O PN 12.5 pipe, Southland District

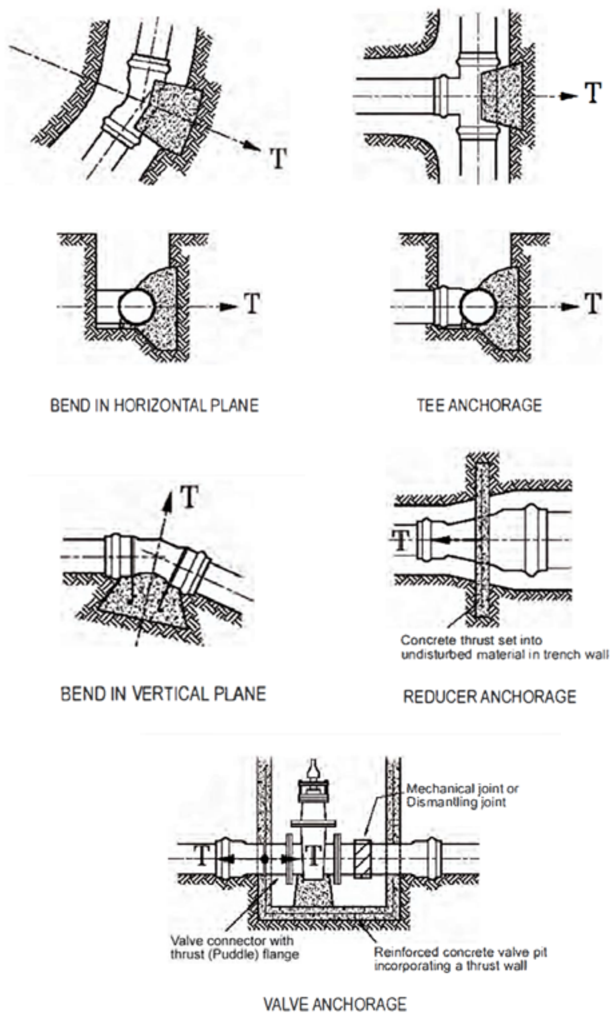


Figure 10.6 - Typical thrust block arrangements (Reference: ASINZS 2566)

Note: Ensure all thrust blocks are in place and fully cured before applying any pressure, including test pressure, to the pipe.

IPLEX APOLLO® PVC-O
STRUCTURAL DESIGN & THRUST SUPPORT

Table 10.1 Example (Series 2 pipe OD) of hydrostatic forces (kN) on rubber ring jointed fittings per 10 metres of hydrostatic head

Pipe DN	Pipe od	Bend 90°	Bend 45°	Bend 22$^1/_2$°	Bend 11$^1/_4$°	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 10.2 Typical soil bearing capacities (kPa) (apply minimum factor of safety 1.1)

Soil group description (AS /NZS 2566.1)	Minimum soil cover above centre line of thrust block (m)			
	0.75	1.0	1.25	1.50
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 in to a 'wall' of undisturbed soil, which is approximately perpendicular to the imposed load.

The equation for this calculation is:

A= (T/b) x f

Where,

A = Thrust bearing area perpendicular to force (m^2)

T = hydrostatic thrust (kN)

b = soil bearing capacity (kPa)

f = factor of safety (in the order of 1.1 to 1.5)

Example:

Question: A DN300 Iplex Apollo® PVC-O pipeline has a maximum operating head (include field test heads) of 120 metres. What is the minimum thrust bearing area **A** for a thrust block for a 90° ductile iron bend buried with 1 metre cover to the centre-line in a type SC soil?

Solution: From Table 10.1, the hydrostatic thrust 'T ' is 12.96kN x 12 = 155.5 kN. From Table 10.2, 'b' = 92 kPa.

Therefore:

A= (155.4 / 92) x 1.1 = **1.85 m²**

IPLEX APOLLO® PVC-O
HANDLING & STORAGE

Iplex recommends careful pipe handling, to prevent un necessary damage. Pipes and fittings must be lifted, (Figure 11.1 & 11.2) not dropped or thrown onto hard surfaces or impacted by sharp objects, which can gauge or score the pipe. Storage areas should be flat and free of large stones, or rubbish. (Figure 11.3)

Pipe should be stored in the original crates, or on timber dunnage, (Figure 2.2 and 11.3) and stack heights limited to 2.5 m approximately for long-term storage. In direct hot sunlight, pipes may bow slightly due to uneven heating of individual pipe lengths. Bowed pipe may be straightened by rotating 1800 in the sun.

PVC pipes can be stored outside for up to 24 months, but for longer term storage, pipes should be protected from direct sunlight, either under cover (Figure 11.4) or with hessian or canvas covers to allow adequate cooling air circulation.

Do not use plastic sheet covers which may heat and damage the pipes.

Socketed pipes should be stacked in layers with sockets "topped and tailed" in the stack and protruding, (Figure 11.3) to avoid distortion.

Mechanical lifting equipment should only use suitable polymer lifting slings (not chains) with dual position lifting points. (Refer Figure 11.2)

When unloading pipes alongside excavated trenches, pipes should be placed on the opposite side of the trench from excavated material.

Figure 11.2 - Mechanical lifting, using two point suspension, and polymer slings, of DN 300 Series 1 PN 12.5 Iplex Apollo® PVC-O pipe in bulk crates, Timaru City

Figure 11.3 - Temporary storage of DN 150 Series 1 Iplex Apollo® PVC-O pipe, in original factory crates on a flat site, near Oamaru, Waitaki District

Figure 11.1 - Handling and unloading of DN150 PN 12.5 Iplex Apollo® PVC-O pipe, preventing abrasion damage from the truck deck or by impacting the road surface. - Feilding, Manawatu District

Figure 11.4 - Long term storage, under secure cover for PVC pressure pipe, - Apia, Western Samoa

IPLEX APOLLO® PVC-O
CUTTING & CHAMFERING

PVC-O pipes can be cut on site using a fine-toothed handsaw or power driven circular abrasive masonry blade (Figure 11.5 & 11.6). Ensure the cut is made square. Apply a 15° chamfer to the cut section, similar to the factory produced chamfer, (Figure 11.9) before attempting to join the pipes. **Do not remove more than 50% of the pipe wall thickness and ensure the chamfer is evenly formed**, with no sharp edges, which could damage the seal.

Figure 11.5 - Cutting pipe with power-driven masonry blade

Figure 11.6 - Chamfering pipe with power-driven masonry blade

Figure 11.7 - Cutting pipe with power-driven masonry blade

Figure 11.8 - Chamfering pipe with hand file

Figure 11.9 - Hand- chamfered Iplex Apollo® PVC-O pipe spigot

IPLEX APOLLO® PVC-O ELASTOMERIC SEAL JOINTING

Socket Cleaning

- Ensure the inside of all pipes, sockets and fittings are completely free of any debris, dirt, grit, and water before joint assembly begins. (figure 11.10 & 11.11)
- Protect the clean socket from entry of dirt and grit , before joint assembly. (Figure 11.12)

Figure 11.10 - Carefully clear away any dirt from the socket mouth

Figure 11.11 - Totally clean socket, ready for jointing

Figure 11.12 - Protect the clean socket from entry of dirt and grit , before joint assembly

Elastomeric Seal Jointing Method (Factory installed, Anger-lock™ Seal Rings)

1. Do not attempt to remove the Anger-lock™ seal on site. It is locked in place (Figure 11.13) at the factory and is designed to be not dislodged by accident or removed by the installer. Thoroughly wipe out, dry and clean the pipe socket and seal in place. (Figure 11.14) Be sure to remove any dirt behind the seal flap, and from inside the pipe.
2. Ensure the pipe spigot is correctly chamfered and has a clearly visible witness mark at the correct insertion depth. (Figure 11.15) Make the witness mark using a soft pencil, crayon or waterproof felt pen.
3. Apply Iplex Medlube jointing lubricant with a brush to the pipe seal and to the spigot, fully covering the pipe circumference, including the pipe chamfer, up to the witness mark. (Figure 11.16). Clear a small space under the socket (Figure 11.14) to ensure the lubricated spigot does not touch the trench or pick up any dirt -this will damage the joint performance.
4. Ensure the pipe spigot and socket are axially aligned with one another. (Figure 11.17) If joint deflection is required do not deflect until after joint assembly is completed. Insert the pipe spigot into the pipe socket (Figure 11.18) and pust in until **the witness mark remains just visible**. (Figure 11.21) Re-adjust correctly to the witness mark after assembly if necessary. In this position, clearance is automatically provided to allow for normal thermal expansion and contraction, seismic resilience and axial rotation. Jointing may be assisted by using a crowbar and protective wooden block across the pipe end. (Figure 11.19)
5. **Do not use a moving excavator bucket to assist with joint assembly** as this may damage the seal ring.
6. The pipe socket should be restrained with bedding or with a jointing fork during joint assembly, (Figure 11.20) to ensure joints assembled previously, are not pushed past their witness mark as the next joint is made.

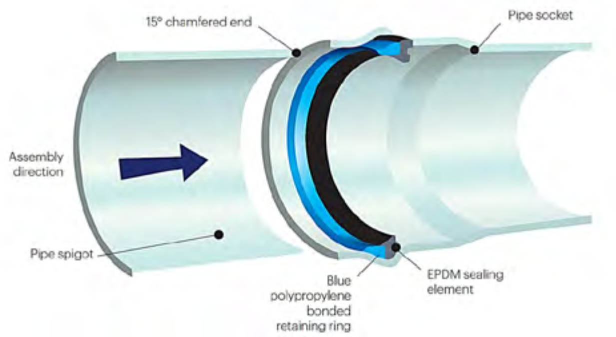


Figure 11.13 - Coss section of joint with Anger-lock™ seal

IPLEX APOLLO® PVC-O
INSTALLATION

Figure 11.14 - Thoroughly clean seal ring and socket interior. Clear a small space under the socket to ensure the lubricated spigot does not touch the trench or pick up any dirt

Figure 11.15 - Check witness mark

Figure 11.16 - Apply Medlube lubricant to both the seal and the spigot with a clean brush

Figure 11.17 - Align the lubricated spiot with the socket mouth

Figure 11.18 - Insert aligned lubricated spigot into socket

Figure 11.19 - Push pipe spigot into the socket through the seal ring using a bar, and wood block to protect the pipe end. DO NOT INSERT PAST THE WITNESS MARK

Figure 11.20 - Positioning of pipe jointing fork

Figure 11.21 - Push joint home until witness mark remains just visible

IPLEX APOLLO® PVC-O
JOINTING LUBRICANT

Jointing lubricant for Anger-lock™ elastomeric seal joints

Iplex Medlube is a lubricant for potable water pressure applications where a bactericidal feature is necessary.

Table 11.1 Average number of joints per litre of Iplex Medlube (estimate only)

Nominal Pipe Diameter	Nominal Pipe Diameter Approx No. of Joints per litre
100	70
150	50
200	40
225	35
250	30
300	25

Jointing "clearance holes" should be locally excavated in the bedding for pipe sockets to ensure the pipes are evenly supported along their full length. (Figure 11.14)

Bedding aggregate should be evenly distributed, to fully surround the pipe (Figure 11.22 & 11.25) and be well compacted beside the pipe (Figure 11.23) before placing backfill above the pipe.

Mechanical couplings and flanged joints, should be left exposed if possible until the pipeline is pressure tested. Ensure that all thrust blocks are in place and fully cured before field pressure testing. Pipe should not be left uncovered. Pipe flotation may occur, in the event of rainfall and water pooling in trench unless it is backfilled with compacted fill to a height of at least 1.5 x 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 in 300mm layers, with suitable backfill material up to pavement level. Heavy mechanical compaction of trench fill should not commence without at least 300mm of compacted backfill covering the pipeline.

Figure 11.22 - Typical placement and "blinding": of granular bedding and surround material

Figure 11.23 - Side compaction of granular bedding and surround material with a trench shield - the side compaction zone is below the shield, directly against the trench wall

IPLEX APOLLO® PVC-O
INSTALLATION

Figure 11.24 - Trench bottom in stoney ground, evenly cut to grade and depth before placing the bedding aggregate. Waitaki District

Figure 11.25 - Placing the selected size imported bedding aggregate, fully surounding the pipe, Waitaki District

Figure 11.26 - Showing correct position of pipe, fully surrounded by selected size imported bedding aggregate, with all other larger size "as dug" aggregate, above the bedding , totally excluded from direct contact with the pipe, Waitaki District

The correct sequence of backfill actions includes placement and compaction of the bedding, under the pipe and secondly, beside and surrounding the pipe barrel, BEFORE placement and compaction of trench backfill above the bedding zone.

(Refer this picture of a DN 200 S2 PN 16 Iplex Apollo® PVC-O trunk watermain, being installed south of Oamaru, for the correct installation sequence with PVC pipe).

IPLEX APOLLO® PVC-O
INSTALLING PIPE ON A CURVED ALIGNMENT

The tolerances on the PVC-O socket shape and rubber ring can allow up to approximately 1° to 1.5° deflection, when assembled to the witness mark.

In addition, Iplex Apollo® PVC-O pipes are flexible enough to allow limited curvature along the pipe length between the joints. The minimum recommended radius of curvature for Iplex Apollo® PVC-O is 200 x pipe OD (rounded numbers) as shown in Table 11.2. Pipes should always be joined in a straight line before changing to the curved construction alignment required. Curved alignment should be even along the pipeline length. (Figure 11.27, 11.28, 11.29 & 11.30)

Do not drill holes into any PVC pipe or install tapping bands with a drilled hole, on any curved sections of pipeline.

Where the required pipeline radius of curvature is less than shown in table 11.2, below, Ductile Iron "Universal" mechanical couplings (Section 9 Page 29) or Ductile Iron bends (Section 9 Page 27) may be used.

Table 11.2 PVC-O pipeline curvature

Nominal Pipe Diameter	Minumum Allowable Radius of Curvature (m)	Minumum Allowable Radius of Curvature (m)
	SERIES 1	SERIES 2
100	23	24
150	32	35
200	45	47
225	-	52
250	-	57
300	63	69

Figure 11.27 - DN 300 Iplex Apollo® PVC-O Series 1 PN 12.5 watermain in 6m lengths, following a curved road allignment, Westland District

Figure 11.28 - DN 300 Iplex Apollo® PVC-O Series 1 PN 10 watermain in 6m lengths, on a curved allignment, Hawkes Bay District

Figure 11.29 - DN 150 Iplex Apollo® PVC-O Series 1 PN 10 watermain, in 6m lengths, on a curved allignment, Hawkes Bay District

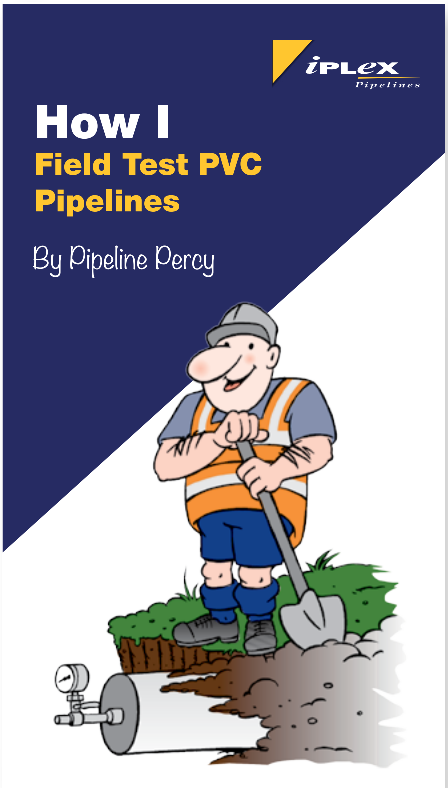
Figure 11.30 - DN 100 Iplex Apollo® PVC-O Series 1 PN 12.5 waste water transmission main, in 6m lengths, on a curved allignment, Gisborne District

PVC Expansion and contraction

A 6-metre length of PVC pipe will expand or contract approximately 4.8 mm for each 10°C rise or fall in temperature. Slight temporary thermal distortion or bending can occur in pipes laying 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 180°, to offset any uneven temperatures within the pipe. Plastic pipe will contract as it cools, after laying in hot weather. Seal ring joint systems will allow for thermal movement of the pipeline, providing they are not inserted past the witness mark.

IPLEX APOLLO® PVC-O
FIELD TESTING PVC PIPELINES

The relevant test procedures and methods of NZS 4404:2010 - Land development and Subdivision Infrastructure, Appendix C, or of AS/NZS 2566.2 "Buried flexible pipelines, Part 2: Installation" are recommended for Iplex PVC-O, pressure pipes. The test pressure should not be less than the maximum design pressure and must not exceed 1.25 x the PN pressure class rating of the pipe, at any point along the pipeline. Refer also to the Iplex PVC field test guidelines at
www.iplex.co.nz - Resources - How to Guides



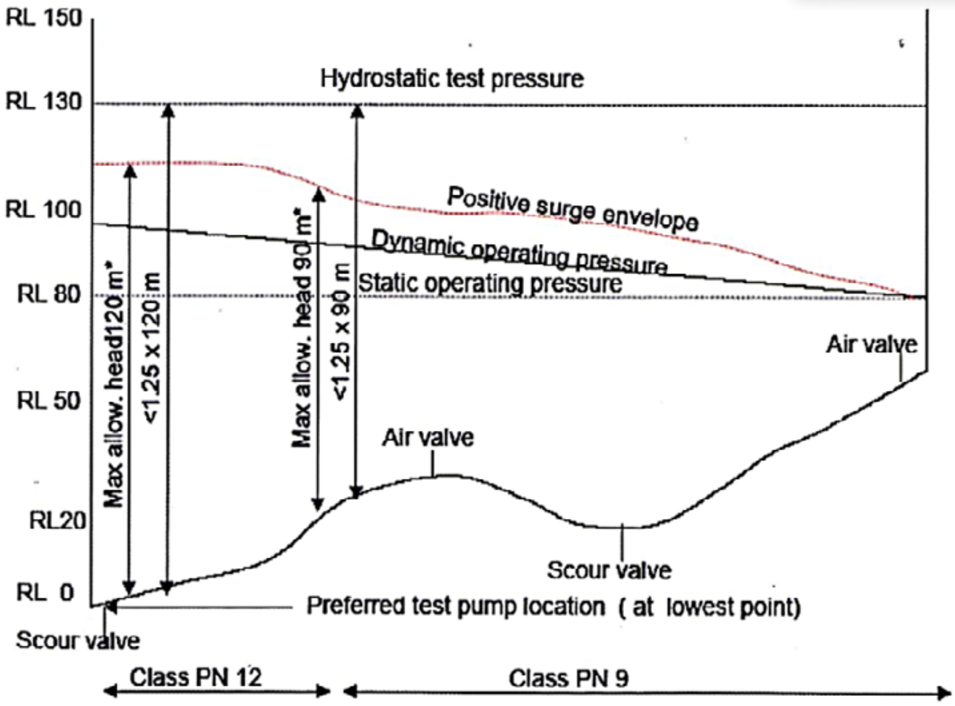


Figure 12.1 - Using longitudinal section of pipeline for determining appropriate hydrostatic test pressures

LH Image- Iplex Apollo® PVC-O, DN 250 S2 PN 12.5 distribution watermain installation under the sealed carriageway of Great South Road, Pokeno, Waikato District

IPLEX APOLLO® PVC-O
PRESSURE TESTING EQUIPMENT

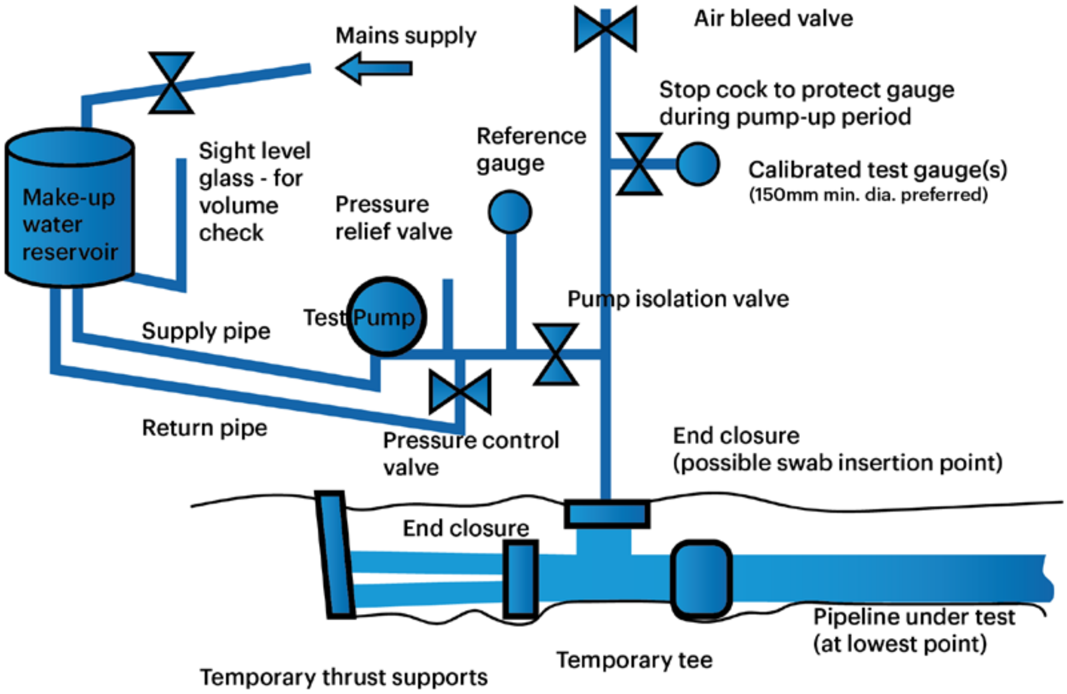


Figure 12.2 - Typical arrangement of pressure test equipment

WARNING:
High pressure air testing is never to used for safety reasons, as the energy stored by compressed air can be destructive and life threatening if released accidentally.

IPLEX APOLLO® PVC-O SPECIFICATION GUIDELINES

How to specify Iplex Apollo® PVC-O Pipe and Installation

Iplex Apollo® PVC-O and Iplex Apollo Blue® PVC-O pressure pipe should be specified as follows, for inclusion in project Tender Documents and Local Authority engineering specifications.

Pipe Identification - Series 1 PN 12.5

Iplex Apollo® PVC-O Bi-axially-orientated PVC (PVC-O) pressure pipe, DN (100 / 150 / 200 / 300), Pressure class PN 12.5, Design Material Class 400, Design Coefficient 1.6, conforming to AS / NZS 4441, coloured... (white = potable water / raw water / industrial/ pressure sewer*, purple = recycled water, cream = pressure sewer).

Pipe Identification - Series 1 PN 10

Iplex Apollo® PVC-O Bi-axially-orientated PVC (PVC-O) pressure pipe, DN (100 / 150 / 200 / 300), Pressure class PN 10, Design Material Class 315, Design Coefficient 1.6, conforming to AS / NZS 4441, coloured...(white = potable water / raw water / industrial / pressure sewer*, purple = recycled water, cream = pressure sewer).

Pipe Identification - Series 2 PN 16 DI OD compatible

Iplex Apollo Blue® PVC-O Bi-axially-orientated PVC (PVC-O) pressure pipe, DN (100 /150 / 200 / 225 / 250 / 300), Pressure class PN 16, Design Material Class 450, Design Coefficient 1.6, conforming to AS / NZS 4441, coloured...(blue = potable water / raw water / industrial, purple = recycled water, cream = pressure sewer).

Pipe Identification - Series 2 PN 12.5 DI OD compatible

Iplex Apollo Blue® PVC-O Bi-axially-orientated PVC (PVC-O) pressure pipe, DN (100 /150 / 200 / 225 / 250 / 300), Pressure class PN 12.5, Design Material Class 355, Design Coefficient 1.6, conforming to AS / NZS 4441, coloured...(blue = potable water / raw water / industrial, purple = recycled water, cream = pressure sewer).

*White colour has been widely accepted and used for PVC sewer rising mains in New Zealand, when accompanied by appropriate identification tape marking above the pipe. Cream is another option for PVC-O pressure sewers.

Pipe Installation

- General Installation
  AS / NZS 2032, "Installation of PVC pipe systems"
- Buried Structural Design
  AS / NZS 2566 Part 1 and Supplement 1 "Buried Flexible Pipelines – Structural Design"
- Detailed installation and on-siteTesting
  AS / NZS 2566 Part 2 "Installation"
- Refer to the Iplex Installation Guide "How I Install PVC Pipes" at www.iplex.co.nz

Field Pressure Testing

Field pressure testing of pressure pipes to be in accordance with the relevant test procedures and methods of NZS 4404:2010 - Land developement and Subdivision Infrastracture, Appendix C or AS / NZS 2566 Part 2, Appendix M, including sections M1, M2, M3 and M4. The recommended test pressure should not be less than the maximum design operating pressure, and at the same time not exceed 1.25 times the pipe pressure rating (PN) at any point along the line.

Refer to the Iplex Installation Guide "How I Field Test PVC Pipelines" at www.iplex.co.nz

Figure 12.3 Site handling of Iplex Apollo® PVC-O DN300 S1 PN12.5 in 6m lengths, Timaru City

IPLEX APOLLO® PVC-O
HOW TO ORDER

You can order Iplex Apollo® PVC-O pipe products using the Iplex Apollo® PVC-O product codes below.

Nominal Size	Product Code	Description	Pressure PN (Bar)	Effective Pipe Length (m)
Iplex Apollo® PVC-O Series 1 Pipe				
DN100	Z880.100PN10.6	Iplex Apollo® PVC-O Pressure Pipe	10	6.0
DN150	Z880.150PN10.6	Iplex Apollo® PVC-O Pressure Pipe	10	6.0
DN200	Z880.1200PN10.6	Iplex Apollo® PVC-O Pressure Pipe	10	6.0
DN300	Z880.300PN10.6	Iplex Apollo® PVC-O Pressure Pipe	10	6.0
DN100	Z880.100PN12.5.6	Iplex Apollo® PVC-O Pressure Pipe	12.5	6.0
DN150	Z880.150PN12.5.6	Iplex Apollo® PVC-O Pressure Pipe	12.5	6.0
DN200	Z880.200PN12.5.6	Iplex Apollo® PVC-O Pressure Pipe	12.5	6.0
DN300	Z880.300PN12.5.6	Iplex Apollo® PVC-O Pressure Pipe	12.5	6.0
Iplex Apollo Blue® PVC-O Series 2 Ductile Iron OD Compatible				
DN100	1880.100PN12.5.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	12.5	6.0
DN150	1880.150PN12.5.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	12.5	6.0
DN200	1880.200PN12.5.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	12.5	6.0
***DN225**	**1880.225PN12.5.6**	**Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe**	**12.5**	**6.0**
DN250	1880.250PN12.5.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	12.5	6.0
***DN300**	**1880.300PN12.5.6**	**Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe**	**12.5**	**6.0**
DN100	1880.100PN16.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	16	6.0
DN150	1880.150PN16.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	16	6.0
DN200	1880.200PN16.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	16	6.0
***DN225**	**1880.225PN16.6**	**Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe**	**16**	**6.0**
DN250	1880.250PN16.6	Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe	16	6.0
***DN300**	**1880.300PN16.6**	**Iplex Apollo Blue® PVC-O™ PVC-O Pressure Pipe**	**16**	**6.0**

***Subject to minimum order quantity and availability.**

Explanation of Product Code

e.g. Z880.150 PN12.5.6
Z880 = Series 1 PVC-O with Anger-lock™ Joint
150 = Nominal bore size
PN12.5 = Pressure class in Bar
6 = 6 metre effective pipe length

e.g. 1880.150 PN12.5.6
1880 = Series 2 PVC-O with Anger-lock™ Joint
150 = Nominal bore size
PN12.5 = Pressure class in Bar
6 = 6 metre effective pipe length

IPLEX®
BUSINESS QUALITY MANAGEMENT SYSTEMS

Quality Assurance

All Iplex® manufacturing plants operate under an ISO 9001 Quality Management System (QMS). External certifying bodies carry out regular audits to provide third-party certification of the Company's QMS.

The Iplex® mechanical testing laboratory in Palmerston North is an IANZ accredited facility, providing added assurance that any measurement and testing is carried out professionally and in a technically reliable manner in accordance with international standards.

Applicable Standard	Licence Type	Licence Number	Conformity Assessment Body
ISO 9001:2015	QMS Accreditation	QEC4169	SAI Global
ISO/IEC 17025:2017	IANZ Accreditation	ACCREDITATION NUMBER 61	IANZ
BEST ENVIRONMENTAL PRACTICE-PVC	BEP-PVC	BEP-PVC-0067	ApprovalMark International
AS/NZS 1254:2010	StandardsMark™	SMKP20126 & SMKP20180	SAI Global
AS/NZS 1260:2017	StandardsMark™	SMKP20184, SMKP20185 & SMK1305	SAI Global
AS/NZS 1260:2017	WaterMark	WM 74530	ApprovalMark International
AS/NZS 1477:2017	StandardsMark™	SMK02569 & SMKP20181	SAI Global
AS/NZS 1477:2017	WaterMark	WM 74868	ApprovalMark International
AS/NZS 4130:2018	StandardsMark™	SMKP20400	SAI Global
AS/NZS 4130:2018	ISO Type 5	AMI 74891	ApprovalMark International
AS/NZS 4441:2017	StandardsMark™	SMKP20682	SAI Global
AS/NZS 4765:2017	StandardsMark™	SMK02570	SAI Global
AS/NZS 61386.21:2015	S-Mark	LIC 2901 & LIC 2910	Bureau Veritas

IPLEX® PIPELINES NZ
THE COMPANY

Iplex® is one of New Zealand's leading manufacturers and suppliers of plastic pipeline systems. Iplex® provides products and services throughout New Zealand and to export markets around the Pacific and other international markets. Iplex® has manufacturing operations in Palmerston North, Christchurch and Ashburton, as well as access to the Iplex® Australia network. Iplex® New Zealand have been manufacturing plastic pipelines in New Zealand since 1962.

Plumbing: The Iplex® plumbing sector covers pipes and fittings used within the property boundary. This includes reticulation of potable and non-potable water, sanitary plumbing, wastewater, drainage and gas reticulation. Iplex® have the capabilities of supplying drain, waste and vent pipes and fittings, rainwater systems, traps and accessories.

Civil: Iplex® provides a wide range of solutions for wastewater, drainage and potable water pipeline projects. Manufacturing both PE (Polyethylene) & PVC (Polyvinylchloride) for both pressure and non-pressure (gravity fed) pipeline systems including civil infrastructure, drainage systems and roading systems.

Iplex® also services the following industry sectors:

Energy and Communications: an important sector for Iplex® NZ and there is a wide range of conduits, ducts and fittings available for new development and maintenance projects. The range covers electrical, communication and gas.

Rural: Iplex® also service the rural market providing pipes and fittings for rural use. Iplex® provide systems for irrigation, stock water, land drainage, culverts and farm dairy effluent.

Iplex Pipelines manufacturing plant and distribution hub in Palmerston North, New Zealand

IPLEX APOLLO® DESIGN & INSTALLATION GUIDE
SEPTEMBER 2023

LIMITATIONS

The information contained in this document is current as at September 2023 and is based on data available to Iplex® Pipelines NZ Ltd at the time of going to print.

All photographic images are intended to provide a general impression only, and should not be relied upon as an accurate example of Iplex® Pipelines NZ Ltd products, installed in accordance with this document or the referenced compliance documents.

This publication replaces all previous editions of the Iplex Apollo® PVC-O Design & Installation Guide. Iplex® Pipelines NZ Ltd reserves the right to change the information contained in this document without prior notice. It is your responsibility to ensure that you have the most up to date information available. You can call toll free on 0800 800 262 or visit www.iplex.co.nz to obtain current information.

Iplex® Pipelines NZ Ltd has used all reasonable endeavours to ensure the accuracy and reliability of the information contained in this document. However, to the maximum extent permitted by law, Iplex® Pipelines NZ Ltd assumes no responsibility or liability for any inaccuracies, omissions or errors in this information nor for any actions taken in reliance on this information. Pipes and fittings have been shown as typical configurations, however, in some cases product dimensions may vary or be changed without notice. In all instances, the reader should contact Iplex® Pipelines for clarification that the specific product is appropriate for their circumstance.

TRADEMARKS

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