Dux

secura Gold

SOLID SIMPLE SECURE

PROVEN IN NZ FOR OVER 30 YEARS

Technical/Installation Manual

V3 - 2022

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Contents

Introduction to Dux Industries Limited

Dux Industries Limited has been, and remains, synonymous with plumbing in New Zealand. Starting from humble beginnings as a small engineering firm based out of Wellington in 1936. Dux introduced the iconic Centreflush in 1964, quickly followed by New Zealand's first plastic wastewater traps in 1966. Dux has grown into a competitive force able to offer the plumbing industry of New Zealand a large and growing range of plumbing and drainage solutions.

Dux revolutionised the plumbing market in the early 1990's introducing the SecuraGold™ system for Hot & Cold Potable Water reticulation using polybutene-1 pipe and de-zincification resistant brass fittings that have grown into one of New Zealand's most commonly used piping systems used in New Zealand.

Today, Dux has a strong focus on innovation and collaboration and providing our customers with solutions developed to improve efficiency by regular engagement with plumbers Dux frequently investigates new fitting or pipe solutions and regularly holds plumber focus groups to gain feedback from plumbers using Dux product, as well as competitive product.

WaterMark Standards

All materials and components used in the SecuraGold™ range are sourced and produced in ISO accredited facilities and holds Australian Water Mark licence number 1289.

CERTIFICATE OF CONFORMITY

SAI Global hereby grants:

Dux Industries Limited

32 Mahia Road, Manurewa, Auckland, New Zealand

WaterMark Certificate of Conformity – Level 1

Evaluated to:

AS/NZS 2642.3:2008 - Polybutylene (PB) plumbing pipe systems - Mechanical jointing fittings for use with polybutylene (PB) pipes for hot and cold water applications

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Issued : 2 February 2017
Expires : 31 March 2022

Originally Certified : 1 April 2011
Current Certification : 2 February 2017

Nicole Grantham
General Manager SAI Global Certification Services

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Product Type:	Polybutylene (PB) Pipe
Product Use:	Cold and Heated Water Supply
Brand:	DUX
Certification Specification/s:	AS/NZS 2642.2:2008 Amdt1 November 2018 Polybutylene (PB) plumbing pipe systems Part 2: Polybutylene (PB) pipe for hot and cold water systems

Issue Date 22nd February 2019
Initial Issue Date: 30th October 2006 (SAI G)
Expiry Date: 21st February 2024

Paul Greig
General Manager

Certificate No.: 1289/1

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Certificate Number: 1289
Issue Date: 22nd February 2019
Issue: 01 Revision: 00

The SecuraGold™ piping system complies with all relevant requirements of the following standards and Codes:

AS/NZS3500	AS/NZS1568
AS/NZS2642	AS2345
AS/NZS1567	C35200

SecuraGold™ meets the requirements of the New Zealand Building Code Clause G12 Water Supplies when installed by a registered plumber to the requirements of this Technical Manual.

Durability

Where SecuraGold™ is Installed by a registered plumber and meets the requirements of this Technical Manual, SecuraGold™ can be expected to meet the requirements of Clause B2/AS1 Table 1 Durability Requirements for Nominated Building Elements (Plumbing and Piping).

Section One – Polybutene Pipe properties

Polybutene-1 (PB-1) resins are high molecular weight isotactic, semi-crystalline thermoplastic polyolefins produced through the polymerisation of Butene-1, Ethylene, and/or Propylene co-monomers.

Polybutene-1 combines the typical characteristics of polyolefins with a unique property mix of high flexibility and outstanding creep resistance over a wide temperature range. Due to a similar molecular structure, PB-1 is very compatible with Polypropylene (PP) and Propylene based thermoplastic elastomers. PB-1 is easily dispersible in Polyethylene (PE) notwithstanding its limited molecular compatibility. SecuraGold™ PB-1 is extruded from grade 4267 PB-1 resin manufactured by Lyondell Basell.

Polybutene-1 Properties	
Temperature	Polybutene-1 will withstand all temperatures in a normal Hot & Cold water reticulation system and can endure temperature variations from -50˚C up to 99˚C. However, restrictions are in place to ensure that H&C systems are protected and under AS/NZS 3500 a maximum temperature of 80˚C should be adhered to.
Freezing	Ice formation will not cause damage to the pipes in a system that has relatively long lengths of pipe as the natural flexibility will accommodate the expansion caused by ice, the pipe will return to its normal state upon thawing. However, a small section of pipe may not have enough flexibility to prevent damage, it is recommended that the minimum length of pipe required to prevent damage is 500mm without lagging. If this length cannot be maintained lagging is essential in areas prone to freezing. Always check with your local council for any specific lagging requirements.
Bending and Flexing	Polybutene-1 pipe can be repeatedly flexed with the smallest bend radius being eight times the outside diameter of the pipe. Care should always be taken when bending pipe to ensure that the pipe does not kink. If a pipe is kinked, then that section should be cut out and not used.
Pressure	Polybutene-1 is pressure rated to PN16 at 20˚C. Due to the standard pressure/temperature relationship, the allowable pressure decreases as temperature increases.

Mechanical	Polybutene-1 is a strong and robust material, its strength is not significantly impacted with temperatures and pressures found in normal residential H&C reticulation systems. It exhibits the highest creep resistance of any of the polyolefins and as a result retains its strength even under long term stress.
Chemical Resistance	Polybutene-1 is resistant to a large number of chemicals including soaps, detergents, acids and alkalis as well as many solvents however, there are a number of chemicals that will attack and damage Polybutene -1, a full chemical resistance chart can be found in Section 4.
Thermal	Polybutene-1 has a high thermal insulation value. This means the pipe will not allow the temperature of the water to drop quickly, so cold or hot water will maintain their respective temperatures between opening of the taps for a longer period making Polybutene-1 more energy efficient. The expansion rate of Polybutene-1 is unusual for a plastic as it is only 1.3×10^4 m/m/˚C the thermal conductivity rating is 0.22 W/(m.k).
Volatile Organic Compound (VOC) Rating	Polybutene-1 pipe is very inert and has been tested for the release of Volatile Organic Compounds and complies with EN852-1, ISO 4120 and ISO 5495, as part of the WaterMark certification Polybutene-1 is required to pass AS/NZS 4020 Testing of products for use in contact with drinking water. Polybutene-1 has a VOC rating of <0.02 mg C/L and <0.02 mg C/m²/day
Electrical	Polybutene-1 has good dielectric properties over a wide range of ambient conditions so is an excellent insulator. Warning – because of its good insulation qualities Polybutene-1 cannot be used for earthing or bonding, a bonding lead should be connected to both ends of any existing metal pipe work.
Anti-Fouling	Due to its relatively high thermal insulation value, exceptionally smooth bore, and high abrasion resistance, scale build up does not normally occur which ensures the maintenance of high flow rates throughout the working life of the pipe.
Water Hammer and Surge	Polybutene-1 can withstand the effect of water hammer because of its high elastic modulus. Polybutene-1 dampens, rather than propagates, pressure waves reducing any associated pipe noise. Under extreme conditions of service water hammer arrestors may be necessary.
Fire Resistance	Polybutene-1 is not a highly flammable material but will still burn, the by products from burning are not toxic or harmful if inhaled.

Performance Characteristics

PB-1 satisfies the demands of the hot and cold pressurised water pipe market with the right balance of properties, including excellent flexibility combined with superior resistance to stress over long periods of time at high temperatures. As a result, PB-1 piping systems are easy to work with, economical to install and deliver long-term performance quality in residential and light commercial piping applications.

Flexibility

	PB-1	PEX	PE-RT	PP-r	PVC-C
Flexural Elasticity Modulus (MPa) Method ISO 178	450	600	550 - 650	800	3500

The advantages of a flexible pipe like PB-1 are translated directly to installation costs, it stands to reason that when a pipe is flexible it is far easier to work with than a more rigid pipe, resulting in faster installation and therefore reduced installation costs.

WelTec carried out a study to determine which system was consistently faster to install, with SecuraGold™ proving to be 45% faster than the nearest competitor system.

Care must be taken as while PB-1 is very flexible, the minimum bend radius of 8 times the pipe diameter should not be exceeded as it will cause the pipe to kink. If the pipe does kink it must be removed from the installation and replaced.

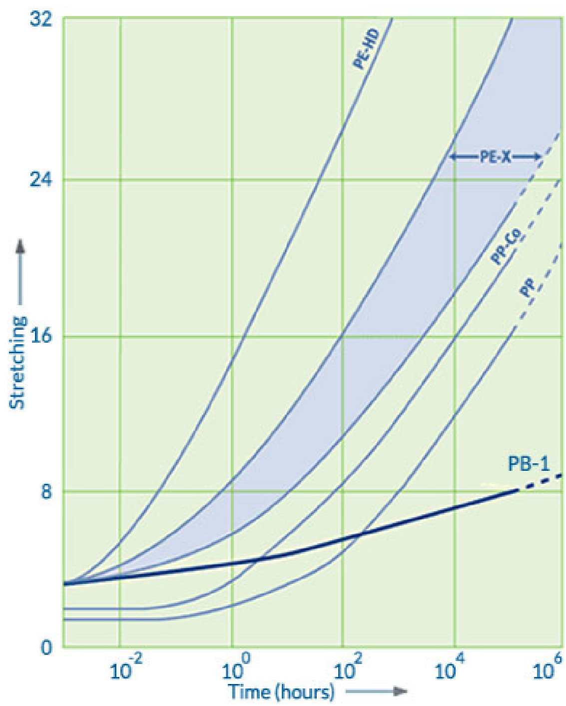
Creep Resistance

Creep is the amount of stretch or give in a material under a given load over time. In pipe systems internal and external pressure works to stretch, expand, pull, and push material away from the point load of a joint or seal.

One of the most important properties or characteristics which sets PB-1 apart from other materials is its outstanding resistance to internal pressure creep over a wide range of temperatures.

All polyolefin materials tend to creep when exposed to continuous applied stress over a long period of time. This cold flow behaviour can be suppressed by creating a three-dimensional network in the polymer structure by either physical or chemical cross linking, as can be found in the manufacture of PEX pipes.

In contrast to other thermoplastics used in these applications, performance modification via compounding, cross-linking or copolymerisation is not necessary for PB-1 piping systems to fulfill the stringent performance standards applied to their use.



In comparison with other polyolefin materials, PB-1 has a higher level of resistance to strain under continually applied stress over long periods of time. This is known as creep behaviour and the graph illustrates the increasingly superior performance of PB-1 over other pipe materials.

The variation you can see in the PEX material is due to the varying processes used to cross link the material of which there are three main methods, (Engel or peroxide method PEX-a, Silane method PEX-b and the Electron Beam method which uses very high energy radiation for PEX-c). Each of these cross-linking processes are open to manufacturing variations which can have a marked effect on how well the cross linking is carried out in contrast to PB-1 where there are no additional modifications necessary.

Acoustic Characteristics

What is water hammer?

Water hammer is a pressure surge or wave resulting when a fluid in motion is forced to stop or change velocity.

Water hammer commonly occurs when a valve closes suddenly at the end of a pipeline system, and a pressure wave propagates in the pipe, it is also known as hydraulic shock.

A significant, nearly instantaneous pressure shock wave may be generated when a valve opens or closes too quickly, or when a pump starts with an empty discharge line or suddenly shuts down. This phenomenon is the result of the sudden change in velocity of the fluid flow in combination with the characteristics of the piping. This shock wave is manifested by a series of hammer blow-like sounds, called water hammer, which may have sufficient magnitude to cause catastrophic failure within the piping system.

There are five factors that determine the severity of water hammer:

- Velocity
- Modulus of elasticity of the pipe material
- Inside diameter of the pipe
- Wall thickness of the pipe
- Valve closing time

The maximum surge pressures caused by water hammer can be calculated using the following equation taken from the 'Handbook of Thermoplastic Piping System Design', Thomas Sixsmith and Reinhard Hanselka, Marcel Dekker Inc., pp 65-69.

Ps = V((3960 E t)/(E t + 3 x 105 DI))½

where:

Ps = surge pressure (psi/bar)

V = water velocity (ft/sec)

DI = inside diameter of the pipe (in)

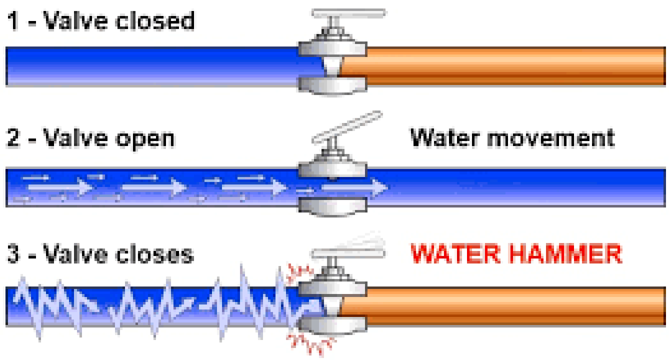
E = modulus of elasticity of the pipe material (psi/MPa)

t = pipe wall thickness (in)

The low elastic modulus of Polybutene-1 combined with reduced wall thickness gives rise to a low surge pressure for a given pipe Outer Diameter (OD) and pressure rating. The table below compares maximum surge pressure for 38.1 mm (1-1/2") OD pipes of different plastic materials, designed for the same pressure service.

	E	E	DI	t	V	Ps	Ps
	[psi]	[MPa]	[mm]	[mm]	[ft/s]	[psi]	[bar]
PB-1	65000	450	32.5(1.28")	3.8(0.15")	5.0	49.5	3.4
PEX	87000	600	28.9(1.14")	5.6(0.22")	5.0	72.4	5.0
PP	116000	800	26.7(1.05")	6.6(0.26")	5.0	93.0	6.4
CPVC	117000	3500	30.9(1.22")	4.6(0.18")	5.0	140.6	9.7

Water hammer is a prevalent issue with more rigid pipe systems and can be quite catastrophic in extreme cases, in these types of incidences water hammer arrestors are required, adding significant costs to the plumbing installation. If water hammer goes unchecked the resulting damage may not be immediately evident but will over the medium-term damage the system as well as the fixtures resulting in large maintenance and repair costs.

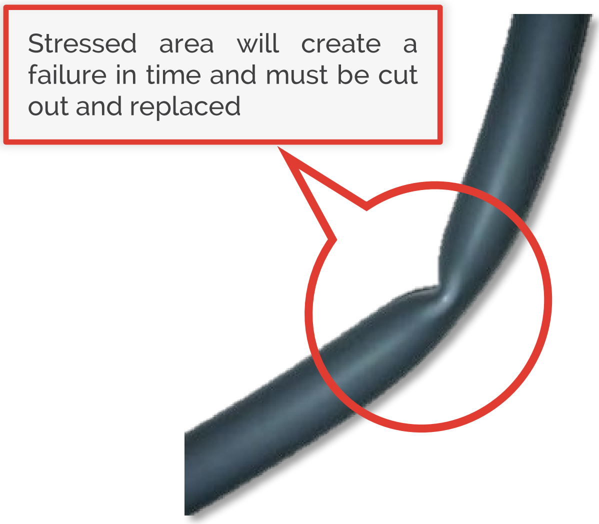


PB-1 systems such as SecuraGold™ do not experience this issue to the same degree.

Bending, Flexing and Changes of Direction

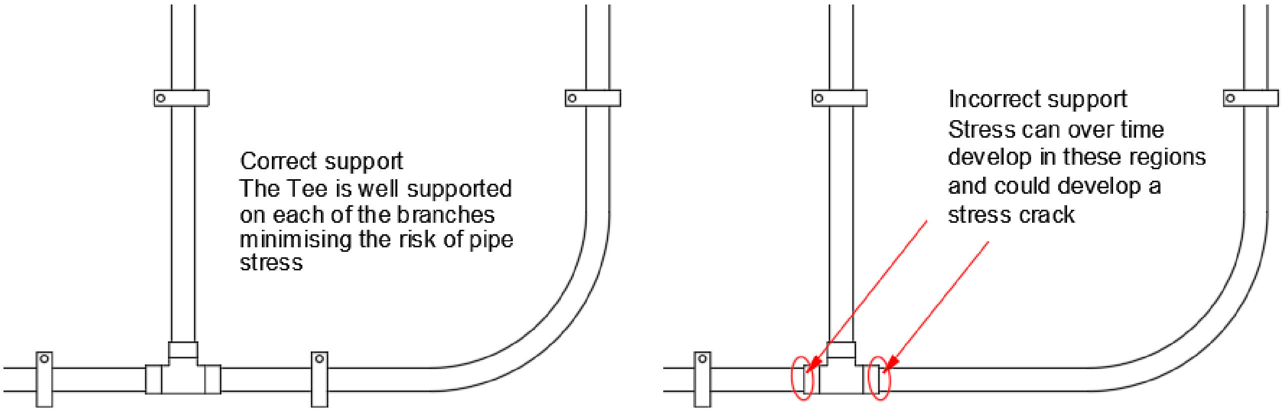
Polybutene-1 pipe is extremely flexible and can be repeatedly bent and flexed with no harm to the pipe. There is an absolute bend radii limit of 8 times the pipe diameter however, it is recommended that no more than 10 times the pipe diameter should be used, extreme bends and kinks will place very high local stress on the pipe wall.

When a pipe is kinked, apart from the obvious collapse of the pipe wall the two sides develop stress marks, seen as whitish areas at the pinch points. These stressed areas will have damaged the walls integrity and will be the point of failure in a reasonably short time. Always check your installation, if any section of pipe has accidently kinked it must be cut out and replaced. If you need to turn a pipe in a tight area it is advisable to use either a 90˚ elbow or multiple 45˚ elbows to negotiate the area.



Wherever there is a change of direction involving a fitting, protection against stress is important and correct application of pipe clips is essential. To ensure that the pipe is stable during the lifetime of an installation especially in areas where a pipe is to be bent around a tight area the correct use of Dux Pipe clips needs to be carried out.

Below is an example of a fully supported fitting and bend and an incorrectly supported bend.



Chemical & Corrosion Resistance

PB-1 is a chemically inert product and as such the chemical and corrosion resistance is very good, a full chart of known resistances can be found as an appendix to this manual. While PB-1 is used as the pipe of choice for the SecuraGold™ Hot & Cold system, some of the concentrations of chemicals being dosed into our potable water systems can be detrimental not only to PB-1 but to all pipe systems, metal and plastic. Chlorine (Cl) and chlorine dioxide (ClO_2) used to treat our water supply When maintained to the dosing rate prescribed by the Drinking Water Standards for New Zealand this is not an issue.

We are all keenly aware of the Havelock North incident in August 2016, where the drinking-water became contaminated causing a widespread outbreak of gastroenteritis during which more than 5000 people were estimated to have fallen ill. Consequently, councils around the country began upping their chlorine dosage rates to prevent a similar situation. At times this was extreme, to the point where hundreds of copper cylinders in the Christchurch region had to be replaced. While replacing the cylinders was the immediate symptom there is a longer term effect on the pipework that is yet to really show itself.

Elevated temperatures, normally found in hot lines, will 'excite' the chlorine molecules making them more aggressive. Pipe materials are designed to withstand this for the duration of their service life when at reasonable levels below 5 ppm which is the limit set by the drinking water standards, typically in a well maintained system levels should be around 2 ppm. At 2 ppm you can start to smell the chlorine, at 4 – 5 ppm the smell and taste would be quite noticeable, and it is advised that drinking water for long periods at these levels should be discouraged.

When looking at the Drinking-water Standards for New Zealand 2005 (Revised 2018) we find Table 2.2: Maximum Acceptable Values for inorganic determinants of health significance

Chlorine should have a MAV of 5 mg/L – Free available chlorine expressed in mg/L as CL_2. ATO. Disinfection must never be compromised.

The maximum value of 5 mg/L or 5PPM is the maximum normal value of chlorine in our water outside of maintenance periods.

Hoop Stress, Pressure vs Temperature

The relationship between pressure and temperature states that as the temperature increases then the allowable pressure must decrease. Therefore, when installing hot water systems knowing the incoming pressure is critical to ensuring the integrity of the system being designed and installed.

This relates to HOOP STRESS as shown in the below table taken from AS/NZS 2642.2

Pipe material temperature ˚C	Extrapolated 50-year long term Hydrostatic Strength MPa	Hydrostatic design test
20	13.6	7.6
40	11.5	6.4
60	9.0	5.0
70	7.6	4.2
80	6.3 (25 y)	3.5
95	4.2 (10y)	2.3

Notes:

1. The hydrostatic design stress has been based upon an extrapolated 50-year long-term hydrostatic strength, but 50 years should not be taken as the life of the material under service conditions at elevated temperatures. The expected accelerated polybutene strength deterioration at 80˚C and 95˚C precludes extrapolation for estimates of 50-year design stress levels.
2. The life expectancy of polybutene pipe is dependent on use/temperature profiles. The manufacturer's recommendations should be sought for applications involving continuous use at temperatures above 60˚C.

In AS/NZS 2642.2 we also find the below table, note I have added two additions showing kPa and PSI conversions as a reference:

Working Pressure Rating of Polybutene-1 Pipe						
Class	Working Pressure MPa					
	20˚C	40˚C	60˚C	72˚C	80˚C (25y)	95˚C (10y)
16	1.6	1.37	1.05	0.88	0.74	0.49
kPa	1600	1370	1050	880	740	490
PSI	232	198	152	127	108	71

NOTE: Manufacturer's recommendations should be sought for appliances involving continuous use at temperatures above 60˚C

Straight Coils

The 25m straight coils are an excellent example of innovation, first started by Dux in the early 2000's using the principle that when polybutene is left to cure the molecular memory of the material will remember the state that the pipe was in during the curing period.

During manufacture of the 25m Lay Straight coils at our Auckland facility the extruded pipe leaves the line and is dropped into 25m long beds, these are then left for the required curing time before being coiled. The coils are wrapped around the outside to facilitate easy removal of the pipe via the centre of the coil.

While there may be some slight turning at the start and ends of the pipe the general length of coil should fall out relatively straight, unlike a traditional coil which acts more like a spring and is more difficult to manage.

This simple process gives the plumber a coiled product that behaves like a 25m straight length.

DUX INNOVATION

Unlike others who join a series of 5m lengths to achieve the 25m Lay Straight Coil the Dux 25m coil is a seamless 25m length of pipe ready for installation.

Using Lay Straight coils allows for easier storage, handling and installation while helping to reduce waste. 25m Lay Straight Coils are available in 12mm, 15mm and 20mm and 28mm.

Storage & Handling

Ensuring that the pipe is in the best possible condition prior to installation is essential to an installation. Polybutene is a very durable and tough material but it is susceptible to damage if handled carelessly, it can be squashed, scratched and/or cut accidently so always take care when storing or handling the pipe.

Storage & Handling
When storing bags or individual lengths of 5m straights for any length of time, lay them flat and out of direct sunlight
Coils should be stacked on a pallet with a sheet of cardboard between the wood and the pipe coil
Coils should not be hung unless a purpose-built hangar has been manufactured that avoids point damage to the pipe is available
Avoid placing heavy or sharp objects on the pipe
Avoid storing coils or lengths in areas where there is the possibility of a heat source or naked flame coming into contact with the pipe
Do not drag bags of 5m straights across tarmac, concrete, or rough surfaces
Do not roll coils across tarmac, concrete, or rough surfaces
Plastic pipes including polybutene are not UV resistant and should be stored away from direct sunlight. UV rays will degrade the molecular composition of the material and will impact on the serviceable life of the pipe and could result in premature failure

WARNING – poor storage can be the cause of damage, a scratch or cut to the pipe affecting more than 10% of the wall thickness will result in a premature failure when under long term pressure.

Section 2 – SecuraGold™

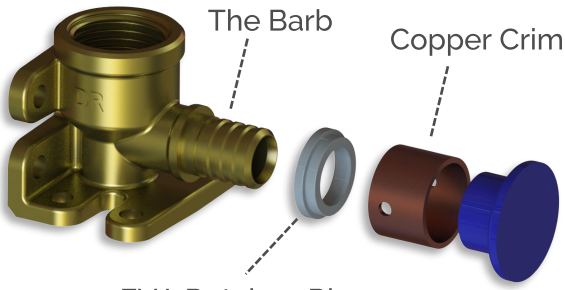
The full range of the SecuraGold™ system includes four pipe sizes, 12mm, 15mm, 20mm and 28mm all available in the standard grey with varying lengths in both straights and coils.

Apart from the grey PB-1 there is also available Lilac (grey water – non-potable), and Green (rainwater).

With over 80 fully DZR compliant brass fittings, 10 standard tools, 1 power tool, 1 pipe cutter, four sizes of pipe clips and a range of accessories, SecuraGold™ is a comprehensive system that will provide a solution for the professional plumber in most residential situations.

All SecuraGold™ fittings are engineered and manufactured to exacting tolerances and standards with all fittings except for the brazing tails (SBT3 & SBT4) comprised of the following four basic components:

- De-zincification resistant brass body
- Copper crimp ring
- EVA retaining ring (Not supplied with the brazing tails due to the nature of connection to copper)
- LDPE protective end cap



De-zincification Resistant Brass

Brass fittings manufactured for SecuraGold™ are all WaterMark certified under license WMKA 1289, WaterMark certification requires a set standard to be maintained, an annual audit is carried out at manufacturing sites as well as a 5-year full re-certification process to ensure SecuraGold™ fittings continue to meet the required standards.

To ensure that SecuraGold™ fittings meet the dezincification standards they undergo the stringent test requirements of AS2345 Dezincification Resistance of Copper Alloys. Each batch of brass is checked prior to the fittings being manufactured, followed by samples being taken after production for testing, and when they arrive at Dux QC additional samples are taken for verification through an independent and certified laboratory to triple check they meet standards.

Material

The makeup of dezincification resistant brass is primarily copper and zinc, trace elements of a number of other chemicals are added for stability. The exact proportions of each component are detailed in AS/NZS 1567 and AS 2345, DZR brass is recognised and adopted worldwide as a premium alloy suitable for water fittings. This standard sets out a number of test requirements that all have to pass, a failure in any of the tests would mean that the products would not be certified.

Mechanical

Dezincification Resistant (DZR) brass is a tough and very durable material that has exceptional forging and machining properties and can withstand very high temperatures and pressure as well as impact damage. These properties allow DZR brass to withstand the rigors of installation and deliver decades of uninterrupted service under a variety of operating conditions.

Corrosion

DZR brass is ideally suited to a hot and cold potable water system and under normal conditions will not corrode and/or be affected by erosion corrosion. However, if the connection between two fittings is not made secure, water at high pressure if allowed to bypass a seal will cut through any material.

Dezincification

Dezincification or de-alloying is a process whereby zinc is leeched from a brass alloy, this occurs especially in stagnant conditions. Dezincification selectively removes zinc from the alloy, leaving behind a porous copper rich material without any structural strength.

There are two forms of dezincification, plug and uniform. Plug-type affects localised areas of a fitting and penetrates deeply into the wall of the fitting, resulting in weeping or seepage in isolated areas. Uniform as shown in the photo of the valve is a general dezincification effect that covers the full body of a fitting causing the walls to thin and break down.

Photo 1: The valve has been severely affected by dezincification and shows all the classic signs – the white powder is zinc oxide while the brass alloy (red area) is now a copper rich material. It has crumbled away due to there being no structural strength.

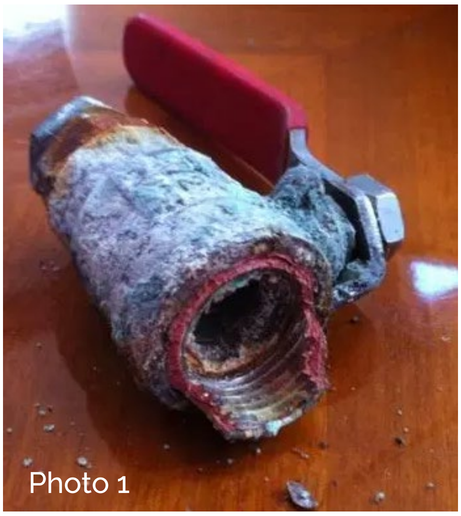


Photo 1

Photo 2: Shows an example of plug-type de-zincification, the photo shows the internal structure of the Plug Type within a body of brass. This type is more difficult to identify as it attacks mainly below the surface and only starts showing as small specs of white powder initially.

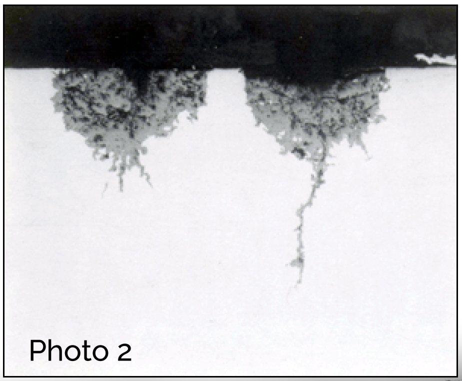


Photo 2

Dezincification requires a complex set of conditions for dezincification to occur including:

- Water with high levels of oxygen and carbon dioxide (Uniform attack)
- Stagnant or slow-moving water (Uniform attack)
- Slightly acidic water, low in salt content and at room temperature (Uniform attack)
- Soft, low pH and low mineral water combined with oxygen, which forms zinc oxide (Uniform attack)
- Waters with high chloride ion content (Uniform attack)
- Neutral or alkaline waters, high in salt content and at or above room temperature (Plug-type attack)

Environmental

SecuraGold™ DZR brass fittings are 100% recyclable.

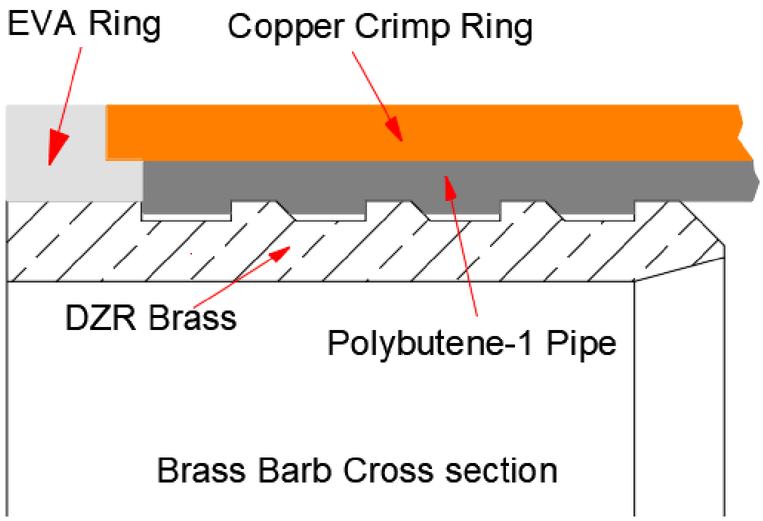
Electrical

IMPORTANT – DZR brass fittings will conduct electrical energy, however as the fittings are installed as part of a non-conductive plastic pipe system SecuraGold™ fittings must never be used for earthing purposes.

Crimping

Crimping technology has been around for a very long time and has proven to be one of the most secure, and faster, methods of sealing a pipe onto a fitting. SecuraGold™ fittings rely on this 'simple' technology to ensure a watertight connection and while it may seem simple there is a lot of engineering behind the parts that all have to interact correctly under the right tolerances to achieve a solid, secure result.

What we can see in the sketch below is the stylised interaction between the components of the fitting and the pipe.



As the copper crimp ring is crimped pressure is applied to the pipe wall which in turn forces the pipe material to close around the barbs creating the seal. The shape of the barbs also acts as a drag on the material preventing pull out under pressure.

If once the fitting has been crimped it is then cut open what you will see on the internal bore of the pipe is a set of witness marks that are a perfect negative image of the barb profile.

If the witness marks are well defined and unbroken it is a sure sign that the crimp was well made, if there are any 'soft' areas where the witness marks fade then this would indicate that there has been a fault either with the components, the tooling, or simply the method of crimping.

The action of making a crimp is carried out in the same manner whether or not it is a power or hand tool. The crimper has a set size and when the two jaws meet the compression of the copper ring should have compressed the copper ring firmly down onto the pipe. With each tool an accompanying gauge tool is provided, this gauge tool gives the plumber the ability to quickly confirm if the crimp has been made correctly.

After the fitting has been crimped the gauge tool suitable for the size of fitting should be able to slip over the copper crimp ring with no force, and freely moved around the circumference of the ring without 'sticking'. Checking crimps with the gauge tool would ideally be carried out after each crimp but should be done at regular intervals throughout an installation.

Magnum Crimp Gauges

Iwiss Crimp Gauge

When the gauge tool is prevented from passing over the crimp ring smoothly or sticks when being moved around the circumference of the crimp ring there is a likelihood that the tool being used needs calibration.

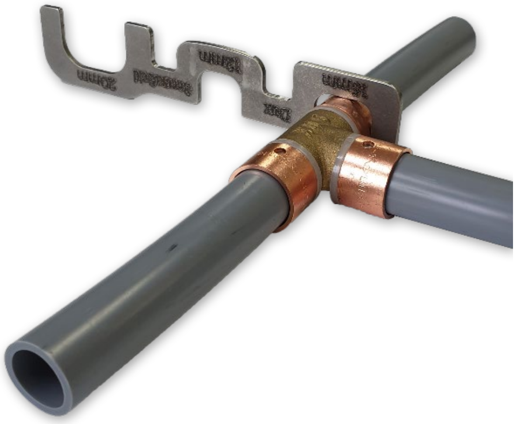
Making a crimp – a four step process

Step 1 – Check that the pipe being used is free from damage, cuts, and score marks as these will lead to premature failure if ignored. Cut the pipe with the correct pipe cutting tool, cutting with a knife or hacksaw will not give a clean straight cut.

Step 2 – Select the appropriate fitting required, remove the protective end cap, and insert the pipe fully into the fitting. The copper crimp ring has two pre-punched eye spy holes that will show the position of the pipe against the retaining ring, if the grey pipe material is visible in these holes then the pipe is correctly inserted

Step 3 – Position the jaws of the crimp tool being used midway on the copper crimp ring and close the handles fully on the tool. When the handles are fully closed it is best practise to hold at this point for a second or two, this ensures that the full compression has been applied to the fitting.

Step 4 – Check the crimp with the gauge tool as previously discussed ensuring that the gauge tool slips easily over the copper crimp ring and can then rotate freely around the circumference of the ring without 'sticking'



If the gauge of the copper crimp ring passes the gauge test, then the fitting is good to go. However, if the gauge tool does not pass over the copper crimp ring freely it is advisable to remove and replace the fitting before you carry on with the installation check that the tool is calibrated correctly.

Note: Under-crimped joints may fail under the long-term pressures of an installation and need to be replaced. If a joint has been found to weep during a hydrostatic test do not re-crimp the fitting cut it out and replace as the pressure of a hydrostatic test can move the pipe under the fitting and break the watertight seal.

The sample photo below shows the damage to the witness marks that can occur.

Tool Maintenance

It is important to ensure that the tools are correctly calibrated and serviced regularly, Dux Industries Territory Managers provide this service free of charge. You can however service and/or calibrate your own tool with a little care.

Servicing

The Magnum and Iwiss tools are susceptible to dirt and grime getting into the internal components that operate the tool, this can cause binding and will prematurely wear out the components and pins. Always ensure the tools are cleaned at the end of the day or when you get back to the workshop. A quick blow out with compressed air will clear the tool of most particles but may need a good cleanout dependent on the environment the tool was used in.

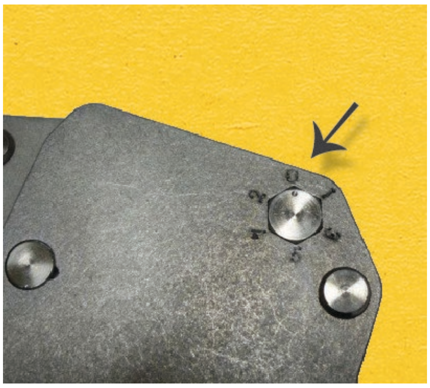
A general 3 in 1 oil can be used to re-lubricate the tools, light lubricants such as CRC are not recommended as the oil does not stay on the pins for any length of time.

Calibration

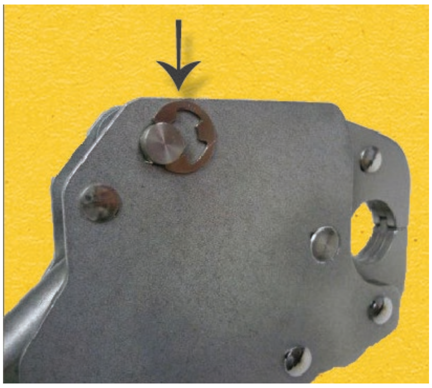
Tool calibration is a relatively simple process for all the manual tools however, care should be exercised when releasing the adjustment clip/bolt on the Magnum and Iwiss tools.

Magnum & Iwiss Crimp tools

Step 1 – Identify the position of the small dot



Step 2 – Remove the E type circlip



Step 3 – Tap out the adjustment bolt until the head is clear of the body. Reposition the dot to the next number, one graduation at a time. Tap in the adjustment bolt until it is flush with the body

Step 4 – Reposition the E type circlip.

Once you have adjusted the tool check it by crimping another fitting, if the fitting does not gauge repeat the above steps or call your local Dux Territory Manger for assistance.

Alba Crimp tools

Step 1 – Identify the position of the small dot

Step 2 – Loosen the Nylock nut

Step 3 – Re-position the dot in the direction of the + arrow, one graduation at a time

Step 4 – Tighten the Nylock nut.

Once you have adjusted the tool check it by crimping another fitting, if the fitting does not gauge repeat the above steps or call your local Dux Territory Manger for assistance.

Section 3 – Installing SecuraGold™

Frequently Asked Questions		
1	What temperature (upper and lower) can Polybutene withstand?	Polybutene can withstand a wide range of working temperatures from -50˚C up to 95˚C however, certain restrictions need to be adhered to, reference P.14 for the Pressure/temperature relationship.
2	What is the maximum pressure that Polybutene pipe can safely withstand?	The rating for Polybutene according to AS/NZS 2642 at 20˚C is 1600kPa however, the temperature and pressure relationship must be considered. The Working Pressure chart on P.14 details the maximum pressure allowed at a given temperature.
3	When installing a 12mm hot line what is the maximum distance it can be run?	To maintain efficiency and speed of delivery it is beneficial to maintain a volume of less than 2 litres of water in your pipeline. 12mm Polybutene pipe holds only 0.073 L/m, that equates to 1.46 litres in a 20m length. 12mm Polybutene pipe will give you maximum efficiency of heat transfer to the outlet.
4	What type of silicone can I use with Polybutene pipe?	Always use a neutral cure silicone with Polybutene pipe as this will not leach any chemicals or affect the taste of the water.
5	When bending Polybutene what are the restrictions?	Polybutene pipe is very flexible and can be repeatedly bent into a tight radius. A radius of 8 x the outside diameter is possible however, to be safe 10 x Diameter is recommended as there is the risk of kinking the pipe if the bend is too tight.
6	When installing Polybutene through polystyrene is protection required?	No, polystyrene is an inert material and will not affect or leach chemicals into the pipe.
7	When tightening a crox nut how many turns of the nut are required to create a seal?	When connecting a crox nut hand tighten until you feel the two sealing surfaces meet and then complete one full turn of the nut.
8	How do I check the gauge of a copper crimp ring correctly?	The gauge tool must be able to slip over the copper ring smoothly and then be able to freely rotate around the circumference without sticking.
9	How many times can a copper crimp ring be crimped?	Only once, additional crimping of the same fitting can be detrimental to the copper.
10	Does the 'seeing eye' on the copper crimp ring compromise its integrity?	No, independent laboratory tests have found there is no basis to this claim. Additionally, there are no recorded failures of SecuraGold™ fittings due to the copper crimp ring.

11	Can Polybutene pipe be installed underground?	Polybutene pipe can be installed underground when care is taken to protect the pipe from damage. If fittings are to be installed underground, they must be well protected and should be wrapped in a Denso style tape with a further protective layer of Mastic to ensure that the fitting is watertight and protected from the surrounding ground conditions.
12	Can Polybutene pipe be installed in direct sunlight?	No, the UV rays are detrimental and will over time break down the material. If pipe is to be installed in an area where there is a potential for direct sunlight, the pipe must be fully protected either with a protective conduit or by painting the pipe with an acrylic paint.

Site and Installation Preparation

Taking the time to work out the route that a pipe out will take within the framework of a new build will allow you to plan the most efficient path for your pipes, specifically the hot water lines. Checking the flow rates and/or pressure losses expected will identify the ideal pipe size to run and the most efficient routes to give the quickest heat transfer to each outlet.

Using 12mm pipe, where possible, has major benefits in terms of heat transfer and overall efficiency to bathroom or kitchen taps allowing the hot water to arrive sooner due to the low volume held within the pipe length. Calculators are available on the Dux website to assist with planning plumbing projects.

Always pre-check your tools are in good condition, if able check that their calibration is correct and that you have enough pipe and fittings to complete the required installation. Always ensure you have a few red pipe clips on hand ready for use when laying the hot lines. Using these at the start and intermittently along the run will ensure the hot and cold pipes are not accidently crossed over.

Check the condition of the pipe prior to installation for transport damage such as cuts, kinks or crush damage, check the ends haven't been damaged from being dragged across rough surfaces, typically this type of damage is a result of poor handling and can be avoided by taking a little extra care when picking up from a merchant. The 25m lay straight coil is an excellent example, these coils are relatively compact and easy to transport and with the pipe 'remembering' its original condition of being straight it can be uncoiled almost as well as a full 25m straight length.

Code of Practice and Local Authority Approvals

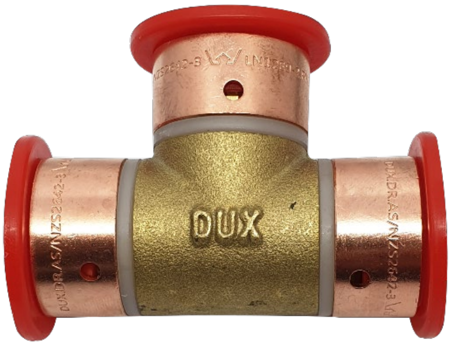
Dux SecuraGold™ is fully certified under the WaterMark licence WMKA 1289 and complies with all necessary standards for use as a potable hot and cold water system in New Zealand. If there are special conditions that a council requires please discuss these with your local Territory Manager who will pass any queries onto the technical team for a response and/or clarification where needed.

System Identification

All pipes are marked with various amounts of information, each metre of pipe has the following:

The information shown from left to right, brand – Dux, size of pipe – 20mm, pressure rating – 16 Bar, material – PB (Polybutene), extrusion line – Line 2, WaterMark logo, standard the pipe is manufactured to – AS/NZS 2642.2, WaterMark licence – 1289, date of manufacture – 1st June 2011 (for this section of pipe) and the time of manufacture 1:30pm. As well as this detail 5mm graduation lines are printed along the full length of the pipe.

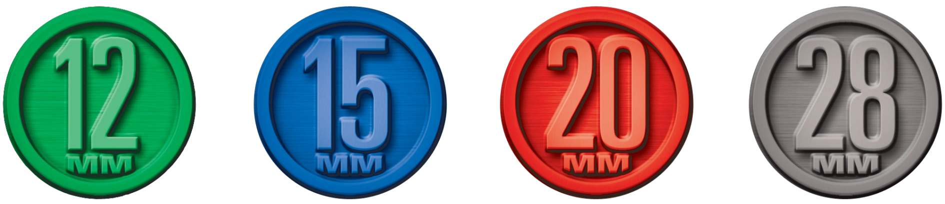
Fittings are marked on the copper crimp ring.



DUX.DR.AS/NZS2642-3 W LN1289-1.PN16.DN22

As with the pipe the information shown includes the brand – Dux, DR symbolising the De-zincification resistance, AS/NZS 2642.3 – the standard, W representing the WaterMark logo, licence number 1289, pressure rating – 16 Bar and the size of the pipe in DN22 (Diameter Nominal) – 20mm

SecuraGold™ brass fittings are available in four sizes – 12mm, 15mm, 20mm & 28mm and feature coloured end caps that protect the integrity of the fitting, allow for quick size identification and match the handle colours of the Magnum and Iwiss tools.



Pipe Fixing

Polybutene pipe the same as all other pipe material variants requires fixing and support in an installation, AS/NZS3500.1 in 5.6 Support and Fixing Above Ground specifies the positioning of these supports in a vertical and horizontal plane. Below has been extracted from this standard verbatim for absolute clarity:

5.6.1 General

	Horizontal Clip		Vertical Clip
	HOT	COLD	
12 mm	500 mm	600 mm	1200 mm
15 mm	500 mm	600 mm	1200 mm
20 mm	600 mm	700 mm	1400 mm
28 mm	600 mm	750 mm	1500 mm
Continuous support tray	2.5 m		

Water services installed above ground shall be retained in position by brackets, clips, or hangars.

5.6.2 Brackets, clips, and hangars

Brackets, clips, and hangars shall be-

a) Formed of material compatible with pipe;
b) Securely attached to the building structure and not to any other service;
c) Designed to withstand the applied loads;
d) Where exposed to a corrosive environment, protected against corrosion;
e) Of like material or lined with a non-abrasive, inert material for that section where contact with the piping may occur;
f) Clamped securely to prevent movement, unless designed to allow for thermal movement;
g) Restrained to prevent lateral movement; and
h) Installed so that no movement can occur while a valve is being operated and so that the weight of the valve is not transferred to the pipe.

5.6.3 Limitations of pipe supports

The following applies:

a) Pipes shall not be supported by brazing or welding short sections of any material to the pipe surface, nor by clamping, brazing, or welding to adjacent pipes.
b) Brackets, clips, and hangars incorporating PVC shall not be used in contact with stainless steel pipes.

5.6.4 Spacing

Water services shall be supported and fixed at the intervals specified in Table 5.6.4.

5.6.5 Securing of pipes and fittings

Any pipe or fitting that may be subjected to strain or torsion shall be positively fastened against twisting or any other movement.

Installation of Heated Water Systems

When installing a heated water system there are several key factors that need to be considered:

a) Reduce, to a minimum, the amount of cold water in a line before hot water flows from a tap
b) Sufficient flow from all outlets to meet the requirements of G12/AS1
c) Be by the shortest practicable route for the main flow heated water pipes and branches to the heated water outlets; and
d) Be the minimum necessary diameter required to supply the outlet draw off

Water flow velocities in heated water piping up to 65°C shall be in accordance with AS/NZS 3500.4 Clause 1.8. Velocity Requirements, the below table shows these values:

Maximum Allowable Velocities		
Piping	Maximum Allowable Velocities (m/s)	
	Copper Pipe	Other materials
Circulatory (flow)	1.2	2.0
Circulatory return line	1.0	1.0
Non-circulatory (flow)	3.0	3.0

Notes:

1. Circulatory piping means piping where there is a forced circulation of heated water
2. Circulatory piping does not include:
    a) Systems where the circulatory flow only occurs in response to activation by a user; and
    b) Primary circulation in a solar water heater
3. In circulatory piping, the maximum flow velocity is derived from the sum of forced circulation and probable simultaneous demand flow in the relevant section of piping
4. Pipe work should be designed for velocities lower than the above maximums to allow for variations in flow

Re-circulated Hot Water Systems

IMPORTANT – Dux Industries does not recommend using a re-circulating hot water pressure system with polybutene pipe, the consistent high temperatures and pressures will reduce the service life of the pipe and may cause premature failure.

Safe Water Temperatures

As per the requirements of G12/AS1; Clause 6.14 Safe water temperatures

6.14.1 Maximum temperatures

The delivered hot water temperature at any sanitary fixture used for personal hygiene shall not exceed:

a) 45˚C for early childhood centres, schools, old people's homes, institutions for people with psychiatric or physical disabilities, hospitals, and
b) 55˚C for all other buildings

COMMENT:

1. At greatest risk from scalding are children, the elderly, and people with physical or intellectual disabilities, particularly those in institutional care.
2. ***Sanitary fixtures*** used for personal hygiene includes showers, baths, hand basins and bidets.

The Temperature/Pressure Relationship

What does this mean and why is it so important for an installation?

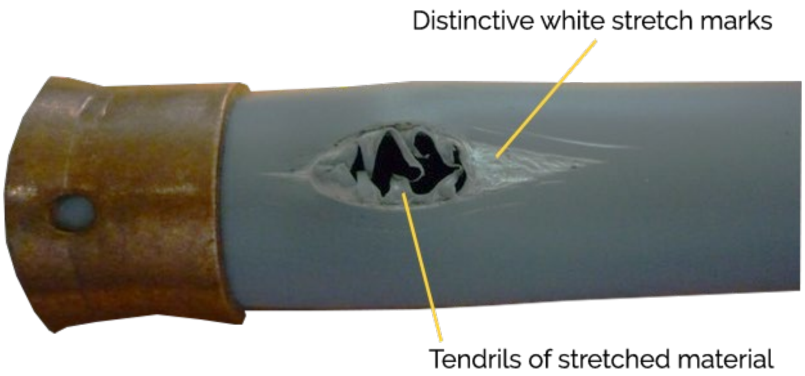
There are limitations placed on all plastic pipes that need to be adhered to, especially when dealing with temperature and pressure. This relationship determines that at varying temperatures maximum set pressures must not be exceeded, the chart on Page 14s details these requirements as set down in the standard AS/NZS 2642.

Exceeding these maximum temperature/pressure combinations can lead to a shortened service life and/or failure of the pipe wall.

In extreme circumstances the wall of the pipe will burst in a very distinctive way, examples of both a hot and cold water burst are covered below. As per normal quality control procedures Dux tests the pipe manufactured with a full "to burst" pressure test using both hot and cold water and have found that the burst patterns are consistent for each type of burst.

Hot Water Burst

When a pipe bursts under a high temperature pressure situation typically you will see a localised stretching of the pipe, almost like a balloon inflating, this will create the distinctive white stretch marks that surround the area. Once burst fine tendrils of thinned material are left bridging around the burst hole.



Cold Water Burst

In contrast a cold-water burst is much rarer due to the higher pressures needed to burst the pipe and will typically fracture in a short-jagged line as shown below. The area around the split will flower out slightly but as you can see the distinction between the hot and cold patterns is quite dramatic.

While these examples are at the extreme ends of the pipe's capabilities there have been occasions where installations have been documented and logged as non-conformance issues by plumbers. It can be plainly seen the distinctive nature of these bursts and the extreme pressure/temperatures needed to cause these types of bursts point to an installation issue rather than a pipe manufacturing issue.

Installation Testing (Hydrostatic Pressure Test)

In accordance with AS/NZS 3500 all installations must be hydrostatically tested after installation, in both new builds and renovations. The hydrostatic pressure should be no less than 1500kPa for a period no less than 30 minutes using cold water only. Pressure testing before wall lining is good trade practice and is strongly recommended.

Note:

1. When pressure testing additions/renovations to an existing installation it is advisable to cap the addition and test independently as the existing pipe work and fixtures may be damaged by the high test pressure.
2. Fire services are subject to individual testing by some network utility operators at a higher pressure and for varied amounts of time.

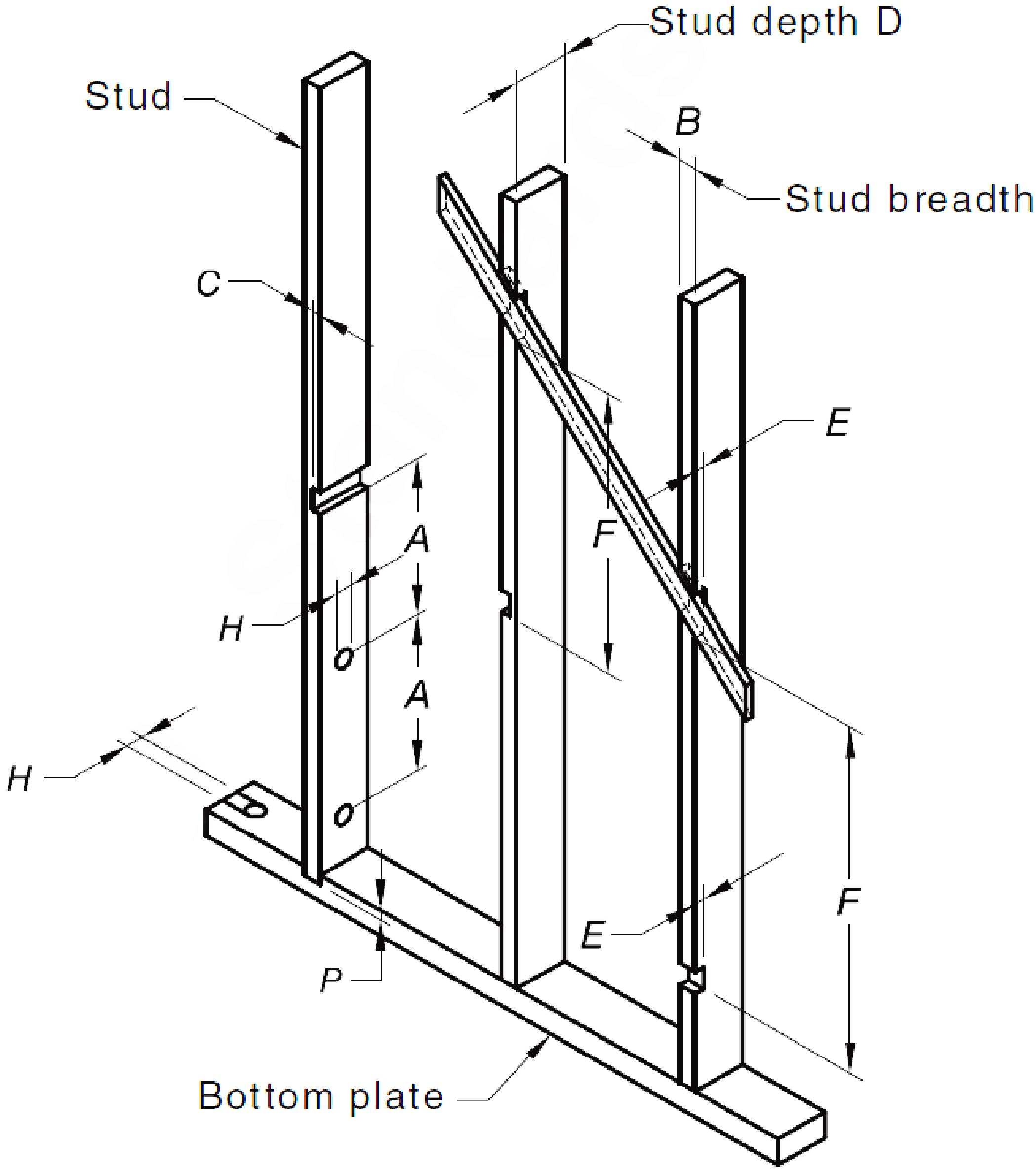
Timber Framework

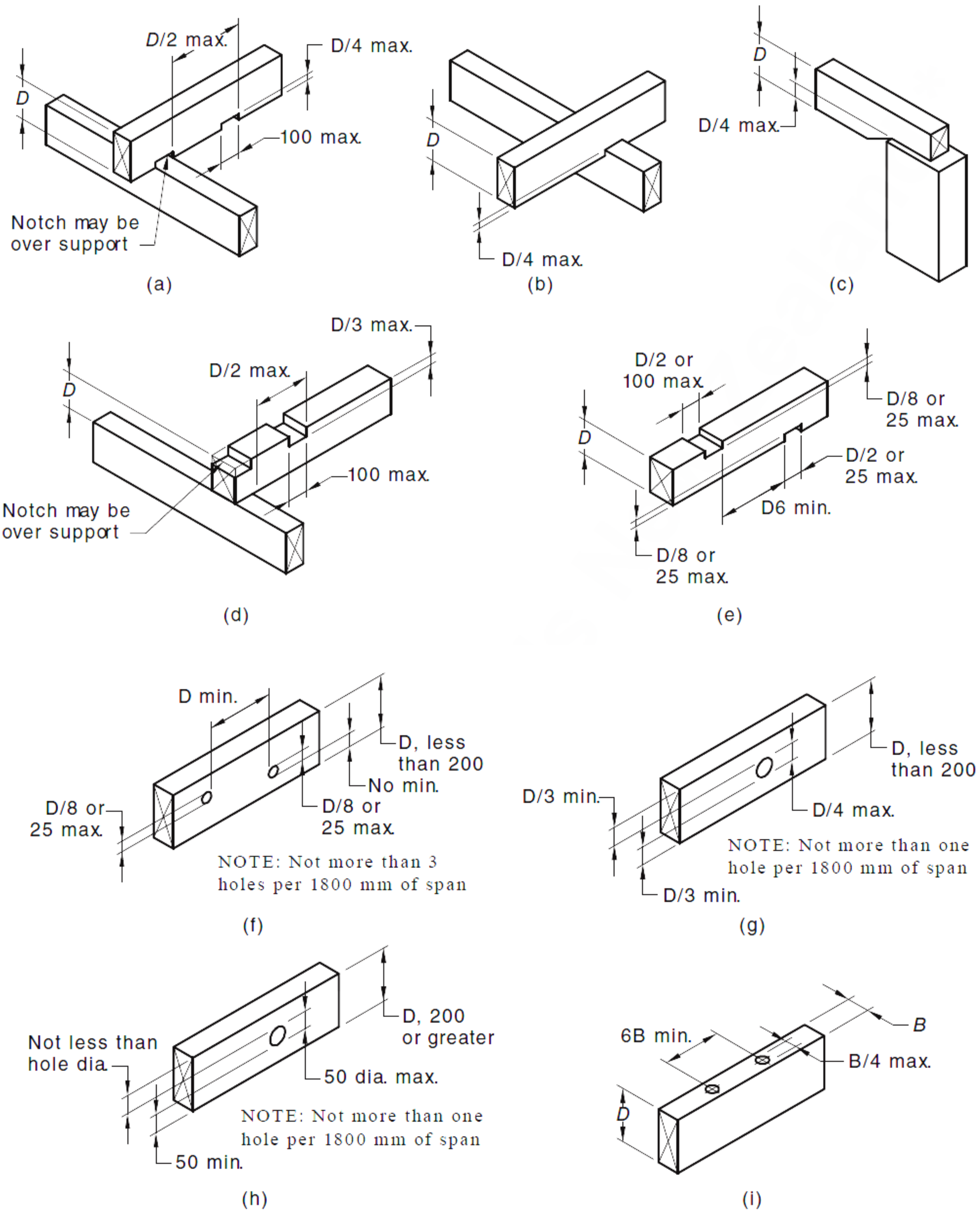
PB-1 is extensively used in timber framed houses throughout New Zealand in the traditional manner by running through notches or chases, or by surface mounting. In many instances they also run through holes drilled through the noggins. This should be done in a manner that is compliant with AS/NZS 3500.1:2003 which includes the requirement to fill the annular space between the pipe and timber with a neutral cure silicone.

Services located in timber framed walls of brick veneer construction shall be installed as follows:

Holes or notches made in timber studs and plates in walls shall be in accordance with the below figure and table:

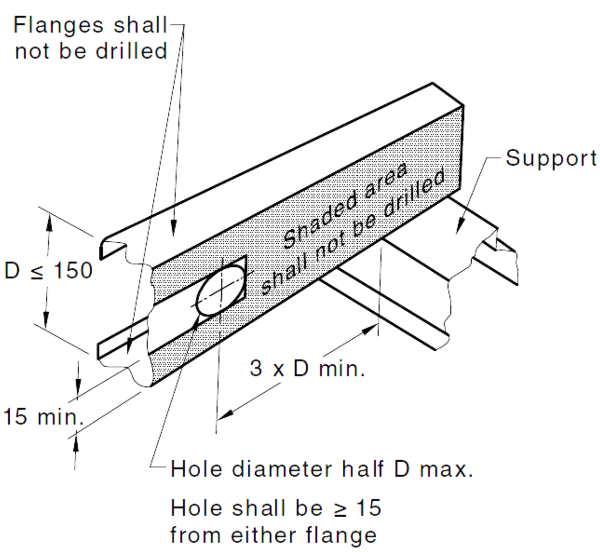
		Limits	
Symbol	Description	Notched	Not Notched
A	Distance between holes and/or notches in stud breadth	Min. 3D	Min. 3D
H	Hole diameter (studs & plates)	Max. 25mm (wide face only)	Max. 25mm (wide face only)
C	Notch into stud breadth	Max. 10mm	Max. 10mm
E	Notch into stud depth	Max. 20mm (for diagonal cut in bracing only) (see note)	Not permitted (see note)
F	Distance between notches in stud depth	Min. 12B	N/A
P	Trenches in plates	3mm max.	
Note: A horizontal line of notches up to 25mm may be provided for the installation of baths			


Stud depth D
Stud
B
Stud breadth
C
E
A
F
H
o
A
H
o
F
E
P
Bottom plate


D/2 max.
D/4 max.
D
100 max.
Notch may be over support
(a)
D
D/4 max.
(b)
D
D/4 max.
(c)
D/3 max.
D/2 max.
D
100 max.
Notch may be over support
(d)
D/2 or 100 max.
D/8 or 25 max.
D
D/2 or 25 max.
D6 min.
D/8 or 25 max.
(e)
D min.
D, less than 200
No min.
D/8 or 25 max.
D/8 or 25 max.
NOTE: Not more than 3 holes per 1800 mm of span
(f)
D, less than 200
D/3 min.
D/4 max.
NOTE: Not more than one hole per 1800 mm of span
D/3 min.
(g)
D, 200 or greater
Not less than hole dia.
50 dia. max.
NOTE: Not more than one hole per 1800 mm of span
50 min.
(h)
B
6B min.
B/4 max.
D
(i)

Metal Framework

Holes drilled or formed in metal studs or plates shall be sized to enable suitable rubber grommets, insulation, or a short sleeve of oversize pipe to be firmly secured in the framework and wrap around the pipe. To ensure no direct contact between the pipe and framework but to allow free longitudinal movement of the pipe through the grommet, lagging or sleeve as shown below.



(a) Hole drilling criteria when D ≤ 150 mm

(b) Hole drilling criteria when D ≥ 150 mm

Acceptable Penetrations to steel floor joists

Care should be taken to ensure that the air cavity moisture barrier within an external wall of any building is not bridged with pipe or pipe duct penetrations and porous pipe insulation materials. A clear air gap is required between the external wall and the pipe insulation material.

Pipes located in cavities shall be installed to prevent the transfer of moisture from the outer to inner wall.

Chases, Ducts or Conduits

Pipes located in chases, ducts or conduits within walls or floors of masonry or concrete construction shall be installed in accordance with the following:

a) Pipes in chases shall be continuously wrapped with an impermeable flexible material

b) Ducts shall be fitted with removable covers

c) Conduits embedded in walls or floors shall comply with the requirements of the New Zealand Building Code as applicable

d) Service pipes shall not be embedded or cast into concrete structures

Under Concrete Slabs

Water service pipes located beneath concrete slabs on ground shall comply with the following:

a) Pipes shall be laid in a narrow trench on a bed of sand or fine-grained soil placed and compacted in a manner that will not damage the piping. There shall be a minimum distance of 75mm between the top of the pipe and the underside of the slab or slab stiffening beam

b) The ends shall be crimped or capped prior to pouring of the concrete and measures shall be taken to protect the exposed pipe from damage

c) Any pipework that penetrates the slab shall be at right angles to the surface of the slab and shall be lagged for the full depth of the slab penetration with:

   i. An impermeable flexible material of not less than 6mm thickness; or

   ii. Impermeable plastic sleeve or conduit providing an equivalent protection

   Note: where termite protection is required, the integrity of the chosen termite protection method should not be compromised.

d) Metal pipes shall be continuously lagged with an impermeable material

e) Soft soldered joints shall not be permitted

f) The number of joints shall be kept to a minimum

Underground

The SecuraGold™ PB-1 pipe can be installed below ground in trenches at depths in accordance with AS/NZS 3500 but must also be in accordance with the local authority guidelines.

The NZBC states in G12/AS1 7.3.2 – an acceptable method of protecting water supply pipes is to provide the minimum covers given below:

a. 600mm – Residential driveways and similar areas subjected to occasional heavy traffic
b. 450mm – Gardens, lawns or other areas not subjected to traffic

Conditions for underground installation

- The trench should be free from sharp objects and large stones preferably a fine compacted sand should line the bottom of the trench
- Snake the pipe slightly the entire length underground to allow for expansion and contraction
- Ensure the backfill is clean, free running and void of debris, sharp objects, and large stones
- Alternatively, the PB-1 pipe can be fed through a conduit but at the entry and exit the conduit must be closed to prevent influx of any backfill
- Joints should be avoided underground
- Before the trench is backfilled the installation should be pressure tested as per the requirements of AS/NZS 3500.1

Masonry Walls

PB-1 pipe should be protected by a conduit when run through a masonry wall and every effort should be made to avoid contact with brick or concrete.

When run through a concrete or brick wall use a conduit, the conduit entry and exit points should extend beyond the wall by approximately 100 – 150mm and the ends taped with an impermeable material to prevent ingress of concrete or brick particles.

Direct Heat

- Avoid installing PB-1 near a direct heat source
- All PB-1 pipes must be kept at least 500mm away from extreme heat sources such as flues or wet back circulation pipes
- Never expose PB-1 to naked flames or hot air guns, if it is necessary to braze or solder near a PB-1 pipe it is strongly advised to try at first to move the pipe the required distance or place a thermal guard between the heat source and the pipe.

Appendix

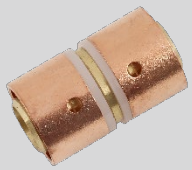
Appendix 1 - The SecuraGold™ Range

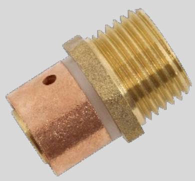
The SecuraGold™ range of pipe and fittings has been developed to meet the demands of most scenarios that a plumber will face when installing a residential hot and cold potable water system.

Straight Pipe	Code	Description	Pack size
	N2PS5	12mm x 5m Straight	20
	N3PS5	15mm x 5m Straight	20
	N4PS5	20mm x 5m Straight	10
	N5PS5	28mm x 5m Straight	5

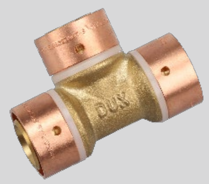
Pipe Coils	Code	Description	Pack size
	N2PC25	12mm x 25m Lay Straight Coil	1
	N3PC25	15mm x 25m Lay Straight Coil	1
	N4PC25	20mm x 25m Lay Straight Coil	1
	N5PC25	28mm x 25m Lay Straight Coil	1
	N2PC50	12mm x 50m Coil	1
	N3PC50	15mm x 50m Coil	1
	N4PC50	20mm x 50m Coil	1
	N2PC100	12mm x 100m Coil	1
	N3PC100	15mm x 100m Coil	1
	N3PC280	15mm x 280m Coil	1

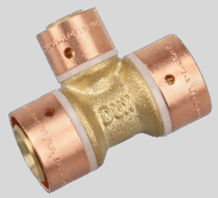
Coloured Pipe	Code	Description	Pack size
	N3PS5L	15mm x 5m Straight (Lilac)	20
	N3PC25L	15mm x 25m Coil (Lilac)	1
	N3PC50L	15mm x 50m Coil (Lilac)	1
	N4PS5L	20mm x 5m Straight (Lilac)	10
	N4PC25L	20mm x 25m Coil (Lilac)	1
	N4PC50L	20mm x 50m Coil (Lilac)	1
	N3PS5G	15mm x 5m Straight (Green)	20
	N3PC25G	15mm x 25m Coil (Green)	1
	N4PS5G	20mm x 5m Straight (Green)	10
	N4PC25G	20mm x 25m Coil (Green)	1

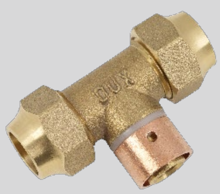
Couplings	Code	Description	Pack size
	SC2	12mm (equal)	10
	SC3	15mm (equal)	10
	SC4	20mm (equal)	10
	SC5	28mm (equal)	10
	SC24	12mm x 20mm (reducing)	10
	SC32	15mm x 12mm (reducing)	10
	SC43	20mm x 15mm (reducing)	10
	SC54	28mm x 20mm (reducing)	10

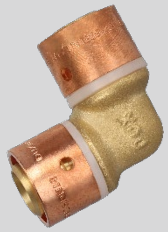
Brass Male Adaptors	Code	Description	Pack size
	SAM3	15mm x ½" BSP	10
	SAM4	20mm x ¾" BSP	10
	SAM5	28mm x 1" BSP	10
	SAM23	12mm x ½" BSP	10
	SAM43	20mm x ½" BSP	10

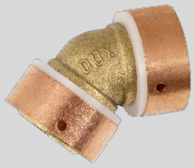
Female Lugged Tee	Code	Description	Pack size
	SWT3	15mm x ½" BSP	10

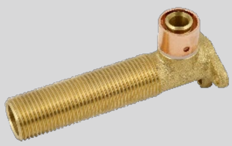
Tees	Code	Description	Pack size
	ST2	12mm	10
	ST3	15mm	10
	ST4	20mm	10
	ST5	28mm	10

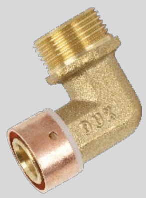
Reducing Tees	Code	Description	Pack size
	ST223	12mm x 12mm x 15mm	10
	ST224	12mm x 12mm x 20mm	10
	ST332	15mm x 15mm x 12mm	10
	ST334	15mm x 15mm x 20mm	10
	ST433	20mm x 15mm x15mm	10
	ST434	20mm x 15mm x 20mm	10
	ST442	20mm x 20mm x 12mm	10
	ST443	20mm x 20mm x 15mm	10
	ST553	28mm x 28mm x 15mm	10
	ST554	28mm x 28mm x 20mm	10

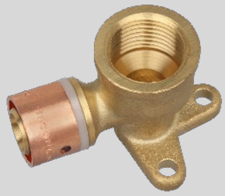
Crox Tee Adaptor	Code	Description	Pack size
	SXT3	½" BSP x 15mm	10

Elbows 90˚	Code	Description	Pack size
	SE2	12mm	10
	SE3	15mm	10
	SE4	20mm	10
	SE5	28mm	10
	SE43	20mm x 15mm (reducing)	10
	SE54	28mm x 20mm (reducing)	10

Elbows 45˚	Code	Description	Pack size
	SE3045	15mm	10
	SE4045	20mm	10
	SE5045	28mm	10

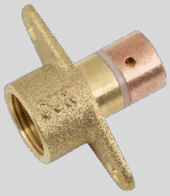
Wingback Elbows (Male)	Code	Description	Pack size
	SWM2100	12mm x ½" BSP (100mm L)	10
	SWM3	15mm x ½" BSP (65mm L)	10
	SWM3100	15mm x ½" BSP (100mm L)	10
	SWM4100	20mm x ¾" BSP (100mm L)	10

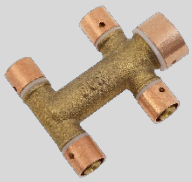
Threaded Elbows Male	Code	Description	Pack size
	SEM3	15mm x ½" BSP	10
	SEM4	20mm x ¾" BSP	10

Wingback Elbows (Female)	Code	Description	Pack size
	SW23	12mm x ½" BSP	10
	SW3	15mm x ½" BSP	10
	SW34	15mm x ¾" BSP	10
	SW4	20mm x ¾" BSP	10
	SW43	20mm x ½" BSP	10

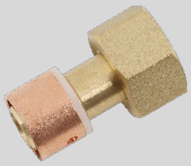
Double Fix Wingback (Male)	Code	Description	Pack size
	SDWM3100	15mm x 100mm x ½" BSP	10
	SDWM3200	15mm x 200mm x ½" BSP	10
	SDWM4100	20mm x 100mm x ¾" BSP	10

Double Fix Wingback (Female)	Code	Description	Pack size
	SDW3	15mm x ½" BSP	10
	SDW4	20mm x ¾" BSP	10
	SDW5	28mm x 1" BSP	10

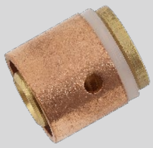
Hose Plate Female	Code	Description	Pack size
	SH3	15mm x ½" BSP	10
	SH4	20mm x ¾" BSP	10

Manifolds	Code	Description	Pack size
	SMF4203	20mm x 3 (12mm x 3 Outlets)	10
	SMF4303	20mm x 3 (15mm x 3 Outlets)	10
	SMF4204	20mm x 4 (12mm x 4 Outlets)	10
	SMF4304	20mm x 4 (15mm x 4 Outlets)	10

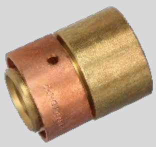
BSP Swivel Elbows	Code	Description	Pack size
	SXE3	15mm x ½" BSP	10
	SXE4	20mm x ¾" BSP	10
	SXE5	28mm x 1" BSP	10
	SXE23	12mm x ½" BSP	10
	SXE24	12mm x ¾" BSP	10
	SXE34	15mm x ¾" BSP	10
	SXE43	20mm x ½" BSP	10



BSP Swivel Connectors	Code	Description	Pack size
	SXC3	15mm x ½" BSP	10
	SXC4	20mm x ¾" BSP	10
	SXC5	28mm x 1" BSP	10
	SXC23	12mm x ½" BSP	10
	SXC43	15mm x ¾" BSP	10
	SXC54	28mm x ¾" BSP	10



Blank Plugs (Brass)	Code	Description	Pack size
	SBP2	12mm	10
	SBP3	15mm	10
	SBP4	20mm	10
	SBP5	28mm	10



Brazing Tails	Code	Description	Pack size
	SBT3	15mm	10
	SBT4	20mm	10

Sealed/Threaded End Caps	Code	Description	Pack size
	STCF3	Female 15mm	10
	STCF4	Female 20mm	10

Plugged Nipples	Code	Description	Pack size
	NPN3	½" BSP	10
	NPN4	¾" BSP	10

IWISS Tools	Code	Description	Pack size
	DCT2	12mm	1
	DCT3	15mm	1
	DCT4	20mm	1
	DCT5	28mm	1

Dux Magnum Crimp Tools	Code	Description	Pack size
	CCT2	12mm	1
	CCT3	15mm	1
	CCT4	20mm	1

Alba Crimp Tools	Code	Description	Pack size
	SCT3	15mm (Long Handle)	1
	SCT4	20mm (Long Handle)	1
	SCT5	28mm (Long Handle)	1

Blucher Crimp Tools	Code	Description	Pack size
	DSPMKIT	Power Crimp Tool with 3 Jaws	1
	DSPM15	15mm Head for SPM24	1
	DSPM20	20mm Head for SPM24	1
	DSPM28	28mm Head for SPM24	1

Pipe Cutter & Accessories	Code	Description	Pack size
	SGPC0V2	Dux Pipe Cutter Ex-Tec	1
	DHB01	Dux Handi-fix Bracket	10

Pipe Clips	Code	Description	Pack size
	PS2	12mm	100
	PS3	15mm*	100
	PS4	20mm*	50
	PS5	28mm	50

*20% Red per box

Appendix 2 - Chemical Resistance Charts

KEY – E = Excellent, G = Good, L = Limited, U = Unsuitable

Chemical	22˚C	66˚C
Acetadehyde	L	U
Acetate Solvents - Crude	E	L
Acetate Solvents - Pure	E	L
Acetic Acid 0 – 10%	E	E
Acetic Acid 10 – 20%	E	E
Acetic Acid 20 – 30%	E	G
Acetic Acid 30 – 60%	E	L
Acetic Acid 80%	E	E
Acetic Acid - Glacial	U	U
Acetic Acid - Vapours	E	L
Acetic Anhydride	U	U
Acetone	E	G
Acetylene	L	U
Adipic Acid	E	L
Allyl Alcohol 96%	E	G
Allyl Chloride	E	G
Alum	L	U
Aluminum Chloride	E	E
Aluminum Floride	E	E
Aluminum Hydroxide	E	E
Aluminum Oxychloride	E	E
Aluminum Nitrate	E	E
Aluminum Sulfate	L	U
Ammonia – Dry Gas	E	E
Ammonia - Liquid	G	L
Ammonium Biflouride	E	E
Ammonium Carbonate	E	E
Ammonium Chloride	E	E
Ammonium Flouride 25%	E	L
Ammonium Hydroxide 28%	E	E

Chemical	22˚C	66˚C
Breeder Pellets – Deriv. Fish	E	E
Brine	E	E
Bromic Acid	E	E
Bromine - Liquid	U	U
Bromine - Water	L	U
Butane	U	U
Butanol - Primary	E	-
Butanol - Secondary	E	-
Butyl Acetate	L	U
Butyl Alcohol	E	E
Butyric Acid 20%	E	L
Calcium Bisulfite	E	E
Calcium Carbonate	E	E
Calcium Chlorate	E	E
Calcium Chloride	E	E
Calcium Hydroxide	E	E
Calcium Nitrate	E	E
Calcium Sulfate	E	E
Cane Sugar Liquors	E	E
Carbon Bisulfide	U	U
Carbon Dioxide (Aqueous Solution)	E	E
Carbon Dioxide Gas (Wet)	E	E
Carbon Monoxide	E	E
Carbon Tetrachloride	U	U
Carbonic Acid	E	E
Casein	E	E
Castor Oil	E	E
Caustic Potash	G	L
Caustic Soda	G	L
Cellosolve	E	G

Ammonium Metaphosphate	E	E
Ammonium Nitrate	E	E
Ammonium Persulfate	E	E
Boron Triflouride	E	E
Chlorine Water	E	G
Chlorobenzene	U	U
Chloroform	L	U
Chlorosulfonic Acid	-	U
Chrome Alum	E	E
Chromic Acid 10%	E	E
Chromic Acid 25%	E	E
Chromic Acid 30%	E	E
Chromic Acid 40%	E	-
Chromic Acid 50%	E	-
Citric acid	E	E
Coconut Oil	G	G
Copper Chloride	E	E
Copper Cyanide	E	E
Copper Fluoride 2%	E	E
Copper Nitrate	E	E
Copper Sulfate	E	E
Core Oils	E	E
Cottonseed Oil	E	E
Cresol	U	U
Cresylic Acid 50%	U	U
Crude Oil - Sour	L	U
Crude Oil - Sweet	L	U
Cyclohexanol	G	L
Cyclohexanon	U	U
Demineralised Water	E	E
Dextrin	E	E
Dextrose	E	E
Diazo Salts	E	E

Chloracetic Acid	U	U
Chloral Hydrate	U	U
Chlorine Gas (Dry)	U	U
Chlorine Gas (Moist)	U	U
Ethyl Alcohol 50 – 98%	E	E
Ethyl Ether	L	U
Ethylene Bromide	U	U
Ethylene Chlorohydrin	U	U
Ethylene Dichloride	G	G
Ethylene Glycol	E	E
Fatty Acids	E	G
Ferric Chloride	E	E
Ferric Nitrate	E	E
Ferric Sulfate	E	E
Ferrous Chloride	E	E
Ferrous Sulfate	E	E
Fish Solubles	E	E
Fluorine Gas - Dry	L	U
Fluorine Gas - Wet	L	U
Fluoroboric Acid	E	E
Fluorosilicic Acid	E	E
Food Products (Such as Milk, Buttermilk, Molasses, Salad Oils, Fruit	E	E
Formaldehyde	E	E
Formic Acid	E	E
Freon – 1 2	E	G
Fructose	E	E
Fruit Pulps and Juices	E	E
Fuel Oil (Containing H2SO4)	U	U
Gallic Acid	E	E
Gas – Coke Oven	E	L
Gas - Manufactured	E	L
Gas – Natural (Dry)	E	L
Gas Natural (Wet)	E	L

Diglycolic Acid	E	E
Dimethylamine	U	U
Dioctylphthalate	L	U
Disodium Phosphate	E	E
Distilled Water	E	E
Ethers	U	U
Ethyl Acetate	L	U
Ethyl Alcohol 0 – 50%	E	E
Heptane	U	U
Hexme	E	G
Hexanol, Tertiary	E	E
Hydrobromic Acid 20%	E	E
Hydrochloric Acid 0 – 25%	E	E
Hydrochloric Acid 25 – 40%	E	E
Hydrocyanic Acid (Hydrogeo Cyanide)	E	E
Hydrofluoric Acid 10%	E	E
Hydrofluoric Acid 48%	E	E
Hydrofluoric Acid 60%	E	E
Hydrogen	E	E
Hydrogen Peroxide 30%	E	G
Hydrogen Peroxide 50%	U	U
Hydrogen Peroxide 90%	U	U
Hydrogen Phosphide	E	E
Hydrogen Sulfide Aqueous Solution	E	E
Hydrogen Sulfide - Dry	E	E
Hydroquinone	E	E
Hypochlorous Acid	E	E
Iodine (In Alcohol)	U	U
Isopropylalcohol	E	E
Kerosene	L	U
Kraft Liquor (Paper Industry)	E	E
Lactic Acid 28%	E	E
Lard Oil	G	L
Lauryl Chloride	G	L
Lead Acetate	E	E
Lime Sulfur	E	E

Gasoline - Refined	U	U
Gasoline - Sour	U	U
Gelatine	E	E
Glucose	E	E
Glycerine (Glycerol)	E	E
Glycol	E	E
Glycolic Acid 30%	E	E
Green Liquor (Paper Industry)	U	U
Maleic Acid	E	E
Malic Acid	E	E
Mercuric Chloride	E	E
Mercuric Cyanide	E	E
Mercurous Nitrate	E	E
Mercury	E	E
Methyl Alcohol	E	E
Methyl Chloride	U	U
Methyl Ethyl Ketone	E	L
Methyl Sulfuric Acid	E	E
Methylene Chloride	G	L
Milk	E	E
Mineral Oils	L	U
Molasses	E	E
Napthalene	G	U
Nickel Acetate	E	E
Nickel Chloride	E	E
Nickel Nitrate	E	E
Nickel Sulfate	E	E
Nicotine	E	E
Nicotine Acid	E	E
Nitric Acid 10%	L	U
Nitric Acid 20%	U	U
Nitric Acid 35%	U	U
Nitric Acid 40%	U	U
Nitric Acid 60%	U	U
Nitric Acid 68%	U	U
Oils and Fats	E	E

Linoleic Acid	E	E
Linseed Oil	E	E
Liquors	E	E
Lubricating Oils	E	E
Magnesium Carbonate	E	E
Magnesium Chloride	E	E
Magnesium Hydroxide	E	E
Magnesium Nitrate	E	E
Magnesium Sulfate	E	E
Picric Acid	E	E
Potassium Acid Sulfate	E	E
Potassium Bicarbonate	E	E
Potassium Bichromate	L	U
Potassium Borate 1%	E	E
Potassium Bromate 10%	E	E
Potassium Bromide	E	E
Potassium Carbonate	E	E
Potassium Chlorate	E	E
Potassium Chloride	E	E
Potassium Chromate 40%	E	E
Potassium Cuprocyanide	E	E
Potassium Cyanide	E	E
Potassium Dichromate 40%	E	E
Potassium Ferricyanide	E	E
Potassium Fluoride	E	E
Potassium Hydroxide 10%	E	E
Potassium Hydroxide 20%	E	E
Potassium Nitrate	E	E
Potassium Perborate	E	E
Potassium Perchlorite	E	E
Potassium Permanganate 10%	E	E
Potassium Persulfate	E	E
Potassium Sulfate	E	E
Potassium Sulfide	E	E
Potassium Thiosulfate	E	E
Propane	E	-
Propyl Alcohol	E	E
Rayon Coagulating Bath	E	E

Oleum	U	U
Oxalic Acid	E	G
Perchloric Acid 10%	L	U
Perchloric Acid 70%	U	U
Phenol	E	L
Phosphoric Acid 0 – 25%	E	E
Phosphoric Acid 25 – 50%	E	G
Phosphoric Acid 50 – 75%	G	L
Photographic Chemicals	E	E
Sodium Acid Sulfate	E	E
Sodium Antimonate	E	E
Sodium Arsenite	E	E
Sodium Benzoate	E	E
Sodium Bicarbonate	E	E
Sodium Bisulfate	E	E
Sodium Bisulfite	E	E
Sodium Bromide	E	E
Sodium Carbonate (Soda Ash)	E	E
Sodium Chlorate	E	E
Sodium Chloride	E	E
Sodium Cyanide	E	E
Sodium Dichromate	E	E
Sodium Ferricyanide	E	E
Sodium Ferrocyanide	E	E
Sodium Fluoride	E	E
Sodium Hydroxide 10%	E	E
Sodium Hydroxide 35%	E	E
Sodium Hydroxide Saturated	E	E
Sodium Hypochlorite	E	E
Sodium Nitrate	E	E
Sodium Nitrite	E	E
Sodium Phosphate - Acid	E	E
Sodium Silicate	E	E
Sodium Sulfate	E	E
Sodium Sulfide	E	E
Sodium Sulfite	E	E
Sodium Thiosulfate (Hypo)	E	E
Stannic Chloride	E	E

Salt Water	E	E	Stannous Chloride	E	E
Selenic Acid	E	G	Stoddards Solvent	E	E
Silicic Acid	E	E	Stearic Acid	E	E
Silver Cyanide	E	E	Sulfur	E	E
Silver Nitrate	L	U	Sulfur Dioxide Gas - Wet	E	L
Silver Plating Solutions	E	G	Sulfuric Acid 0 – 10%	E	E
Soaps	E	E	Sulfuric Acid 10 – 30%	E	E
Sodium Acetate	E	E	Sulfuric Acid 30 – 50%	E	E
Sulfuric Acid 50 – 75%	L	U	Urea	E	E
Sulfuric Acid 75 – 90%	U	U	Urine	E	E
Sulfuric Acid 95%	U	U	Vinegar	E	E
Sulfurous Acid	E	E	Water – Acid Mine Water	E	E
Sulphur Trioxide	L	U	Water - Distilled	E	E
Tannic Acid	E	E	Water - Fresh	E	E
Tanning Liquors	E	G	Water - Salt	E	E
Tattaric Acid	E	E	Whiskey	E	E
Tetrahydrofurane	L	U	White Gasoline	U	U
Thionyl Chloride	E	E	Wines (Still)	E	E
Toluol or Toluene	U	U	Xylene or Xylol	U	U
Trichloroethylene	U	U	Zinc Chromate	E	E
Triethanolamine	E	L	Zinc Cyanide	E	E
Trisodium Phosphate	E	E	Zinc Nitrate	E	E
Turpentine	U	U	Zinc Sulfate	E	E

Key: E = Excellent, G = Good, L = Limited, U = Unsuitable

DISCLAIMER: The Polybutene Chemical Resistance Chart is supplied as a guide only, due to variable strengths, applications, and combinations of chemicals no warranty can be expressed or implied. The onus must be on the end user to carry out their own tests to determine suitability for their particular purpose and/or application.

Appendix 3 – Flow Rates & Pressure Loss

All pipes are affected by pressure loss and this needs to be considered when designing a Hot & Cold water reticulation system. This will allow the installer to maintain the correct flow rates prescribed by the New Zealand Building Code. For the acceptable flow rates to outlets reference Table 3 from G12/AS1.

Table 3: Acceptable Flow Rates to Sanitary Fixtures
Paragraph 5.3.1

Sanitary fixture	Flow rate and temperature l/s and °C	How measured
Bath	0.3 at 45°C	Mix hot and cold water to achieve 45°C
Sink	0.2 at 60°C* (hot) and 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously
Laundry tub	0.2 at 60°C* (hot) and 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously
Basin	0.1 at 45°C	Mix hot and cold water to achieve 45°C
Shower	0.1 at 42°C	Mix hot and cold water to achieve 42°C

* The temperatures in this table relate to the temperature of the water used by people in the daily use of the *fixture*.

Note:

The flow rates required by Table 3 shall be capable of being delivered simultaneously to the kitchen sink and one other *fixture*.

FLOW RATE CALCULATIONS

There are several factors involved with the calculation of friction loss through pipes and fittings that need to be considered:

a. Velocity
b. Reynolds number (roughness of the pipe bore)
c. Flow Type (Laminar or Turbulent)
d. Temperature - Kinematic Velocity (measured in Centistokes (cST)
e. Density of the water (kg/m³)
f. Length of pipe (m)
g. Head Pressure where required.

Below is an example of the calculations required to determine the pressure drop in a 15mm PB-1 pipe, 20m in length.

Velocity

To calculate the velocity of water through a 15mm PB pipe the following calculation is used:

$V = Q \times 21.22/D^2$

Pipe Ø	Flow Rate l/min (Q)	Constant	D^2	m/sec.
15mm	12	21.22	161.29	1.58

Note: mean pipe internal diameter used

At a flow rate of 12 l/min. the velocity of the water would be 1.58 m/sec

Reynolds Number

To calculate the Reynolds number (Re): Re = 1000 x v x D/Kv

Pipe Ø	Constant	Velocity (m/sec)	Bore (mm)	Kinematic Velocity (kv)	Reynold number (Re)
15mm	1000	V = 1.58	D = 12.70	Kv = 1.004 (@20˚C)	Re = 19970.51

The Reynolds number is 19970.51, this number determines the type of flow characteristic passing through the pipe. Flow can be either Laminar or Turbulent when passing through a pipe and this, during the calculations, can be determined if the Reynolds number is less or greater than 2300. A number <2300 is Laminar while >2300 the flow is deemed to be Turbulent. Flows through average household plumbing systems would be deemed Turbulent.

Flow Type

The calculation for the type of flow is:

$F = 0.3164 \times Re^{-0.25}$

0.3164	Constant number
0.084120666	0.3164 x 19970.51
0.026615779	Total friction factor
Turbulent	Flow type

This number is the friction factor in relation to the flow, the Reynolds number, and the Kinematic Velocity @ 20˚C

Temperature – Kinematic Velocity

The temperature (˚C) is given a value in kinematic Velocity that is measured in a unit called Centistokes (cST)

Temperature – kinematic Velocity @ ˚C			
˚C	cST Value	˚C	cST Value
20	1.004	70	0.413
30	0.801	80	0.365
40	0.658	90	0.326
50	0.553	100	0.294
60	0.475		

Pipe Size and Volume per Metre				
Pipe	Mean Outside Ø (mm)	Mean Bore Ø (mm)	D^2	Volume (L/m)
12mm	12.70	9.40	88.36	0.069
15mm	16.00	12.70	161.29	0.126
20mm	22.20	17.83	317.91	0.249
28mm	28.00	22.25	495.06	0.392

To give an understanding of the volumes held in the SecuraGold™ range of Polybutene pipes the following table has been calculated at set lengths.

Polybutene Pipe Volumes in L/Metre				
Metre	12mm	15mm	20mm	28mm
1	0.069	0.126	0.249	0.392
5	0.345	0.630	1.245	1.960
10	0.690	1.260	2.490	3.920
15	1.035	1.890	3.735	5.880
20	1.380	2.520	4.980	7.840
25	1.725	3.150	6.225	9.800

Using the information above we can now start determining the expected flow rates and pressure loss through a given pipe.

12mm PB-1 Pipe Nominal Bore = 9.40mm

Expected Flow Rate - Litres/Second at 20˚ C

Metre	100	200	300	400	500	600	700	800	900	1000
1	0.69	1.00	1.23	1.43	1.61	1.77	1.91	2.05	2.18	2.30
2	0.48	0.69	0.86	1.00	1.12	1.23	1.34	1.43	1.52	1.61
3	0.38	0.56	0.69	0.80	0.91	1.00	1.08	1.16	1.23	1.30
4	0.33	0.48	0.59	0.69	0.78	0.86	0.93	1.00	1.06	1.12
5	0.29	0.42	0.53	0.61	0.69	0.76	0.83	0.89	0.94	1.00
6	0.26	0.38	0.48	0.56	0.63	0.69	0.75	0.81	0.86	0.91
7	0.24	0.35	0.44	0.51	0.58	0.64	0.69	0.74	0.79	0.84
8	0.22	0.33	0.41	0.48	0.54	0.59	0.64	0.69	0.74	0.78
9	0.21	0.31	0.38	0.45	0.50	0.56	0.61	0.65	0.69	0.73
10	0.20	0.29	0.36	0.42	0.48	0.53	0.57	0.61	0.65	0.69
11	0.19	0.28	0.34	0.40	0.45	0.50	0.54	0.58	0.62	0.66
12	0.18	0.26	0.33	0.38	0.43	0.48	0.52	0.56	0.59	0.63
13	0.17	0.25	0.31	0.37	0.41	0.46	0.50	0.53	0.57	0.60
14	0.17	0.24	0.30	0.35	0.40	0.44	0.48	0.51	0.55	0.58
15	0.16	0.23	0.29	0.34	0.38	0.42	0.46	0.49	0.53	0.56
16	0.15	0.22	0.28	0.33	0.37	0.41	0.44	0.48	0.51	0.54
17	0.15	0.22	0.27	0.32	0.36	0.40	0.43	0.46	0.49	0.52
18	0.14	0.21	0.26	0.31	0.35	0.38	0.42	0.45	0.48	0.51
19	0.14	0.20	0.26	0.30	0.34	0.37	0.41	0.44	0.46	0.49
20	0.14	0.20	0.25	0.29	0.33	0.36	0.39	0.42	0.45	0.48
21	0.13	0.19	0.24	0.28	0.32	0.35	0.38	0.41	0.44	0.47
22	0.13	0.19	0.24	0.28	0.31	0.34	0.37	0.40	0.43	0.45
23	0.13	0.18	0.23	0.27	0.30	0.34	0.37	0.39	0.42	0.44
24	0.12	0.18	0.22	0.26	0.30	0.33	0.36	0.38	0.41	0.43
25	0.12	0.18	0.22	0.26	0.29	0.32	0.35	0.38	0.40	0.42
26	0.12	0.17	0.22	0.25	0.28	0.31	0.34	0.37	0.39	0.41
27	0.11	0.17	0.21	0.25	0.28	0.31	0.33	0.36	0.38	0.41
28	0.11	0.16	0.21	0.24	0.27	0.30	0.33	0.35	0.38	0.40
29	0.11	0.16	0.20	0.24	0.27	0.30	0.32	0.35	0.37	0.39
30	0.11	0.16	0.20	0.23	0.26	0.29	0.32	0.34	0.36	0.38

kPa

Note: the above flow rates pertain to an uninterrupted pipe length only

Expected Flow Rate - Litres/Second at 60˚ C

Metre	100	200	300	400	500	600	700	800	900	1000
1	0.72	1.03	1.27	1.48	1.65	1.82	1.96	2.10	2.23	2.35
2	0.50	0.72	0.89	1.03	1.16	1.27	1.38	1.48	1.57	1.65
3	0.41	0.59	0.72	0.84	0.94	1.03	1.12	1.20	1.27	1.34
4	0.35	0.50	0.62	0.72	0.81	0.89	0.97	1.03	1.10	1.16
5	0.31	0.45	0.55	0.64	0.72	0.79	0.86	0.92	0.98	1.03
6	0.28	0.41	0.50	0.59	0.66	0.72	0.78	0.84	0.89	0.94
7	0.26	0.38	0.46	0.54	0.61	0.67	0.72	0.78	0.82	0.87
8	0.24	0.35	0.43	0.50	0.57	0.62	0.67	0.72	0.77	0.81
9	0.23	0.33	0.41	0.47	0.53	0.59	0.63	0.68	0.72	0.76
10	0.21	0.31	0.39	0.45	0.50	0.55	0.60	0.64	0.68	0.72
11	0.20	0.30	0.37	0.43	0.48	0.53	0.57	0.61	0.65	0.69
12	0.19	0.28	0.35	0.41	0.46	0.50	0.55	0.59	0.62	0.66
13	0.19	0.27	0.34	0.39	0.44	0.48	0.52	0.56	0.60	0.63
14	0.18	0.26	0.32	0.38	0.42	0.46	0.50	0.54	0.57	0.61
15	0.17	0.25	0.31	0.36	0.41	0.45	0.49	0.52	0.55	0.59
16	0.17	0.24	0.30	0.35	0.39	0.43	0.47	0.50	0.54	0.57
17	0.16	0.23	0.29	0.34	0.38	0.42	0.46	0.49	0.52	0.55
18	0.16	0.23	0.28	0.33	0.37	0.41	0.44	0.47	0.50	0.53
19	0.15	0.22	0.27	0.32	0.36	0.40	0.43	0.46	0.49	0.52
20	0.15	0.21	0.27	0.31	0.35	0.39	0.42	0.45	0.48	0.50
21	0.14	0.21	0.26	0.30	0.34	0.38	0.41	0.44	0.46	0.49
22	0.14	0.20	0.25	0.30	0.33	0.37	0.40	0.43	0.45	0.48
23	0.14	0.20	0.25	0.29	0.33	0.36	0.39	0.42	0.44	0.46
24	0.13	0.19	0.24	0.28	0.32	0.35	0.38	0.41	0.43	0.45
25	0.13	0.19	0.24	0.28	0.31	0.34	0.37	0.40	0.42	0.44
26	0.13	0.19	0.23	0.27	0.30	0.34	0.36	0.39	0.42	0.44
27	0.13	0.18	0.23	0.26	0.30	0.33	0.36	0.38	0.41	0.43
28	0.12	0.18	0.22	0.26	0.29	0.32	0.35	0.38	0.40	0.42
29	0.12	0.18	0.22	0.26	0.29	0.32	0.34	0.37	0.39	0.41
30	0.12	0.17	0.21	0.25	0.28	0.31	0.34	0.36	0.39	0.41

kPa

Note: the above flow rates pertain to an uninterrupted pipe length only

15mm PB-1 Pipe Nominal Bore = 12.70mm

Expected Flow Rate - Litres/Second at 20˚ C

Metre	100	200	300	400	500	600	700	800	900	1000
1	1.54	2.21	2.73	3.17	3.55	3.90	4.22	4.52	4.81	5.07
2	1.06	1.54	1.90	2.21	2.48	2.73	2.95	3.17	3.36	3.55
3	0.86	1.24	1.54	1.79	2.01	2.21	2.39	2.57	2.73	2.88
4	0.73	1.06	1.32	1.54	1.73	1.90	2.06	2.21	2.35	2.48
5	0.65	0.94	1.17	1.36	1.54	1.69	1.83	1.97	2.09	2.21
6	0.59	0.86	1.06	1.24	1.39	1.54	1.67	1.79	1.90	2.01
7	0.54	0.79	0.98	1.14	1.29	1.42	1.54	1.65	1.75	1.85
8	0.50	0.73	0.91	1.06	1.20	1.32	1.43	1.54	1.63	1.73
9	0.47	0.69	0.86	1.00	1.12	1.24	1.34	1.44	1.54	1.62
10	0.44	0.65	0.81	0.94	1.06	1.17	1.27	1.36	1.45	1.54
11	0.42	0.62	0.77	0.90	1.01	1.11	1.21	1.30	1.38	1.46
12	0.40	0.59	0.73	0.86	0.96	1.06	1.15	1.24	1.32	1.39
13	0.39	0.56	0.70	0.82	0.92	1.02	1.11	1.19	1.26	1.34
14	0.37	0.54	0.67	0.79	0.89	0.98	1.06	1.14	1.22	1.29
15	0.36	0.52	0.65	0.76	0.86	0.94	1.02	1.10	1.17	1.24
16	0.34	0.50	0.63	0.73	0.83	0.91	0.99	1.06	1.13	1.20
17	0.33	0.49	0.61	0.71	0.80	0.88	0.96	1.03	1.10	1.16
18	0.32	0.47	0.59	0.69	0.78	0.86	0.93	1.00	1.06	1.12
19	0.31	0.46	0.57	0.67	0.75	0.83	0.90	0.97	1.03	1.09
20	0.30	0.45	0.56	0.65	0.73	0.81	0.88	0.94	1.01	1.06
21	0.30	0.43	0.54	0.63	0.71	0.79	0.86	0.92	0.98	1.04
22	0.29	0.42	0.53	0.62	0.71	0.77	0.83	0.90	0.96	1.01
23	0.28	0.41	0.52	0.60	0.68	0.75	0.82	0.88	0.93	0.99
24	0.28	0.40	0.50	0.59	0.66	0.73	0.80	0.86	0.91	0.96
25	0.27	0.39	0.49	0.58	0.65	0.72	0.78	0.84	0.89	0.94
26	0.26	0.39	0.48	0.56	0.64	0.70	0.76	0.82	0.87	0.92
27	0.26	0.38	0.47	0.55	0.62	0.69	0.75	0.80	0.86	0.91
28	0.25	0.37	0.46	0.54	0.61	0.67	0.73	0.79	0.84	0.89
29	0.25	0.36	0.45	0.53	0.60	0.66	0.72	0.77	0.82	0.87
30	0.24	0.36	0.45	0.52	0.59	0.65	0.71	0.76	0.81	0.86

kPa

Note: the above flow rates pertain to an uninterrupted pipe length only

Expected Flow Rate - Litres/Second at 60˚ C

Metre	100	200	300	400	500	600	700	800	900	1000
1	1.60	2.28	2.81	3.25	3.64	4.00	4.32	4.63	4.91	5.18
2	1.12	1.60	1.97	2.28	2.56	2.81	3.04	3.25	3.45	3.64
3	0.90	1.30	1.60	1.85	2.08	2.28	2.47	2.65	2.81	2.96
4	0.78	1.12	1.40	1.60	1.79	1.97	2.13	2.28	2.43	2.56
5	0.69	0.99	1.23	1.42	1.60	1.76	1.90	2.04	2.16	2.28
6	0.63	0.90	1.12	1.30	1.45	1.60	1.73	1.85	1.97	2.08
7	0.58	0.83	1.03	1.20	1.34	1.48	1.60	1.71	1.82	1.92
8	0.54	0.78	0.96	1.12	1.25	1.38	1.49	1.60	1.70	1.80
9	0.51	0.73	0.90	1.05	1.18	1.30	1.40	1.50	1.60	1.69
10	0.48	0.69	0.85	0.99	1.12	1.23	1.33	1.42	1.51	1.60
11	0.45	0.66	0.81	0.95	1.06	1.17	1.27	1.36	1.44	1.52
12	0.43	0.63	0.78	0.90	1.01	1.12	1.21	1.30	1.38	1.45
13	0.42	0.60	0.74	0.87	0.97	1.07	1.16	1.24	1.32	1.40
14	0.40	0.58	0.72	0.83	0.94	1.03	1.12	1.20	1.27	1.34
15	0.38	0.56	0.69	0.80	0.90	0.99	1.08	1.15	1.23	1.30
16	0.37	0.54	0.67	0.78	0.87	0.96	1.04	1.12	1.19	1.25
17	0.36	0.52	0.65	0.75	0.85	0.93	1.01	1.08	1.15	1.21
18	0.35	0.51	0.63	0.73	0.82	0.90	0.98	1.05	1.12	1.18
19	0.34	0.49	0.61	0.71	0.80	0.88	0.95	1.02	1.08	1.15
20	0.33	0.48	0.59	0.69	0.78	0.85	0.93	0.99	1.06	1.12
21	0.32	0.47	0.58	0.67	0.76	0.83	0.90	0.97	1.03	1.09
22	0.31	0.45	0.56	0.66	0.74	0.81	0.88	0.95	1.01	1.06
23	0.31	0.44	0.55	0.64	0.72	0.79	0.86	0.92	0.98	1.04
24	0.30	0.43	0.54	0.63	0.71	0.78	0.84	0.90	0.96	1.01
25	0.29	0.42	0.53	0.61	0.69	0.76	0.82	0.88	0.94	0.99
26	0.29	0.42	0.52	0.60	0.68	0.74	0.81	0.87	0.92	0.97
27	0.28	0.41	0.51	0.59	0.66	0.73	0.79	0.85	0.90	0.95
28	0.27	0.40	0.50	0.58	0.65	0.72	0.78	0.83	0.89	0.94
29	0.27	0.39	0.49	0.57	0.64	0.70	0.76	0.82	0.87	0.92
30	0.26	0.38	0.48	0.56	0.63	0.69	0.75	0.80	0.85	0.90

kPa

Note: the above flow rates pertain to an uninterrupted pipe length only

20mm PB-1 Pipe Nominal Bore = 17.83mm

Expected Flow Rate - Litres/Second at 20° C

Metre \ kPa	100	200	300	400	500	600	700	800	900	1000
1	3.88	5.56	6.86	7.96	8.93	9.80	10.61	11.36	12.06	12.73
2	2.69	3.88	4.79	5.56	6.25	6.86	7.43	7.96	8.46	8.93
3	2.17	3.13	3.88	4.51	5.06	5.56	6.03	6.46	6.86	7.25
4	1.86	2.69	3.33	3.88	4.36	4.79	5.19	5.56	5.91	6.25
5	1.65	2.40	2.96	3.45	3.88	4.26	4.62	4.95	5.27	5.56
6	1.50	2.17	2.69	3.13	3.52	3.88	4.20	4.51	4.79	5.06
7	1.38	2.00	2.48	2.89	3.25	3.58	3.88	4.16	4.42	4.67
8	1.28	1.86	2.31	2.69	3.03	3.33	3.61	3.88	4.12	4.36
9	1.20	1.75	2.17	2.53	2.85	3.13	3.40	3.64	3.88	4.10
10	1.14	1.65	2.05	2.39	2.69	2.96	3.21	3.48	3.67	3.88
11	1.08	1.57	1.95	2.27	2.56	2.82	3.06	3.28	3.49	3.69
12	1.03	1.50	1.86	2.17	2.44	2.69	2.92	3.13	3.33	3.52
13	0.99	1.43	1.78	2.08	2.34	2.58	2.80	3.00	3.20	3.38
14	0.95	1.38	1.71	2.00	2.25	2.48	2.69	2.89	3.07	3.25
15	0.91	1.33	1.65	1.93	2.17	2.39	2.59	2.79	2.96	3.13
16	0.88	1.28	1.60	1.86	2.10	2.31	2.51	2.69	2.86	3.03
17	0.85	1.24	1.54	1.80	2.03	2.24	2.43	2.61	2.77	2.93
18	0.83	1.20	1.50	1.75	1.97	2.17	2.36	2.53	2.69	2.85
19	0.80	1.17	1.46	1.70	1.91	2.11	2.29	2.46	2.62	2.77
20	0.78	1.14	1.42	1.65	1.86	2.05	2.23	2.39	2.55	2.69
21	0.76	1.11	1.38	1.61	1.81	2.00	2.17	2.33	2.48	2.62
22	0.74	1.08	1.34	1.57	1.77	1.95	2.12	2.27	2.42	2.56
23	0.72	1.05	1.31	1.53	1.73	1.90	2.07	2.22	2.36	2.50
24	0.70	1.03	1.28	1.50	1.69	1.86	2.02	2.17	2.31	2.44
25	0.70	1.01	1.25	1.47	1.65	1.82	1.98	2.12	2.26	2.39
26	0.67	0.99	1.23	1.43	1.62	1.78	1.94	2.08	2.21	2.34
27	0.66	0.97	1.20	1.41	1.59	1.75	1.90	2.04	2.17	2.30
28	0.65	0.95	1.18	1.38	1.55	1.71	1.86	2.00	2.13	2.25
29	0.63	0.93	1.16	1.35	1.53	1.68	1.83	1.96	2.09	2.21
30	0.62	0.91	1.14	1.33	1.50	1.65	1.79	1.93	2.05	2.17

Note: the above flow rates pertain to an uninterrupted pipe length only

Expected Flow Rate - Litres/Second at 60° C

Metre \ kPa	100	200	300	400	500	600	700	800	900	1000
1	4.02	5.73	7.04	8.15	9.13	10.01	10.83	11.58	12.29	12.97
2	2.81	4.02	4.95	5.73	6.42	7.04	7.62	8.15	8.66	9.13
3	2.28	3.26	4.02	4.66	5.22	5.73	6.20	6.63	7.04	7.43
4	1.96	2.81	3.46	4.02	4.50	4.95	5.35	5.73	6.08	6.42
5	1.74	2.50	3.09	3.58	4.02	4.41	4.77	5.11	5.43	5.73
6	1.58	2.28	2.81	3.26	3.66	4.02	4.35	4.66	4.95	5.22
7	1.46	2.01	2.59	3.01	3.38	3.71	4.02	4.30	4.57	4.82
8	1.36	1.96	2.42	2.81	3.15	3.46	3.75	4.02	4.27	4.50
9	1.28	1.84	2.28	2.64	2.97	3.26	3.53	3.78	4.02	4.24
10	1.21	1.74	2.15	2.50	2.81	3.09	3.34	3.58	3.81	4.02
11	1.15	1.66	2.05	2.38	2.67	2.94	3.18	3.41	3.62	3.83
12	1.10	1.58	1.96	2.28	2.56	2.81	3.04	3.26	3.46	3.66
13	1.05	1.52	1.88	2.18	2.45	2.70	2.92	3.13	3.32	3.51
14	1.01	1.46	1.81	2.10	2.36	2.59	2.81	3.01	3.20	3.38
15	0.98	1.41	1.74	2.03	2.28	2.50	2.71	2.90	3.09	3.26
16	0.94	1.36	1.68	1.96	2.20	2.42	2.62	2.81	2.99	3.15
17	0.91	1.32	1.63	1.90	2.13	2.34	2.54	2.72	2.89	3.06
18	0.88	1.28	1.58	1.84	2.07	2.28	2.47	2.64	2.81	2.97
19	0.86	1.24	1.54	1.79	2.01	2.21	2.40	2.57	2.73	2.89
20	0.84	1.21	1.50	1.74	1.96	2.15	2.33	2.50	2.66	2.81
21	0.81	1.18	1.46	1.70	1.91	2.10	2.28	2.44	2.59	2.74
22	0.79	1.15	1.43	1.66	1.86	2.05	2.22	2.38	2.53	2.67
23	0.78	1.12	1.39	1.62	1.82	2.00	2.17	2.33	2.47	2.61
24	0.76	1.10	1.36	1.58	1.78	1.96	2.12	2.28	2.42	2.56
25	0.74	1.07	1.33	1.55	1.74	1.92	2.08	2.23	2.37	2.50
26	0.73	1.05	1.30	1.52	1.71	1.88	2.04	2.18	2.32	2.45
27	0.71	1.03	1.28	1.49	1.67	1.84	2.00	2.14	2.28	2.40
28	0.70	1.01	1.25	1.46	1.64	1.81	1.96	2.10	2.23	2.36
29	0.69	0.99	1.23	1.43	1.61	1.77	1.92	2.06	2.19	2.32
30	0.67	0.98	1.21	1.41	1.58	1.74	1.89	2.03	2.15	2.28

Note: the above flow rates pertain to an uninterrupted pipe length only

28mm PB-1 Pipe Nominal Bore = 22.25mm

Expected Flow Rate - Litres/Second at 20° C

Metre \ kPa	100	200	300	400	500	600	700	800	900	1000
1	6.72	9.63	11.88	13.75	15.42	16.93	18.32	19.61	20.82	21.97
2	4.67	6.72	8.30	9.62	10.80	11.86	12.84	13.75	14.61	15.42
3	3.77	5.44	6.72	7.80	8.76	9.62	10.42	11.17	11.86	12.52
4	3.24	4.67	5.78	6.72	7.54	8.29	8.98	9.62	10.23	10.80
5	2.87	4.15	5.14	5.98	6.72	7.38	8.00	8.57	9.11	9.62
6	2.61	3.77	4.67	5.43	6.11	6.72	7.28	7.80	8.29	8.76
7	2.40	3.48	4.31	5.01	5.63	6.20	6.72	7.20	7.65	8.08
8	2.23	3.24	4.02	4.67	5.25	5.78	6.26	6.72	7.14	7.54
9	2.10	3.04	3.77	4.39	4.94	5.43	5.89	6.31	6.72	7.09
10	1.98	2.87	3.57	4.15	4.67	5.14	5.57	5.98	6.36	6.72
11	1.88	2.73	3.39	3.95	4.44	4.89	5.30	5.69	6.05	6.39
12	1.80	2.61	3.24	3.77	4.24	4.67	5.06	5.43	5.78	6.11
13	1.72	2.50	3.10	3.61	4.07	4.48	4.86	5.21	5.54	5.85
14	1.65	2.40	2.98	3.47	3.91	4.30	4.67	5.01	5.33	5.63
15	1.59	2.31	2.87	3.35	3.77	4.15	4.50	4.83	5.14	5.43
16	1.54	2.23	2.78	2.23	3.64	4.01	4.35	4.67	4.97	5.25
17	1.49	2.16	2.69	3.13	3.53	3.88	4.21	4.52	4.81	5.09
18	1.44	2.10	2.61	3.04	3.42	3.77	4.09	4.39	4.67	4.94
19	1.40	2.04	2.53	2.95	3.32	3.66	3.97	4.26	4.54	4.80
20	1.36	1.98	2.46	2.87	3.23	3.56	3.87	4.15	4.42	4.67
21	1.32	1.93	2.40	2.80	3.15	3.47	3.77	4.04	4.30	4.55
22	1.29	1.88	2.34	2.73	3.07	3.39	3.68	3.95	4.20	4.44
23	1.26	1.84	2.29	2.67	3.00	3.31	3.59	3.85	4.10	4.34
24	1.23	1.80	2.23	2.60	2.94	3.23	3.51	3.77	4.01	4.24
25	1.20	1.76	2.19	2.55	2.87	3.17	3.44	3.69	3.93	4.15
26	1.18	1.72	2.14	2.50	2.81	3.10	3.36	3.61	3.84	4.07
27	1.15	1.68	2.10	2.45	2.76	3.04	3.30	3.54	3.77	3.98
28	1.13	1.65	2.05	2.40	2.70	2.98	3.23	3.47	3.70	3.91
29	1.11	1.62	2.02	2.35	2.65	2.92	3.17	3.41	3.63	3.84
30	1.09	1.59	1.98	2.31	2.61	2.87	3.12	3.35	3.56	3.77

Note: the above flow rates pertain to an uninterrupted pipe length only

Expected Flow Rate - Litres/Second at 60° C

Metre \ kPa	100	200	300	400	500	600	700	800	900	1000
1	6.94	9.89	12.15	14.07	15.75	17.27	18.67	19.97	21.20	22.36
2	4.86	6.94	8.54	9.89	11.08	12.15	13.14	14.07	14.93	15.75
3	3.94	5.64	6.94	8.04	9.01	9.89	10.70	11.45	12.16	12.82
4	3.39	4.86	5.99	6.94	7.78	8.54	9.24	9.89	12.50	11.08
5	3.02	4.33	5.34	6.19	6.94	7.62	8.24	8.83	9.37	9.89
6	2.75	3.94	4.86	5.64	6.32	6.94	7.51	8.04	8.54	9.01
7	2.53	3.64	4.49	5.21	5.84	6.41	6.94	7.43	7.89	8.33
8	2.36	3.39	4.19	4.86	5.45	5.99	6.48	6.94	7.37	7.78
9	2.22	3.19	3.94	4.57	5.13	5.64	6.10	6.53	6.94	7.33
10	2.10	3.02	3.73	4.33	4.86	5.34	5.78	6.19	6.58	6.94
11	2.00	2.87	3.55	4.12	4.63	5.08	5.50	5.89	6.26	6.61
12	1.91	2.74	3.39	3.94	4.42	4.86	5.26	5.64	5.99	6.32
13	1.83	2.63	3.25	3.78	4.24	4.66	5.05	5.41	5.75	6.07
14	1.76	2.53	3.13	3.64	4.08	4.49	4.86	5.21	5.53	5.84
15	1.69	2.44	3.02	3.51	3.94	4.33	4.69	5.02	5.34	5.64
16	1.64	2.36	2.92	3.39	3.81	4.19	4.54	4.86	5.16	5.45
17	1.58	2.29	2.83	3.29	3.69	4.06	4.40	4.71	5.00	5.28
18	1.54	2.22	2.75	3.19	3.58	3.94	4.27	4.57	4.86	5.13
19	1.49	2.16	2.67	3.10	3.48	3.83	4.15	4.45	4.73	4.99
20	1.45	2.10	2.60	3.02	3.39	3.73	4.04	4.33	4.60	4.86
21	1.42	2.05	2.53	2.94	3.31	3.64	3.94	4.22	4.49	4.74
22	1.38	2.00	2.47	2.87	3.23	3.55	3.85	4.12	4.38	4.63
23	1.35	1.95	2.41	2.81	3.15	3.47	3.76	4.03	4.28	4.52
24	1.32	1.91	2.36	2.75	3.08	3.39	3.68	3.94	4.19	4.42
25	1.29	1.87	2.31	2.69	3.02	3.32	3.60	3.86	4.10	4.33
26	1.26	1.83	2.26	2.63	2.96	3.25	3.53	3.78	4.02	4.24
27	1.24	1.79	2.22	2.58	2.90	3.19	3.46	3.71	3.94	4.16
28	1.21	1.76	2.18	2.53	2.85	3.13	3.39	3.64	3.87	4.08
29	1.19	1.72	2.14	2.49	2.79	3.07	3.33	3.57	3.80	4.01
30	1.17	1.69	2.10	2.44	2.75	3.02	3.27	3.51	3.73	3.94

Note: the above flow rates pertain to an uninterrupted pipe length only

The following Pressure Drop Tables have been calculated using the NZBC Acceptable flow rates to an appliance and converted to litres per minute. The calculations are an expected loss on an uninterrupted pipe length. An average of 1m can be allowed for each individual fitting that is installed into the line.

Acceptable flow rates to sanitary fixtures – NZBC G12/AS1			
Sanitary Fixture	Flow rate and temperature l/s and °C	How Measured	l/min
Bath	0.3 at 45°C	Mix hot and cold water to achieve 45°C	18
Sink	0.2 at 60°C* (hot) 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously	12
Laundry Tub	0.2 at 60°C* (hot) 0.2 (cold)	Flow rates required at both hot and cold taps but not simultaneously	12
Basin	0.1 at 45°C	Mix hot and cold water to achieve 45°C	6
Shower	0.1 at 42°C	Mix hot and cold water to achieve 42°C	6
*The temperatures in this table relate to the temperature of the water used by people in the daily use of the fixture			
Note: The flow rates required by this table shall be capable of being delivered simultaneously to the kitchen sink and one other fixture			

(Please note that the following tables are a guide only)

The below table has been calculated from an independently verified formula by: Professor Bruce Melville, FRSNZ, FIPENZ
Professor and Head of Department, Department of Civil and Environmental Engineering, The University of Auckland

12mm Pipe Pressure Drop (kPa)

Acceptable flow rates to sanitary fixtures in NZBG G12/AS1

Bath	0.3 l/s at 45°C	18 l/min
Sink	0.2 l/s at 60°C	12 l/min
Laur	0.2 l/s at 60°C	12 l/min
Basi	0.1 l/s at 45°C	6 l/min
Shov	0.1 l/s at 45°C	6 l/min

Length (m)	kPa Pressure drop at required 6 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	1.58	1.49	1.41	1.35	1.29	1.24	1.19	1.15
1	3.16	2.98	2.83	2.69	2.58	2.48	2.39	2.31
1.5	4.74	4.47	4.24	4.04	3.87	3.72	3.58	3.46
2	6.32	5.96	5.65	5.39	5.16	4.96	4.78	4.61
2.5	7.90	7.45	7.06	6.74	6.45	6.20	5.97	5.77
3	9.48	8.93	8.48	8.08	7.74	7.44	7.17	6.92
3.5	11.06	10.42	9.89	9.43	9.03	8.67	8.36	8.07
4	12.64	11.91	11.30	10.78	10.32	9.91	9.55	9.23
4.5	14.22	13.40	12.71	12.12	11.61	11.15	10.75	10.38
5	15.80	14.89	14.13	13.47	12.90	12.39	11.94	11.53
10	31.59	29.78	28.25	26.94	25.81	24.78	23.88	23.06
15	47.39	44.67	42.38	40.41	38.71	37.17	35.82	34.59
20	63.18	59.56	56.51	53.88	51.61	49.57	47.76	46.12
25	78.98	74.45	70.64	67.35	64.52	61.96	59.71	57.66
30	94.78	89.34	84.76	80.82	77.42	74.35	71.65	69.19
35	110.57	104.23	98.89	94.29	90.32	86.74	83.59	80.72
40	126.37	119.12	113.02	107.76	103.23	99.13	95.53	92.25
45	142.16	134.01	127.14	121.22	116.13	111.52	107.47	103.78
50	157.96	148.90	141.27	134.69	129.03	123.91	119.41	115.31

Length (m)	kPa Pressure drop at required 12 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	5.31	5.01	4.75	4.53	4.34	4.17	4.02	3.88
1	10.63	10.02	9.50	9.06	8.68	8.34	8.03	7.56
1.5	15.94	15.03	14.26	13.59	13.02	12.50	12.05	11.64
2	21.25	20.03	19.01	18.12	17.36	16.67	16.07	15.51
2.5	26.57	25.04	23.76	22.65	21.70	20.84	20.08	19.39
3	31.88	30.05	28.51	27.18	26.04	25.01	24.10	23.27
3.5	37.19	35.06	33.26	31.71	30.38	29.18	28.12	27.15
4	42.51	40.07	38.01	36.24	34.72	33.34	32.13	31.03
4.5	47.82	45.08	42.77	40.78	39.06	37.51	36.15	34.91
5	53.13	50.09	47.52	45.31	43.40	41.68	40.17	38.79
10	106.26	100.17	95.04	90.61	86.80	83.36	80.33	77.57
15	159.39	150.26	142.55	135.92	130.21	125.04	120.49	116.36
20	212.52	200.34	190.07	181.22	173.61	166.72	160.66	155.14
25	265.66	250.43	237.59	226.53	217.01	208.40	200.82	193.93
30	318.79	300.51	285.11	271.83	260.41	250.07	240.99	232.71
35	371.92	350.60	332.63	317.14	303.81	291.75	281.15	271.50
40	425.05	400.68	380.14	362.44	347.21	333.43	321.32	310.28
45	478.18	450.76	427.66	407.75	390.62	375.11	361.48	349.07
50	531.31	500.85	475.18	453.05	434.02	416.79	401.65	387.85

Length (m)	kPa Pressure drop at required 18 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	10.80	10.18	9.66	9.21	8.82	8.47	8.17	7.89
1	21.60	20.37	19.32	18.42	17.65	16.95	16.33	15.77
1.5	32.41	30.55	28.98	27.63	26.47	25.42	24.50	23.66
2	43.21	40.73	38.64	36.84	35.30	33.90	32.66	31.54
2.5	54.01	50.91	48.30	46.06	44.12	42.37	40.83	39.43
3	64.81	61.10	57.97	55.27	52.94	50.84	49.00	47.31
3.5	75.62	71.28	67.63	64.48	61.77	59.32	57.16	55.20
4	86.42	81.46	77.29	73.69	70.59	67.79	65.33	63.08
4.5	97.22	91.65	86.95	82.90	79.42	76.26	73.49	70.97
5	108.02	101.83	96.61	92.11	88.24	84.74	81.66	78.86
10	216.04	203.66	193.22	184.22	176.48	169.48	163.32	157.71
15	324.06	305.48	289.83	276.33	264.72	254.21	244.98	236.56
20	432.08	407.31	386.44	368.44	352.96	338.95	326.64	315.42
25	540.10	509.14	483.04	460.55	441.20	423.69	408.29	394.27
30	648.13	610.97	579.65	552.66	529.44	508.43	489.95	473.13
35	756.15	712.80	676.26	644.77	617.68	593.16	571.61	551.98
40	864.17	814.62	772.87	736.88	705.92	677.90	653.27	630.84
45	972.18	916.45	869.48	828.99	794.16	762.64	734.93	709.69
50	1080.21	1018.28	966.09	921.10	882.40	847.38	816.59	788.55

The below table has been calculated from an independently verified formula by: Professor Bruce Melville, FRSNZ, FIPENZ
Professor and Head of Department, Department of Civil and Environmental Engineering, The University of Auckland

15mm Pipe Pressure Drop in kPa

Acceptable flow rates to sanitary fixtures in NZBG G12/AS1

Bath	0.3 l/s at 45°C	18 l/min
Sink	0.2 l/s at 60°C	12 l/min
Laur	0.2 l/s at 60°C	12 l/min
Basi	0.1 l/s at 45°C	6 l/min
Shov	0.1 l/s at 45°C	6 l/min

Length (m)	kPa Pressure drop at required 6 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.38	0.36	0.34	0.32	0.31	0.30	0.29	0.28
1	0.76	0.71	0.68	0.65	0.62	0.59	0.57	0.55
1.5	1.14	1.07	1.02	0.97	0.93	0.89	0.86	0.83
2	1.51	1.43	1.35	1.29	1.24	1.19	1.14	1.11
2.5	1.89	1.78	1.69	1.61	1.55	1.48	1.43	1.38
3	2.27	2.14	2.03	1.94	1.85	1.78	1.72	1.66
3.5	2.65	2.50	2.37	2.26	2.16	2.08	2.00	1.93
4	3.03	2.85	2.71	2.58	2.47	2.37	2.29	2.21
4.5	3.41	3.21	3.05	2.90	2.78	2.67	2.57	2.49
5	3.78	3.57	3.38	3.23	3.09	2.97	2.86	2.76
10	7.57	7.13	6.77	6.45	6.18	5.94	5.72	5.52
15	11.35	10.70	10.15	9.68	9.27	8.90	8.58	8.29
20	15.13	14.27	13.53	12.90	12.36	11.87	11.44	11.05
25	18.92	17.83	16.92	16.13	15.45	14.84	14.30	13.81
30	22.70	21.40	20.30	19.36	18.54	17.81	17.16	16.57
35	26.48	24.96	23.69	22.58	21.63	20.77	20.02	19.33
40	30.27	28.53	27.07	25.81	24.72	23.74	22.88	22.09
45	34.05	32.10	30.45	29.03	27.81	26.71	25.74	24.86
50	37.83	35.66	33.84	32.26	30.90	29.68	28.60	27.62

Length (m)	kPa Pressure drop at required 12 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	1.27	1.20	1.14	1.09	1.04	1.00	0.96	0.93
1	2.55	2.40	2.28	2.17	2.08	2.00	1.92	1.86
1.5	3.82	3.60	3.41	3.26	3.12	3.00	2.89	2.79
2	5.09	4.80	4.55	4.34	4.16	3.99	3.85	3.72
2.5	6.36	6.00	5.69	5.43	5.20	4.99	4.81	4.65
3	7.64	7.20	6.83	6.51	6.24	5.99	5.77	5.57
3.5	8.91	8.40	7.97	7.60	7.28	6.99	6.73	6.50
4	10.18	9.60	9.11	8.68	8.32	7.99	7.70	7.43
4.5	11.45	10.80	10.24	9.77	9.36	8.98	8.66	8.36
5	12.73	12.00	11.38	10.85	10.40	9.98	9.62	9.29
10	25.45	23.99	22.76	21.70	20.79	19.97	19.24	18.58
15	38.18	35.99	34.14	32.55	31.19	29.95	28.86	27.87
20	50.90	47.98	45.52	43.40	41.58	39.93	38.48	37.16
25	63.63	59.98	56.90	54.25	51.98	49.91	48.10	46.45
30	76.35	71.97	68.29	65.11	62.37	59.89	57.72	55.74
35	89.08	83.97	79.67	75.96	72.77	69.88	67.34	65.03
40	101.80	95.97	91.05	86.81	83.16	79.86	76.96	74.31
45	114.53	107.96	102.43	97.66	93.55	89.84	86.58	83.60
50	127.25	119.96	113.81	108.51	103.95	99.82	96.20	92.89

Length (m)	kPa Pressure drop at required 18 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	2.59	2.44	2.31	2.21	2.11	2.03	1.96	1.89
1	5.17	4.88	4.63	4.41	4.23	4.06	3.91	3.78
1.5	7.76	7.32	6.94	6.62	6.34	6.09	5.87	5.67
2	10.35	9.76	9.26	8.82	8.45	8.12	7.82	7.55
2.5	12.94	12.19	11.57	11.03	10.57	10.15	9.78	9.44
3	15.52	14.63	13.88	13.24	12.68	12.18	11.74	11.33
3.5	18.11	17.07	16.20	15.44	14.79	14.21	13.69	13.22
4	20.70	19.51	18.51	17.65	16.91	16.24	15.65	15.11
4.5	23.28	21.95	20.82	19.86	19.02	18.27	17.60	17.00
5	25.87	24.39	23.14	22.06	21.13	20.30	19.56	18.89
10	51.74	48.78	46.28	44.12	42.27	40.59	39.12	37.77
15	77.62	73.17	69.42	66.18	63.40	60.89	58.67	56.66
20	103.49	97.55	92.55	88.24	84.54	81.18	78.23	75.54
25	129.36	121.94	115.69	110.30	105.67	101.48	97.79	94.43
30	155.23	146.33	138.83	132.37	126.80	121.77	117.35	113.32
35	181.10	170.72	161.97	154.43	147.94	142.07	136.90	132.20
40	206.97	195.11	185.11	176.49	169.07	162.36	156.46	151.09
45	232.84	219.50	208.24	198.55	190.21	182.66	176.02	169.98
50	258.72	243.88	231.38	220.61	211.34	202.95	195.58	188.86

The below table has been calculated from an independently verified formula by: Professor Bruce Melville, FRSNZ, FIPENZ
Professor and Head of Department, Department of Civil and Environmental Engineering, The University of Auckland

20mm Pipe Pressure Drop in kPa

Acceptable flow rates to sanitary fixtures in NZBG G12/AS1

Bath	0.3 l/s at 45°C	18 l/min
Sink	0.2 l/s at 60°C	12 l/min
Laur	0.2 l/s at 60°C	12 l/min
Basi	0.1 l/s at 45°C	6 l/min
Shov	0.1 l/s at 45°C	6 l/min

Length (m)	kPa Pressure drop at required 6 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.06
1	0.15	0.14	0.13	0.13	0.12	0.12	0.11	0.11
1.5	0.22	0.21	0.20	0.19	0.18	0.18	0.17	0.16
2	0.30	0.28	0.27	0.26	0.24	0.23	0.23	0.22
2.5	0.37	0.35	0.33	0.32	0.31	0.29	0.28	0.27
3	0.45	0.42	0.40	0.38	0.37	0.35	0.34	0.33
3.5	0.52	0.49	0.47	0.45	0.43	0.41	0.40	0.38
4	0.60	0.56	0.53	0.51	0.49	0.47	0.45	0.44
4.5	0.67	0.63	0.60	0.57	0.55	0.53	0.51	0.49
5	0.75	0.70	0.67	0.64	0.61	0.59	0.56	0.55
10	1.49	1.41	1.34	1.27	1.22	1.17	1.13	1.09
15	2.24	2.11	2.00	1.91	1.83	1.76	1.69	1.64
20	2.99	2.82	2.67	2.55	2.44	2.34	2.26	2.18
25	3.73	3.52	3.34	3.18	3.05	2.93	2.82	2.73
30	4.48	4.22	4.01	3.82	3.66	3.51	3.39	3.27
35	5.23	4.93	4.67	4.46	4.27	4.10	3.95	3.82
40	5.97	5.63	5.34	5.09	4.88	4.69	4.52	4.36
45	6.72	6.34	6.01	5.73	5.49	5.27	5.08	4.91
50	7.47	7.04	6.68	6.37	6.10	5.86	5.64	5.45

Length (m)	kPa Pressure drop at required 12 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.25	0.24	0.23	0.21	0.21	0.20	0.19	0.18
1	0.50	0.47	0.45	0.43	0.41	0.39	0.38	0.37
1.5	0.75	0.71	0.67	0.64	0.62	0.59	0.57	0.55
2	1.01	0.95	0.90	0.86	0.82	0.79	0.76	0.73
2.5	1.26	1.18	1.12	1.07	1.03	0.99	0.95	0.92
3	1.51	1.42	1.35	1.29	1.23	1.18	1.14	1.10
3.5	1.76	1.66	1.57	1.50	1.44	1.38	1.33	1.28
4	2.01	1.89	1.80	1.71	1.64	1.58	1.52	1.47
4.5	2.26	2.13	2.02	1.93	1.85	1.77	1.71	1.65
5	2.51	2.37	2.25	2.14	2.05	1.97	1.90	1.83
10	5.02	4.74	4.49	4.28	4.10	3.94	3.80	3.67
15	7.53	7.10	6.74	6.42	6.16	5.91	5.70	5.50
20	10.05	9.47	8.98	8.57	8.21	7.88	7.59	7.33
25	12.56	11.84	11.23	10.71	10.26	9.85	9.49	9.17
30	15.07	14.21	13.48	12.85	12.31	11.82	11.39	11.00
35	17.58	16.57	15.72	14.99	14.36	13.79	13.29	12.83
40	20.09	18.94	17.97	17.13	16.41	15.76	15.19	14.67
45	22.60	21.31	20.22	19.27	18.46	17.73	17.09	16.50
50	25.11	23.67	22.46	21.42	20.52	19.70	18.99	18.33

Length (m)	kPa Pressure drop at required 18 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.51	0.48	0.46	0.44	0.42	0.40	0.39	0.37
1	1.02	0.96	0.91	0.87	0.83	0.80	0.77	0.75
1.5	1.53	1.44	1.37	1.31	1.25	1.20	1.16	1.12
2	2.04	1.93	1.83	1.74	1.67	1.60	1.54	1.49
2.5	2.55	2.41	2.28	2.18	2.09	2.00	1.93	1.86
3	3.06	2.89	2.74	2.61	2.50	2.40	2.32	2.24
3.5	3.57	3.37	3.20	3.05	2.92	2.80	2.70	2.61
4	4.09	3.85	3.65	3.48	3.34	3.20	3.09	2.98
4.5	4.60	4.33	4.11	3.92	3.75	3.61	3.47	3.36
5	5.11	4.81	4.57	4.35	4.17	4.01	3.86	3.73
10	10.21	9.63	9.13	8.71	8.34	8.01	7.72	7.46
15	15.32	14.44	13.70	13.06	12.51	12.02	11.58	11.18
20	20.42	19.25	18.27	17.42	16.68	16.02	15.44	14.91
25	25.53	24.07	22.83	21.77	20.86	20.03	19.30	18.64
30	30.64	28.88	27.40	26.12	25.03	24.03	23.16	22.36
35	35.74	33.69	31.97	30.48	29.20	28.04	27.02	26.09
40	40.85	38.51	36.53	34.83	33.37	32.04	30.88	29.82
45	45.95	43.32	41.10	39.19	37.54	36.05	34.74	33.55
50	51.06	48.13	45.67	43.54	41.71	40.05	38.60	37.27

The below table has been calculated from an independently verified formula by: Professor Bruce Melville, FRSNZ, FIPENZ Professor and Head of Department, Department of Civil and Environmental Engineering, The University of Auckland

28mm Pipe Pressure Drop in kPa

Acceptable flow rates to sanitary fixtures in NZBG G12/AS1

Bath	0.3 l/s at 45°C	18 l/min
Sink	0.2 l/s at 60°C	12 l/min
Laur	0.2 l/s at 60°C	12 l/min
Basi	0.1 l/s at 45°C	6 l/min
Shov	0.1 l/s at 45°C	6 l/min

Length (m)	kPa Pressure drop at required 6 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
1	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04
1.5	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06
2	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.08
2.5	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.10
3	0.16	0.15	0.14	0.14	0.13	0.12	0.12	0.12
3.5	0.19	0.17	0.17	0.16	0.15	0.15	0.14	0.14
4	0.21	0.20	0.19	0.18	0.17	0.17	0.16	0.15
4.5	0.24	0.22	0.21	0.20	0.19	0.19	0.18	0.17
5	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19
10	0.53	0.50	0.47	0.45	0.43	0.42	0.40	0.39
15	0.79	0.75	0.71	0.68	0.65	0.62	0.60	0.58
20	1.06	1.00	0.95	0.90	0.86	0.83	0.80	0.77
25	1.32	1.25	1.18	1.13	1.08	1.04	1.00	0.96
30	1.59	1.49	1.42	1.35	1.30	1.24	1.20	1.16
35	1.85	1.74	1.65	1.58	1.51	1.45	1.40	1.35
40	2.11	1.99	1.89	1.80	1.73	1.66	1.60	1.54
45	2.38	2.24	2.13	2.03	1.94	1.87	1.80	1.74
50	2.64	2.49	2.36	2.25	2.16	2.07	2.00	1.93

Length (m)	kPa Pressure drop at required 12 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07
1	0.18	0.17	0.16	0.15	0.15	0.14	0.13	0.13
1.5	0.27	0.25	0.24	0.23	0.22	0.21	0.20	0.20
2	0.36	0.34	0.32	0.30	0.29	0.28	0.27	0.26
2.5	0.44	0.42	0.40	0.38	0.36	0.35	0.34	0.32
3	0.53	0.50	0.48	0.46	0.44	0.42	0.40	0.39
3.5	0.62	0.59	0.56	0.53	0.51	0.49	0.47	0.45
4	0.71	0.67	0.64	0.61	0.58	0.56	0.54	0.52
4.5	0.80	0.75	0.72	0.68	0.65	0.63	0.61	0.58
5	0.89	0.84	0.80	0.76	0.73	0.70	0.67	0.65
10	1.78	1.68	1.59	1.52	1.45	1.39	1.34	1.30
15	2.67	2.51	2.38	2.27	2.18	2.09	2.02	1.95
20	3.56	3.35	3.18	3.03	2.90	2.79	2.69	2.60
25	4.44	4.19	3.97	3.79	3.63	3.49	3.36	3.24
30	5.33	5.03	4.77	4.55	4.36	4.18	4.03	3.89
35	6.22	5.86	5.56	5.30	5.08	4.88	4.70	4.54
40	7.11	6.70	6.36	6.06	5.81	5.58	5.37	5.19
45	8.00	7.54	7.15	6.82	6.53	6.27	6.05	5.84
50	8.89	8.38	7.95	7.58	7.26	6.97	6.72	6.49

Length (m)	kPa Pressure drop at required 18 l/min							
	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C
0.5	0.18	0.17	0.16	0.15	0.15	0.14	0.14	0.13
1	0.36	0.34	0.32	0.31	0.30	0.28	0.27	0.26
1.5	0.54	0.51	0.49	0.46	0.44	0.43	0.41	0.40
2	0.72	0.68	0.65	0.62	0.59	0.57	0.55	0.53
2.5	0.90	0.85	0.81	0.77	0.74	0.71	0.68	0.66
3	1.08	1.02	0.97	0.92	0.89	0.85	0.82	0.79
3.5	1.27	1.19	1.13	1.08	1.03	0.99	0.96	0.92
4	1.45	1.36	1.29	1.23	1.18	1.13	1.09	1.06
4.5	1.63	1.53	1.45	1.39	1.33	1.28	1.23	1.19
5	1.81	1.70	1.62	1.54	1.48	1.42	1.37	1.32
10	3.61	3.41	3.23	3.08	2.95	2.84	2.73	2.64
15	5.42	5.11	4.85	4.62	4.43	4.25	4.10	3.96
20	7.23	6.81	6.46	6.16	5.90	5.67	5.46	5.28
25	9.03	8.52	8.08	7.70	7.38	7.09	6.83	6.60
30	10.84	10.22	9.70	9.24	8.86	8.50	8.20	7.91
35	12.65	11.92	11.31	10.78	10.33	9.92	9.56	9.23
40	14.45	13.63	12.93	12.33	11.81	11.34	10.93	10.55
45	16.26	15.33	14.54	13.87	13.28	12.76	12.29	11.87
50	18.07	17.03	16.16	15.41	14.76	14.17	13.66	13.19

Pressure Conversion

kPa	Bar	PSI	MPa
1	0.01	0.1450	0.001
100	1.00	14.40	0.1
200	2.00	29.01	0.2
300	3.00	43.51	0.3
400	4.00	58.02	0.4
500	5.00	72.52	0.5
600	6.00	87.02	0.6
700	7.00	101.53	0.7
800	8.00	116.03	0.8
900	9.00	130.53	0.9
1000	10.00	145.04	1

Definition of Terms

Term	Definition
Dezincification	Dezincification of brass is a form of selective corrosion that happens when Zinc is leached out of the alloy leaving a porous copper fitting
Dezincification Resistant (DZR/DR)	Dezincification Resistant brass is a specifically modified brass alloy purposefully made to be suitable for potable water reticulation.
Elastic Modulus	Elastic Modulus or Modulus of Elasticity is the mathematical description of an object or substance's tendency to be deformed elastically (i.e. non-permanently) when a force is applied to it.
EVA	Ethylene Vinyl Acetate is the co-polymer of Ethylene and Vinyl Acetate. It is a polymer that approaches elastomeric materials in softness and flexibility but can be processed like other thermoplastics.
Hydrostatic Pressure	The pressure exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity. Hydrostatic pressure increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward force from above.
Isotactic	A type of polymeric molecular structure containing a sequence of regularly spaced, asymmetric atoms arranged in like configuration in a polymer chain.
Kinematic Velocity	A measure of the resistance to flow of a fluid, equal to its absolute viscosity divided by its density, usually measured in stokes.
Laminar flow	Sometimes known as streamline flow, occurs when a fluid flows in parallel layers, with no disruption between the layers. At low velocities the fluid tends to flow without lateral mixing and adjacent layers slide past one another like playing cards.
LDPE	Low Density Polyethylene is a thermoplastic made from petroleum and has the distinction of being the first grade of polyethylene produced in 1933.
Potable	Drinking water or potable water is water pure enough to be consumed or used with low risk of immediate or long term harm.
Thermal Conductivity	The property of a material to conduct heat, materials with a high level of thermal conductivity allows heat to transfer at a faster rate than those with a low thermal conductivity.

Thermoplastic	Also known as thermo-softening plastic is a polymer that turns to a liquid when heated and freezes to a very glassy state when cooled sufficiently. Most thermoplastics are high molecular weight polymers.
Turbulent Flow	Movement of a fluid in which subcurrents in the fluid display turbulence, moving in irregular patterns, while the overall flow is in one direction. Turbulent flow is common in non-viscous fluids moving at high velocities.
Viscosity	Viscosity is a measure of the resistance of a fluid which is being deformed by either shear stress or tensile stress.
Volatile Organic Compounds (VOC)	Volatile Organic Compounds are emitted as gases from certain solids or liquids. VOC's include a variety of chemicals, some of which may have short or long term adverse health risks.

Compatibility of PB-1 Systems

Dux SecuraGold™ fittings and pipes are manufactured to AS/NZS 2642.1, 2 and 3 standards and as such compatible PB-1 pipe which has been manufactured to the same standard would be suitable for use with SecuraGold™ fittings specifically for maintenance situations and not full new installations. If the pipe specifications are correct to the AS/NZS 2642.2 standard and the crimped fitting/s gauge appropriately Dux will guarantee the connection.
(Note: This statement excludes all PB-1 pipe and fittings manufactured/supplied by LEAP)