Technical guide

U-PVC & O-PVC Pressure Pipe System

wavin


wavin ACADEMY


wavin
wavin
wavin

About WAVIN

Wavin is one of the leading companies in the plastic pipe industry in Turkey. Our company offers a wide range of high-quality pipe and fittings system solutions for building and infrastructure. Our company, which has a history of more than half a century, started production in 1971 in Adana. Pilsa Plastik A.Ş. was purchased by Wavin B.V, the largest European company in its own field in the Netherlands in 2008.

In 2012, all Wavin companies joined the Mexichem family which is South America's giant petrochemicals and raw materials producer. Mexichem announced its new name as ORBIA in 2019. ORBIA, with its new changing business structure, provides professional support to its customers with its products and services in 5 main business lines: Building & Infrastructure, Flour, Datacom, Precision Agriculture and Polymer Solutions. With the new structuring of ORBIA, its main mission is to advance life around the world.

In 2019, with the renewed business structure of ORBIA, building & infrastructure business line was started to represent by WAVIN, a single and strong brand across the globe. WAVIN operates in more than 40 countries around the world in 4 main regions: Europe-Middle East-Africa, Asia-Pacific, Latin America and USA-Canada with 12.000 employees.

Wavin is now a global leader in the supply of plastic pipe systems and solutions for both above and below ground applications in projects around the world. Since the 1950s, we have built an unrivalled reputation for continuous innovation, intelligent problem-solving, dedicated technical support and the highest standards.

Wavin Turkey offers traditional products such as PPR-C clean water, PVC wastewater as well as the innovative products such as Tigris Press-fit systems, SiTech+ low noise pipes, Qickstream siphonic rainwater drainage systems, Q-Bic Plus infiltration systems, Tegra plastic manholes etc. to the sector. Wavin Academy which is the first training centre of the sector. was opened in 2014 within our factory in Adana, Tens of thousands of visitors from various levels of the mechanical installation sector have been able to increase their expertise by attending training at Wavin Academy since 2014. Our company provides fast service with Adana, Istanbul, Ankara and Izmir offices, distribution centres located in Istanbul and Adana and wide dealers network. In addition to our sales staff, our expert engineers and technical personnel support our customers for the projects.

To get more information about our company and products, please visit our website www.wavin.com.tr and follow us on our social media accounts.

1. Materials for water distribution

1.1 Classification of plastics for piping systems

The development of plastics used in gas and water distribution is continuous. In recent years outstanding progress has been achieved.

The creation of new material types with increased strength, higher property consistency and at the same time good or better processability are paramount. Moreover, European standardisation already shows the first conceivable effects in as far as classification systems come into use today, with subsequent lasting influences on pipe construction with plastics (prEN 1555, prEN 12201, EN1452).

The starting point for the new classification system according to ISO 12162 and EN 32162 is the long-term behaviour of the respective material under internal pressure. For this purpose, values are obtained with a pipe-type specimen filled with water at different temperatures and evaluated by means of the Standard Extrapolation Method in accordance with ISO/DIS 9080.

Procedure

At different temperatures, different internal pressures (= circumferential stress in the pipe wall) are applied to the specimens. The (load) duration until break is determined. The respective breaking stress is applied over the appropriate load time. This results in the load duration graph.

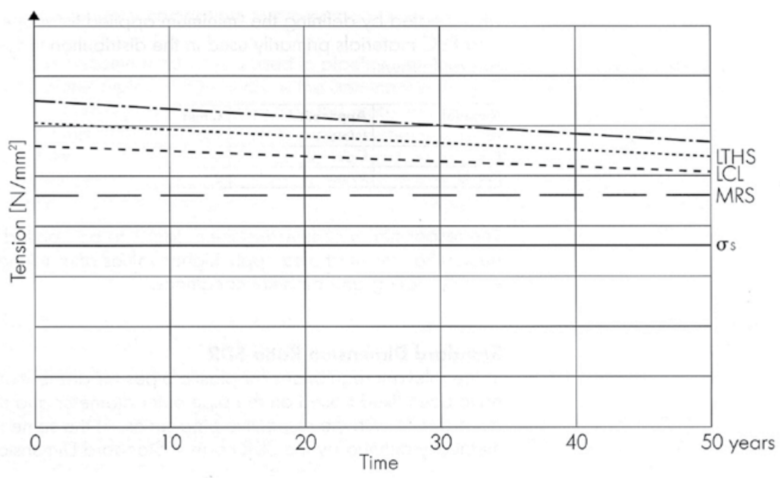
The circumferential stress values for 20°C are extrapolated to 50 years according to ISO/DIS 9080 and lead to

- the LTHS anticipated value, 50 years (Long Term Hydrostatic Strength),
- the 97.5 % LCL (Lower Confidence Limit).

This LCL value is categorised in accordance with the Renard series of numbers (R10 or R20 in accordance with ISO 3 and ISO 497). The calculated LCL value is reduced to the next lower Renard number. This results in the required MRS (Minimum Required Strength).

This MRS value in MPa is the basis for the classification. The MRS value multiplied by 10 results in the "classification" of the material. As example, common PE pipe materials. They have a MRS of 10 MPa. They are therefore called PE 100 in accordance with the new system.

Unlike the existing classification methods based upon the dimensional stress and the "safety coefficients" (sometimes different in each nation), the new system refers to a uniformly determined material parameter. This eliminates earlier misunderstandings due to the different starting points.



From classification to application

The MRS value represents the long-term circumferential stress in the pipe where the break may occur after 50 years at the earliest. The calculation stress ss is applied for dimensioning of the piping network. This is calculated from:

$$\sigma_S = \frac{MRS}{C}$$

with C= total operating coefficient.

The total operating coefficient replaces the classical "safety coefficient" and considers the facts of application, the installation conditions etc.

Within the course of harmonisation of standards in Europe, uniform guidelines were also created by defining the “minimum applied total operating coefficient’. For PE materials primarily used in the distribution industry, the minimum values for C are as follows:

	Material	C
PVC-U <-->	PVC 250	2.0
PVC-O <-->	PVC 315	1.6
	PVC 355	1.6
	PVC 400	1.6
	PVC 410	1.4
	PVC 500	1.4

The responsibility of selecting the C factor to be applied lies with the planning engineer, who can/must also apply higher values after taking into consideration all relevant operating and ambient conditions.

1.2 Standard Dimension Ratio SDR

In the relevant regulations for plastic pipes for distribution, specific pipe dimensions have been fixed based on the pipe outer diameter and the pipe wall thickness in accordance with the respective pipe series. At the same time, each pipe series is geometrically defined by the SDR code = Standard Dimension Ratio, whereby:

SDR = d / e

or

SDR = 2[s] + 1

to calculate [s]:

$$[s] = \frac{\text{outside diameter - wall thickness}}{\text{2 x wall thickness}}$$

The essential pipe series used for gas and water distribution are described by the pipe outer diameter d and the pipe wall thickness e.

The relation between the SDR geometrical code and the maximum permitted internal pressure in the pipes important for the user is produced from the equations:

σ_u= p x (da – e) / (20 x e)
and

$\sigma_v = \sigma_u \leq \sigma_{zul.}$
The following equation:

SDR = 20 x ($\sigma_{zul.}$/p) + 1
If one defines, based on the PE tensile properties for the life span of 50 years for example,

$\sigma_{zul.}$= MRS/C
The following relation is produced:

SDR = ((20/p) x (MRS/C)) + 1

As alternate you can use

$$\text{SDR} = \frac{\text{outside diameter}}{\text{wall thickness}}$$

or

$$\text{SDR} = \frac{\text{OD}}{\text{e}}$$

2. General material properties of PVC-U

Polyvinylchloride PVC-U

Polyvinylchloride is more commonly known by its abbreviated name PVC. It is the oldest and most common plastic, being used in many branches of the industry as well as in daily life. Contrary to popular belief, this plastic that comes from the thermoplastic group is easily cementable, fusible, repeatedly reshapeable under heat, and highly recyclable. Scrap PVC may be recycled.

PVC is made by polymerising vinylchloride, a gas-like monomer.
Wavin pipes, fittings and valves for buried pipelines and for installations of drinking water systems are manufactured from PVC-U (PVC unplasticized) without softener and without fillers. For industrial applications, besides PVC-U, even PVC-C (PVC rechlorinated) is used. PVC-C is distinguished by a higher temperature resistance and is exclusively solvent cemented.

To enable working on extruding, calandering and injection moulding machines, additives should be added to the PVC-U. They are lubricants and stabilizers; moreover, if the product should be dyed, then pigments should be added. The total of all additives is below 5 %.

Additives

Metal stabilizers are used for protection against thermal decomposition during treatment and against the effects of UV radiation. Wavin uses tin stabilized PVC for manufacturing fittings and valves. This ensures that the products can be used worldwide in the food industry, for example, drinking water applications.

Chemical resistance

PVC-U is resistant against most acids and alkalis. As a result, it is also used for storage and transport of aggressive media. That is why, PVC-U is preferred in pipe constructions like:

- Drinking water main lines
- Drinking water supply lines
- Discharge lines
- Irrigation lines
- Plant construction
- Piping systems for the industry

Plastic pipe systems are ideal for transporting a wide variety of chemicals and are widely used in industries where conveyance of highly corrosive liquids and gases require products with excellent corrosion resistance.

PVC pipe systems have outstanding resistance to a wide range of chemical reagents at temperatures up to 50 °C.

In general PVC is suitable to convey most strong acids, alkalies and aqueous solutions (except those which are strongly oxidising), aliphatic hydrocarbons, fluorides, photographic and plating solutions, brine, mireral oils, fats and alcohols. The suitability of a PVC pipeline for conveying a given chemical will depend on such factors as: the concentration of the chemical in the fluid to be conveyed, flow rates, the presence of pockets or “dead spots” in the pipeline and other factors.

PVC should not normally be used with aldehydes and ketones, ethers, cyclic ethers, esters and aromatic and chlorinated hydrocarbons, nitro compounds, some petrol/benzine mixtures, and similar solvents which lead to a marked swelling and softening of the material. Consideration should also be given to the effect of the fluid on the rubber ring. Unless otherwise specified, rings of natural rubber will be supplied.

Natural rubber gaskets are generally resistant to most inorganic chemicals, including acids, alkalis including salts, together with organic acids, alcohols, ketones and aldehydes. They can be attacked by ozone, strong acids, oils, greases and many hydrocarbons however.

Where soil conditions are unknown or known to be harmful, a soils analysis should be carried out to determine any likely contaminents or talk directly to Wavin.

Wavin provides extensive technical support and will be pleased to assist when doubt exists over a product’s suitability.

Phone +90 322 999 10 00 | +90 322 346 07 07

Technical data

Wavin PVC-U pressure pipes are in accordance with EN 1452. The pipes are manufactured from unplasticized PVC.

Colour:
Dark grey

Identification

Wavin pressure pipes bear the following signs:

Pilsa, qualitymark, standard number, material, pressure, diameter, manufacture number, date, wavin.

PVC dimensions

In the pipe industry there are two different ways to indicate the dimension. One is the DN size (nominal diameter), which is used for iron pipes. The second one is used for the plastics industry which is OD (outside diameter). The next table indicates the OD sizes against the DN size for PVC pipes.

Technical data for PVC pipes:		**Typical Values**	
Designation: PVC		**Unit**	**Test Method:**
Density 1410	kg/m³	ISO 1183	
Modulus of elasticity (1 mm/min.)	3000	MPa	ISO 527
Melt index		g/10 min	ISO 1133 cond. 18
Linear coefficient of thermal expansion	$0.7x10^{-4}$	$° K^{-1}$	VDE 0304
Specific heat	1.0	J/g ° K	Calorimetric at 23 °C
Thermal conductivity	0.15	W/m ° K	DIN 52 612 at 23 °C
Min. radius of curvature	300 x dy *		at 20°C

Effect on drinking water	Wavin's pressure pipes and fittings are tested and approved according to The Ministry Of Health demands and found suitable for conducting potable water in water supply systems.
Chemical resistance	Refer to DS/ISO DATA 7 "Unplasticized polyvinyl chloride pipes and fittings. Chemical resistance with respect to fluids."
*dy = outside diameter of plastic pipe	

DN	OD
40	50
50	63
65	75
70	-
80	90
100	110
125	125
125	140
150	160
150	180
200	200
200	225
250	250
250	280
300	315
350	355
400	400
400	450
500	500
500	560
600	630

Features & Benefits

PVC-U pressure pipes and fittings are manufactured from unplasticised polyvinyl chloride polymer which is a thermoplastic material commonly used for potable water distribution, irrigation systems and sewer mains.

The high strength to weight ratio, together with exceptional resistance to corrosion makes these pipes ideal for major infrastructure applications.

Range
The pipes and fittings are available in diameters from 20 mm - 400 mm and in pressure classes ranging from PN 6 to PN 16. Also unique tensile resistant couplers are available in other operating Wavin companies and may be offered upon request. The PVC-U pressure pipes are available in socketed and plain ended lengths. They can be jointed in various ways. (See installation).

Fields of application
The PVC-U pressure pipes and fittings from Wavin are suitable for the following applications:

- potable water distribution systems
- industrial process pipelines
- pressure sewer
- effluent pipelines
- slurry pipelines
- irrigation and watering systems

Features and benefits

- **High reliability and proven service performance**
  PVC-U pipes and fittings are the preferred piping material world-wide for potable water supply and distribution pipes.
- **Complete plastic system**
  Extensive range of pipes and fittings.
- **Smooth bore, free from incrustations**
  Maintaining a smooth internal surface, preventing the build-up of deposits. Minimum maintenance required.
- **Corrosion resistant**
  Durable and complete plastic system with smooth internal bore.
- **Light weight**
  Which makes it easy to handle and install, resulting in reduced laying costs.
- **Reliable and durable**
  Both, the easy rubber ring push-fit system and solvent cement ensure a tight and durable connection.
- **Safe for potable water supply**
  PVC-U is proven to be one of the most reliable and safe piping materials for potable water.
- **Effective rubber ring seal joint**
  Reduced jointing effort and improved reliability.
- **High chemical resistance**
  Wavin PVC-U pressure pipes and fittings are resistant to a great number of chemical agents.

Meeting all requirements
Wavin PVC-U pipes and fittings meet all the major European standards like DIN8061/62, ISO4422, EN1452, etc. Product and material certificates offer the customer the highest level of quality and reliability. (See 5. Standards & Regulations.)

Special projects
A specialised team within Wavin is dedicated to supplying all required products for large-scale pipe projects; Wavin's own products can be combined with those of other manufacturers to supply a complete package to the customer. This team is experienced in arranging very large quantities of product "right on time" to complex construction projects. Upon request technical advice and training can be offered by Wavin experts to assist in these projects.

3. General material properties of Apollo bi-axial PVC-O

The Apollo pressure pipe is the result of several years of research by Wavin to develop a fully Bi-axial oriented PVC pipe based on the proven properties of PVC-U. Apollo not only offers a pipeline material with increased strength and increased toughness over standard PVC-U and polyethylene, but also a much-improved ductility and therefore pipe performance. This new material provides a water distribution pipe that is substantially tougher and lighter in weight. Apollo has been developed specifically for potable water pressure distribution systems.

Range

Apollo is available in 10 bar, 12.5 bar and 16 bar from 110 mm to 315 mm in diameter. The pipes are coloured cream Apollo pipes are produced plain ended or with integral sockets. The Apollo pipes have an effective length of 6 metres. Other lengths are available on request.

A full range of standard PVC-U is available to complement the Apollo pipes. Ductile iron fittings may be offered from other operating group companies upon request.

Fields of application

Apollo is applicable for potable water pressure distribution systems. Apollo can also be used for buried non-potable applications such as grey water, irrigation and sewer pumping mains.

Features and benefits

- **High burst strength**
  Increased material strength allows reduced wall thickness and therefore a reduced pipe weight per metre.
- **High impact strength**
  Provides better protection against damage during storage, handling and installation than conventional PVC-U pipes.
- **Resistance to low temperatures**
  The increased toughness allows pipe installation at temperatures down
  to -20 °C.
- **Resistance to point loading**
  The layered wall structure of Apollo reduces the chance of premature failure under point loading conditions.
- **Light weight**
  As less material is used, Apollo pipes are not only lighter than the equivalent PVC-U pipes but are seven times lighter than ductile iron. Thus an absolute winner in ease of handling and installation.
- **Improved flow performance**
  The reduced wall thickness of Apollo pipes results in a larger bore compared to an equivalent PVC-U pipe.
  The flow capacity is improved by approximately 5%.
- **Joint integrity**
  The Apollo on-line consistent socketing process with ”factory fitted” ring seal, eliminates the risk of ring
  displacement during jointing.
- **Excellent hydraulic characteristics**
  The non-corrosive smooth bore maintains the excellent flow properties.
- **Improved properties against surge and fatigue**

Meeting all requirements

Published standards on Bi-axially oriented PVC-U are:

• TSE ISO 16422

Absolutely superior!

The Apollo pipe from Wavin is produced by an unique patented in-line process. Apollo is the first pipe to be successfully oriented in line, in both the hoop and the axial direction manufactured by a continuous process.

The orientation process is based on the concept of stretching molecules to produce a true laminated wall structure, significantly increasing mechanical strength and material toughness. (See figure 1).

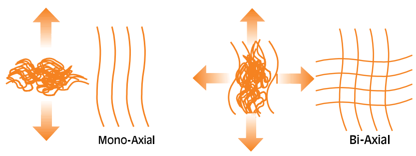


Figure 1. Mono-axial and Bi-axial Orientation

The increased strenght of Apollo is a direct result of the fact that oriented molecules can take more load.

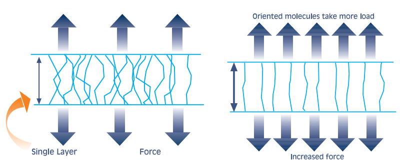


Figure 2. Increased Strenght of Apollo

Product details

Apollo has been designed as a 10 bar pressure pipe system operating with a safety factor of 1.6

Apollo socket

Apollo sockets are manufactured on-line by a process which supports the socket internally, preserving hoop as well as axial orientation in the socket. This method ensures the consistency of socket size and eliminates the risk of ring displacement during pipe jointing.

The Apollo process allows optimum balance between hoop and axial stretching to maintain wall thickness throughout the socket.

Figure 4: The Apollo ring sea

Apollo ring

The Apollo ring seal, shown below, has been specifically designed for use with molecular oriented PVC-O, providing a combined lip and compression seal which is firmly locked inside the pipe socket (see below).

When two pipes are pushed together, the rubber sealing element is designed to deform, creating a sealing pressure acting on both the socket and spigot.

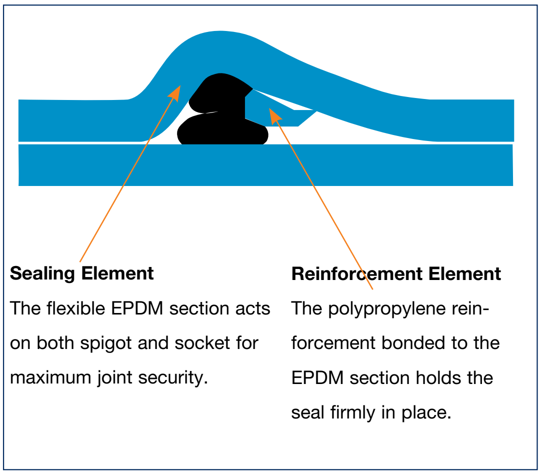
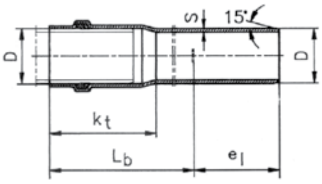


Figure 5: The Apollo sealing and reinforcement elements.

4. U-PVC and Apollo (O-PVC) product range

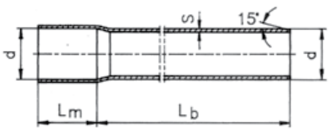
U-PVC Rubber Ring Joint Pipe



D (inch)	D (mm)	KT (mm)	PN 6 S (mm)	PN 6.3 S (mm)	PN 7.5 S (mm)	PN 8 S (mm)	PN 10 S (mm)	PN 12.5 S (mm)	PN 16 S (mm)	PN 20 S (mm)	PN 25 S (mm)
1/2"	20								1.5	1.9	
3/4"	25							1.5	1.9	2.3	
1"	32					1.5	1.6	1.9	2.4	2.9	
1 1/4"	40			1.5		1.6	1.9	2.4	3.0	3.7	
1 1/2"	50	109	1.5	1.6		2.0	2.4	3.0	3.7	4.6	
2"	63	114	1.9	2.0		2.5	3.0	3.8	4.7	5.8	
2 1/2"	75	120	2.2	2.3		2.9	3.6	4.5	5.6	6.8	
3"	90	127	2.7	2.8		3.5	4.3	5.4	6.7	8.2	
4"	110	137	2.7		3.2	3.4	4.2	5.3	6.6	8.1	10.0
4 1/2"	125	144	3.1		3.7	3.9	4.8	6.0	7.4	9.2	11.4
5"	140	151	3.5		4.1	4.3	5.4	6.7	8.3	10.3	12.6
6"	160	159	4.0		4.7	4.9	6.2	7.7	9.5	11.8	14.6
7"	200	176	4.9		5.9	6.2	7.7	9.6	11.9	14.7	18.2
8"	225	184	5.5		6.6	6.9	8.6	10.8	13.4	16.6	
9"	250	199	6.2		7.3	7.7	9.6	11.9	14.8	18.4	
10"	280	212	6.9		8.2	8.6	10.7	13.4	16.6	20.0	
12"	315	229	7.7		9.2	9.7	12.1	15.0	18.7	23.2	
14"	355	248	8.7		10.4	10.9	13.6	16.9	21.1	26.1	
16"	400	275	9.8		11.7	12.3	15.3	19.1	23.7	29.4	

*For special requests you may contact to your sales representative.

U-PVC Solvent Cement Jointing Pipes



TSB YM

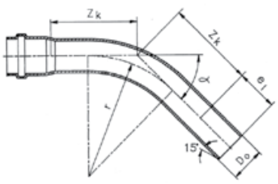
d (inch)	d (mm)	DN (mm)	Lm (mm)	PN 6 S (mm)	PN 6.3 S (mm)	PN 7.5 S (mm)	PN 8 S (mm)	PN 10 S (mm)	PN 12,5 S (mm)	PN 16 S (mm)	PN 20 S (mm)	PN 25 S (mm)
1/2"	20	15	26							1,5	1,9	
3/4"	25	20	26						1,5	1,9	2,3	
1"	32	25	26				1,5	1,6	1,9	2,4	2,9	
1 1/4"	40	32	35		1,5		1,6	1,9	2,4	3,0	3,7	
1 1/2"	50	40	47	1,5	1,6		2,0	2,4	3,0	3,7	4,6	
2"	63	50	61	1,9	2,0		2,5	3,0	3,8	4,7	5,8	
2 1/2"	75	65	69	2,2	2,3		2,9	3,6	4,5	5,6	6,8	
3"	90	80	79	2,7	2,8		3,5	4,3	5,4	6,7	8,2	
4"	110	100	92	2,7		3,2	3,4	4,2	5,3	6,6	8,1	10,0
4 1/2"	125	110	102	3,1		3,7	3,9	4,8	6,0	7,4	9,2	11,4
5"	140	125	112	3,5		4,1	4,3	5,4	6,7	8,3	10,3	12,6
6"	160	150	145	4,0		4,7	4,9	6,2	7,7	9,5	11,8	14,6
7"	200	175	168	4,9		5,9	6,2	7,7	9,6	11,9	14,7	18,2
8"	225	200	188	5,5		6,6	6,9	8,6	10,8	13,4	16,6	
9"	250	225	193	6,2		7,3	7,7	9,6	11,9	14,8	18,4	
10"	280	250	206	6,9		8,2	8,6	10,7	13,4	16,6	20,0	
12"	315	300	229	7,7		9,2	9,7	12,1	15,0	18,7	23,2	
14"	355	350	254	8,7		10,4	10,9	13,6	16,9	21,1	26,1	
16"	400	400	279	9,8		11,7	12,3	15,3	19,1	23,7	29,4	

*For special requests you may contact to your sales representative.

Apollo O-PVC Pipes - PN 10

Do (mm)	Wall Thickness (mm)
110	2,4
125	2,8
140	3,1
160	3,5
200	4,4
225	5,0
250	5,5
280	6,2
315	6,9

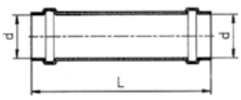
U-PVC Long Bend with Rubber Ring Socket



GMK 11° - 22° - 30° - 45° - 60° / GMQ 90°

Outside Diameter Do (mm)	Average Bending Radius r (mm)	11°	22°	30°	45°	90°
		Zk (mm)				
63	221	46	68	84	117	246
75	263	55	81	100	139	293
90	315	66	97	120	166	351
110	385	81	119	147	203	429
125	438	92	135	167	231	488
140	490	103	151	187	259	546
160	560	118	173	214	296	624
200	700	147	216	268	370	780

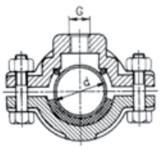
Socket



GMMU

Do (mm)	DN (mm)	L (mm)
50	40	200
63	50	270
75	65	300
90	80	310
110	100	330
125	110	350
140	125	360
160	150	380
200	175	400
225	200	450
250	225	460
280	250	480
315	300	500
355	350	550
400	400	600

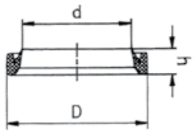
Clamp Saddle



TS-E PK (PP3)

Do (mm)	DN (mm)	Z (mm)
32	25	1/2”
40	32	1/2”
50	40	3/4”
50	40	1”
63	50	3/4”-1”
75	65	3/4”-1”
90	80	3/4”-1”
110	100	3/4”
110	100	1”

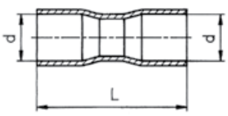
Gasket



TSB Seal

Do (mm)	DN (mm)
50	40
63	50
75	65
90	80
110	100
125	110
140	125
160	150
200	175
225	200
250	225
280	250
315	300
355	350
400	400

Socket

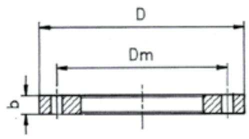


Ürün Kodu: YMM

Do (mm)	DN (mm)	L (mm)
25	20	74
32	25	87
40	32	103

*Further requests please contact to Wavin sales representatives.

Flange



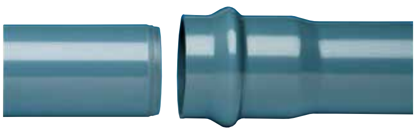
Ürün Kodu: F-L (Pik)

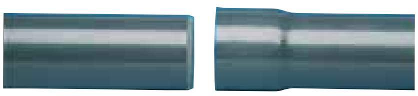
Do_1 (mm)	DN (mm)	D (mm)	Dm (mm)	b (mm)
20	15	95	65	10
25	20	105	75	12
32	25	115	85	14
40	32	140	100	15
50	40	150	110	17
63	50	165	125	18
63	50	165	125	30
75	65	185	145	18
75	65	185	145	30
90	80	200	160	19
90	80	200	160	35
110	100	220	180	20
110	100	220	180	35
125	110	250	210	40
140	125	250	210	40

5. Installation

The jointing possibilities of Wavin PVC-U pressure pipes and fittings are various. The possible assembly solutions are:

- Rubber ring / push-fit jointing
- Solvent cement jointing
- Mechanical jointing
- Flanged connections





For underground applications the solvent cement joint is NOT recommended! The rubber ring seal joint is by far the preferred jointing technique for underground applications.

Selection of the appropriate installation method must be based on local circumstances.

Rubber ring jointing

The rubber ring push-fit connection for PVC piping systems is distinguished by its simple and quick installation and a long service life with unchanging properties. The push-fit connection is not longitudinal force-connected. It enables connecting PVC pipes and fittings. Installation is above ground and only possible without pressure. Buried pressure pipelines should be installed with abutment (for instance, according to DVGW GW 310) or with appropriate protection against longitudinal movement.

PVC push-fit connections are used in the following applications:

- Water distribution
- Service water systems
- Irrigation
- Pressure and vacuum
- Drainage

All sizes of Wavin PVC pressure pipes and fittings are supplied with a rubber-ring sealing system in order to make jointing as easy and secure as possible. The system is based on factory fitted, fixed rubber rings.
The rubber rings on the pipes are pre-lubricated at the factory with a special long lasting silicone lubricant, which offers the following advantages:

- Correct consistency, both at high and low temperatures
- Waterproof
- No noxious substances
- Approved for usage in drinking water lines

To ensure that the pipes remain internally clean - even in the pipe trench - both pipe ends are sealed by special tightly fitting plastic caps. The sealing system makes jointing of both pipes and fittings easier.

Insert the spigot end into the socket pipe end. Chamfering is not necessary with the sealing system. Jointing is easy as the rubber ring is of the low-compression type.

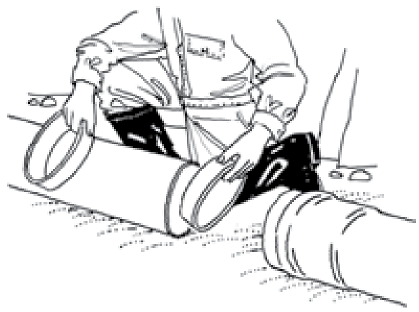


Figure 6.

Remove the protective sealing cap both from the socket end of the pipe already laid and from the spigot end of the next pipe.

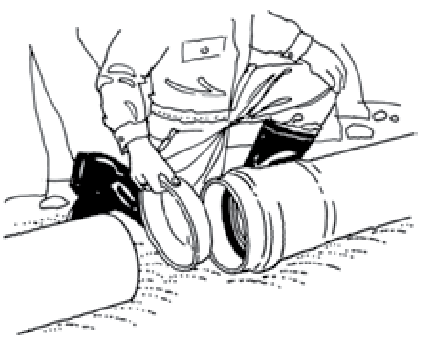


Figure 7.

The factory fitted rubber ring is pre-lubricated with long lasting silicone lubricant. NB: When jointing to fittings do not forget to apply lubricant to the rubber ring.

Figure 8.

Centre pipe and socket end. Ensure that the spigot end is inserted in the socket at the correct angle. Chamfering is unnecessary. If pipes need to be cut, the pipe ends must be chamfered and be de-burred using a rasp or scraper.

Figure 9.

Push the spigot into the socket until it reaches the depth of entry mark, do not over insert. This must be done manually. Use a steel crowbar if necessary. Protect the pipe end with a block of wood.

Figure 10.

If a crowbar does not give sufficient leverage, special jointing tackle (straps and hoist) can be used…

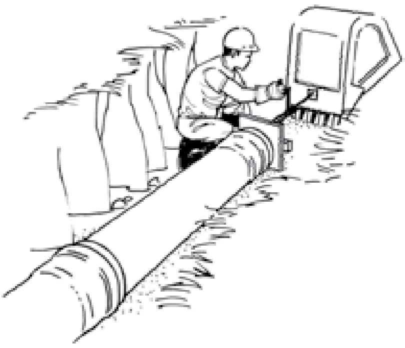


Figure 11.

…or a jack, with the bucket of the excavator as back bracing.

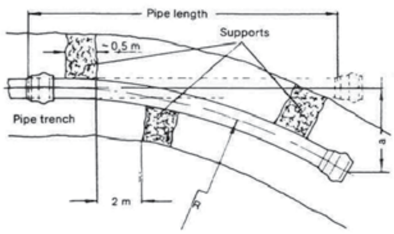
NB:
Never use the bucket of the excavator to push the pipes together.

The integral rubber ring joint is a non-positive axial joint. Pipe component parts incorporating integral rubber ring joints may be laid into any soil - with the exception of not bearing soil to ground category 2.22 of DIN 18300.

If the pipeline is to carry liquids of a temperature exceeding 15°C, ensure there is free thermal movement of the pipe within the socket.

In case of pipes laid in pits the expansion and the support regulations must be taken into account.

Bends, elbows, end pieces, valves, hydrants, branches etc. installed in non-positive axial pipelines must be adequately supported and anchored.
The figures below indicate the necessary support. See chapter 10 Anchorage.



DN	D1) mm	R M	A in meters for pipe lengths of 6 m	A in meters for pipe lengths of 12 m
50	63	18,9	0,94	3,69
65	75	22,5	0,80	3,13
80	90	27,0	0,66	2,63
100	110	33,0	0,54	2,16
125	140	42,0	0,43	1,70
150	160	48,0	0,38	1,49
200	225	67,5	0,27	1,07
250	280	84,0	0,22	0,86
300	315	94,5	0,19	0,76
400	450	135,0	0,13	0,54

1) Outside pipe diameter

Solvent cement jointing

Solvent cement jointing calls for adequate technical knowledge that can be acquired from appropriate training courses.

The dimensions of Wavin fittings and pipes generally correspond to the most diverse national standards as well as to the ISO 727. These fittings can be connected with all PVC-U pipes whose outer diameter tolerances conform to ISO 11922-1.

The solvent cement joint is a positive axial joint.
It is particularly recommended for:

- Not bearing soils (ground category 2.22 to DIN 18300).
- Pipes laid in ducts and pits.
- Underwater and bridge pipelines.

The adhesive employed is on the basis of te-trahydrofurane (THF) to DIN 16970 and rule R 1.1.7 of the Gütegemeinschaft Kunststoffrohre e.V.

In case of drinking water pipelines, the adhesive must also be in accordance with DIN 19532. The adhesive supplied by Wavin meets these requirements.

Tools and accessories

The following materials and tools are required for connecting pipes and fittings:

THF adhesive Basis tetrahydrofurane
Cleaner Basis methylene chloride

Adhesive and cleaner consumption for 100 joints:

DN	Adhesive kg	Cleaner Litres
25	ca. 0,7	ca. 0,35
32	ca. 1,0	ca. 0,50
40	ca. 1,3	ca. 0,65
50	ca. 1,5	ca. 0,75
65	ca. 2,0	ca. 1,00
80	4,0 – 5,0	2,0 – 2,50
100	6,0 – 8,0	3,00 – 4,00
125	12,0 – 13,0	6,0 – 6,50
150	16,0 – 19,0	8,0 – 9,50
200	23,0 – 26,0	11,5 – 13,0
250	34,0 – 37,0	17,0 – 18,50

Lubricant consumption

DN	Lubricant
50	50 joints 1 kg
65 + 80	30 joints 1 kg
100	25 joints 1 kg
125	20 joints 1 kg
150	15 joints 1 kg
200 – 250	10 joints 1 kg

Paint brush (unlacquered, natural bristles)

DN	mm brush
Up to 25	8 mm round brush
From 32	25/3 mm flat brush
From 65	50/10 mm flat brush
From 200	65/20 mm flat brush

Lubricant in tubes of 150 g, 250 g, 500 g, 1000 g.

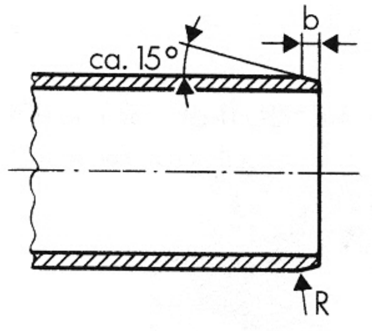
Absorbent, non-fibering, uncoloured paper
Brush socket
Plastic pipe cutter or saw
Chamfering device or file
cut 2, medium
Shaver
Soft pencil
Jointing tackle from DN 150 recommendable
from DN 200 required

Note: for larger pipe dimensions, please contact Wavin for the consumption of adhesive, lubricant and cleaner.

Preparations

Pipe must be cut off at right angles.
Cut by means of a fine toothed saw or a suitable plastic pipe cutter. Utilise adequate devices to make certain that the pipe end is square to the pipe axis.

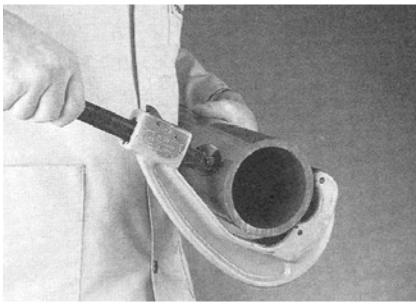
Remove any burr or unevenness from the sawn-ends by means of a shaver or an arm file. Carefully chamfer the cut pipe ends prior to jointing, as illustrated in the sketch below.



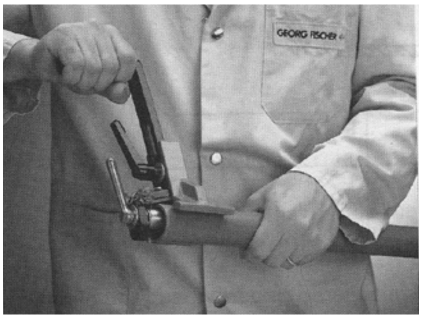
Pipe outer diameter mm	B
6-16 mm	1-2 mm
20-50 mm	2-4 mm
63 mm <=	4-6 mm

Important: Well-chamfered and rounded pipe ends prevent the layer of solvent cement from being removed as the pipe is inserted into the fitting.

Note: If necessary, mark the desired position of the fitting on both the pipe and fitting before cementing. Marking the jointing length on the pipe end makes it possible to check whether the pipe has been inserted to the full extent of the socket. Close tolerances do not always allow the spigot to be pushed into a socket in dry condition, but only after the adhesive has been applied. In such cases the depth of entry should also be marked.



Cutting the pipe to length.



Chamfering the pipe.

Storage

Adhesive and cleaner must be stored in a cool and dry place. Pay attention to the maximum storage time of the adhesive (approximately 2 years). THF-adhesive (solvent cement) is supplied ready to use. The viscous structure is to ensure perfect cementing, therefore do not dilute. Adhesive of the correct consistency will run down evenly from a wooden spatula held in an inclined position in form of a flag. Adhesive running off lumpy is unsuitable and must be disposed of. Seal the tin and the brush during the cementing breaks or else the adhesive will dry up and be useless (note protective measures). Prior to every usage, the adhesive is to be stirred. Should there be a film on the adhesive or the brush, it must be removed prior to stirring.

Cementing

A strong, dense-type glue is recommended, especially for coupling large diameters, where the clearance may be high due to the ovalisation effect: such clearance, anyhow, in order to guarantee a perfect seal, should never exceed 0,6 mm with a dense-type adhesive and 0,3 mm with a fluid-type adhesive. In order to obtain a perfect joint, it is recommended that the adhesive manufacturer's instructions be strictly followed.

Wipe the pipe end and the socket with a clean cloth. Clean the outside of the pipe end and the inside of the socket thoroughly with PVC-U cleaner and absorbent paper. Use a fresh piece of paper each time. Cleaned areas must be dry before the cement is applied. Remove any condensation, which may have formed on the parts. The cleaner should dissolve the pipe surface. Check if the PVC-U is actually dissolved. If not, then roughen the surface using abrasive cloth k 80 and clean again.

Note: Pipe end and fitting socket must be dry and free from grease and dirt.

Stir the adhesive thoroughly prior to usage. To ensure that both jointing surfaces are completely covered with a smooth, even layer of cement, the brush should be generously coated with solvent cement. Start with applying a normal layer of cement to the inside of the fitting socket from the inside to the outside and then a thicker one to the pipe end with firm brush pressure. Work in well. The brush strokes over the pipe end should always be in an axial direction. Apply the adhesive evenly. Replace the lid of the solvent cement tin after use

to prevent the solvent from evaporating. Close the tin of solvent cement during work intervals.
As the solvent cement sets quickly, the parts should be slid together within one minute starting from the application of solvent cement. Push the chamfered pipe end into the socket immediately to depth of entry mark without twisting and bring them to correct alignment. Hold them in this position for a short while, until initial bonding has taken place.

Note: Insert the pipe to the full depth of the socket and ensure that the outlet of the fitting is in the correct position.

The process of applying the adhesive to the parts and their assembly must be effected within 3 minutes. Remove any surplus cement immediately using absorbent paper, otherwise the outer skin of the pipe would be dissolved too much.
Do not move the cemented parts during the first five minutes. Completed joints must be held at 20-30 °C for approx. 10 minutes. At temperatures below 10°C this time in increased to 15 minutes. Solvent-cemented pipes must not be lowered into the trench before 10-12 hours have elapsed.

The solvent cement manufacturer's instructions concerning how long to wait before handling, and concerning sticking and pressure testing the system should be carefully followed. Generally speaking, none of these operations should take place within the first 24 hours after making the joint.

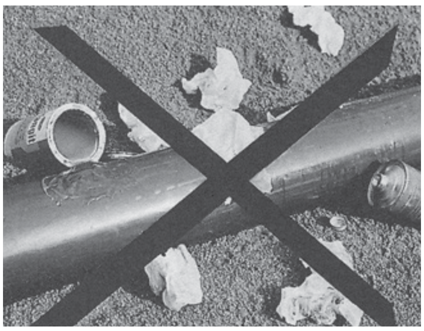
The joints can be made single handed for pipes with diameters up to 90 mm. For 110 mm and larger pipes, two people are needed to apply the solvent cement on the fitting socket and pipe end simultaneously in order to avoid exceeding the maximum handling time.
A jointing tackle eases the assembly of pipes above DN 125.

Solvent cement coat at d ≥ 110 mm.

In case of temperatures above 20°C and/or windy conditions the open time of the adhesive is reduced. This applies also to pipe surfaces heated by the sun. Avoid overheating when cementing at summer temperatures by protecting the jointing area from direct sunlight. If necessary, cool the pipe end with water before cementing.

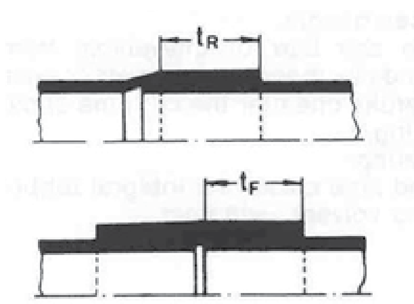
Special protective measures must be taken at temperatures below + 5 °C.
At temperatures near freezing point pipe ends and fittings should be warmed to bring them to hand temperature. Next, remove any condensation or ice. Solvent cement and cleaner should be stored at room temperature prior to cementing.

Note: Both solvent cement and cleaner dissolve PVC-U. Therefore pipes and fittings must not be laid on or allowed to come into contact with spilled solvent cement or paper containing cement residues.



The pipe pit should not be used as a garbage dump.

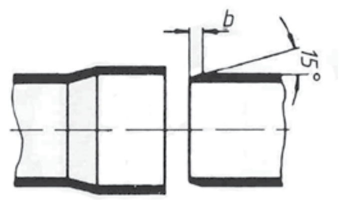
Minimum cementing lengths



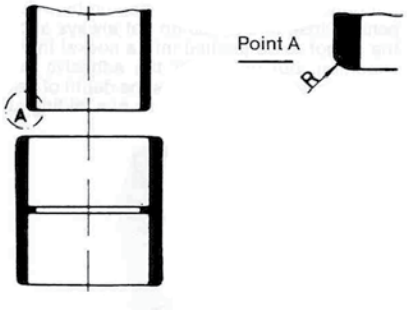
DN	t_R* mm	t_F* mm
50	63	37.5
65	70	43.5
80	79	51.0
100	91	61.0
125	109	76.0
150	121	86.0
200	160	-
250	193	-
300	214	-

* to DIN 19532

Chamfering



Outside pipe diameter mm	b mm
6 – 16	2
20 – 50	3 – 5
63 – 110	6
125 – 200	11 – 18
225 – 315	20 – 26



Outside pipe diameter	R
mm	mm
6-16	2
20-50	3
63-315	5

Drying time and pressure test

The drying time, before the joint may be subjected to testing or operating pressures, depends on the ambient temperature and the tolerances.

As a general rule, allow at least:
1 hour waiting time per bar operating pressure

Nominal	Test pressure*	Waiting time
PN 10	15 bar	15 h
PN 16	21 bar	24 h
*1,5 x PN, max (PN + 5) bar		

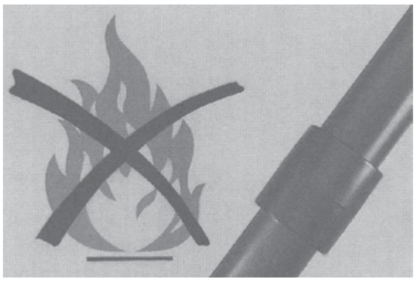
Cleaning of the tools

Clean the brush with dry absorbent paper after use. Brushes must be dry before being re-used. Cleaner that has been used for washing the brush must not be applied to the mating surfaces.

Safety precautions

Solvent cement and cleaner contain highly volatile solvents. This makes good ventilation or adequate fume extraction essential in closed spaces. Since the solvent fumes are heavier than air, extraction must occur at floor level, or at least below the working level. Dispose of paper, which has been used for cleaning or for the removal of surplus cement in closed containers to minimise the amount of solvent fumes in the air.

Solvent cement and cleaner are inflammable. Thus all open fires and any sparking must be avoided, before commencing work. Switch off unprotected electrical equipment, electric heaters, etc. Smoking is prohibited! Furthermore, observe all instructions issued by the solvent cement manufacturers (for example, on the tin label and in any supplementary documentation).



No naked flames when cementing
No smoking.

Protect pipes and fittings from spilled solvent cement, cleaner and absorbent paper, which has been used to wipe off solvent cement. Do not dispose of surplus solvent cement or cleaner in drainage systems.

Use hand gloves for protection to avoid the skin from coming into contact with the solvent cement and cleaner. Rub protective cream on the hands before commencing work. Use a skin protective cream after cleaning and after completion of work.

Wash eyes with water thoroughly, if the solvent cement comes in contact with the eye. Visit the doctor! Immediately change clothes soiled with solvent cement.

Do not close the cement pipelines during the drying process. This is particularly important at temperatures below + 5°C, where there is a danger of damaging the material.

Because of the danger of explosion, do not perform any welding near pipes, which have been cemented but are not yet filled. Danger of explosion!

Remove the solvent vapours from pipelines, working rooms and pits prior to welding.

Just before welding fill water into the pipeline, flush and blow through in order to remove flammable mixtures. Fill water into finished pipelines even if they are not put into operation immediately.

Always obey the safety regulations issued by the authorities responsible.

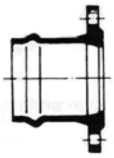
Application limits

For the chemical resistance of solvent cement joints and other technical tips, please refer the appropriate specifications of the solvent cement manufacturer.

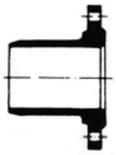
Connections

The following connections can be utilised for connecting PVC-U-piping systems to metal pipes or fittings:

- Flanged sockets and flanged spigots to DIN 16451 sheets 6 and 7, to connect integral rubber ring joint pipes to flanges.

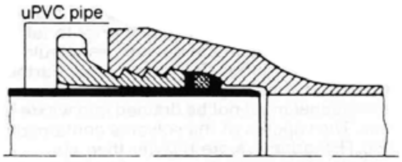


Flanged sockets



Flanged spigots

- A special union rubber ring with green edge to connect to union sockets. It compensates for the diameter difference of PVC-U and cast-iron pipes.

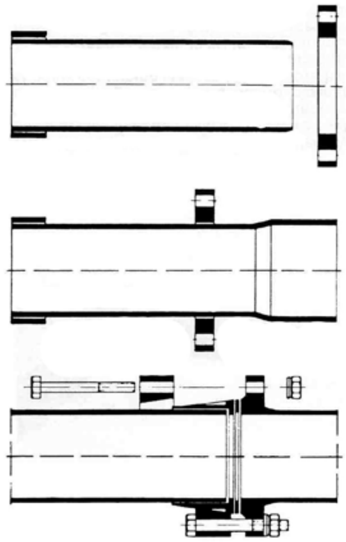


- Flanged connections (conical flanged bush or special flanged sockets or spigots) for solvent weld socket pipes.

The screws must not be tightened for 30 minutes, at ambient temperatures near the freezing point for 45 minutes, after the last joint has been made.

If pipe component parts are misaligned then warm the pipe over a length of approximately 50 cm at a distance of approximately 1 m from the flanged joint prior to tightening these screws. Use a warm air device or a propane gas flame to apply even gentle heat to the pipe, warming it to approximately 120-140 °C. Take care not to overheat the pipe. Heat marks are brown and/or bubbles.

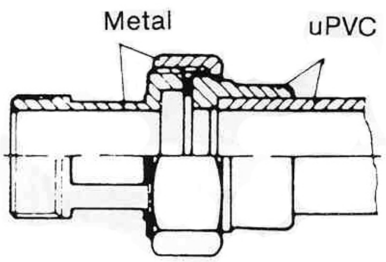
Welding torches and soldering lamps are unsuitable. Then tighten the screws evenly and crosswise.



Use unions to DIN 8063, sheet 3, to connect to male and female threaded parts.

Support cast-iron and heavy fittings so that their weight does not affect the pipeline.

Pipe bends are used for changing the direction of the pipeline. To a limited extent advantage can be taken of the elasticity of the pipe material and the pipe bent without being warmed. The a figures of the table are not to be exceeded.



Support the pipe as shown below by means of stonefree, tampered soil in order to prevent the spigot from being angled in the socket when bending the pipe.

House service connections

For taking service connections from the mains, branches or tapping fittings can be used.

For tapping only crown drills incorporating sufficiently dimensioned flutes may be utilised.

The drill must be designed in such way that the cut disk cannot fall into the pipe. The drilling diameters and the bow widths of the tapping fittings are to be in accordance with the following table.

	Outside pipe diameter d	Minimum bow width b	Maximum tapping diameter
DN	mm	mm	mm
80	90	62	32
100	110	70	40
125	140	70	40
150	160	70	40
200	225	80	50
250	280	80	50
300	315	80	50
400	450	80	50

Install a protection sleeve into the wall duct in case of drinking water pipes in accordance with DIN 1988.

Hydraulic testing

In order to prevent the pipeline from moving back, fill the line to a height of approximately 80 cm prior to pressure testing, leaving joints exposed. Use a test pressure gauge of quality 1.0 having a measuring range of 0-16 and 0-25 bars respectively and a minimum diameter of 160 mm.

It is recommended to utilise additionally a recording pressure gauge having an adequate measuring range.

DIN 4279, sheets 1and 7, describe how to carry out the hydraulic tests.
Maximum test pressure 1.5 x PN

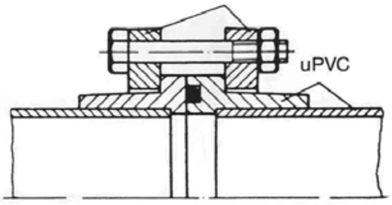
Corrosion proofing of metallic accessories

If it is necessary to protect metallic component parts or fittings against corrosion then hot or solvent masses must not come into contact with the PVC-U pipe. Prevent the pipe from coming into direct contact with sealing or protecting materials attacking PVC-U (see DIN 16929). Normally joints should only be protected after the hydraulic test.

Flange type connection

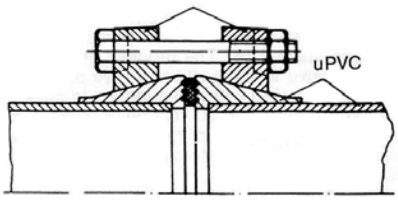
Pipes can be connected by means of the following detachable or rigid types of joints:
Flange adaptors to DIN 8063, sheet 4

Plastic material or metal.

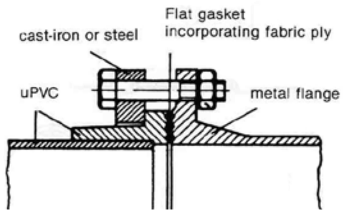


Or conical flange type bushes to DIN 8063, sheet 4

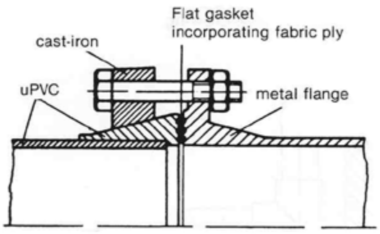
Cast iron.



Flange adaptors to DIN 8063, sheet 4, are utilised for connections to metal flanges.

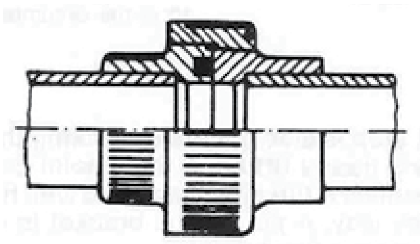


Or conical flange type bushes to DIN 8063, sheet 4.

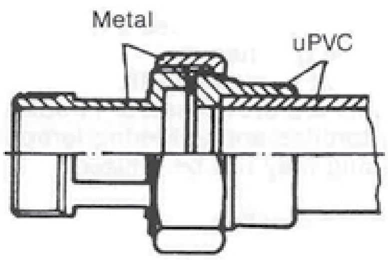


Threaded or adapter joints

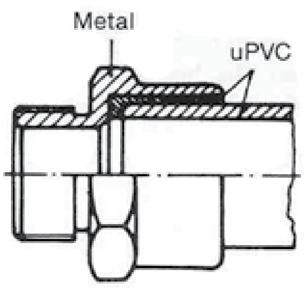
Adaptor joints must be detachable but when fitted rigid. Use metal joints only when connecting to metal pipes or fittings.



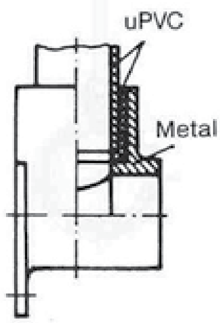
Composite union to DIN 8063, sheet 3. Male or female type of union fabricated from malleable cast-iron or brass in



accordance with DIN 8063, sheet 3. Male or female thread type of adaptor socket to DIN 8063, sheet 11. PVC-U pipe and adaptor socket represent a rigid joint.



Wall disk according to DIN 8063, sheet 10. PVC-U pipe and wall disk represent a rigid joint.



Connections to PVC-U threaded fittings

For the connection of PVC-U pipes to appliances or fittings made of plastic material which have a male or female thread, PVC-U threaded fittings according to DIN 8063, sheets 6 to 9, can be utilised. For sealing the thread use only PTFE tape. Customary sealing material can contain substances detrimental to PVC-U. Therefore usage is not allowed.

Changes of direction

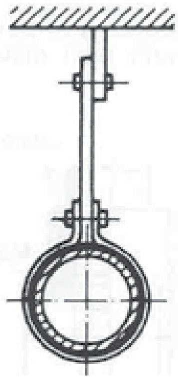
In case of changes of direction, as for instance minor centre locations (swan-neck bends), the changes may not be carried out in a cold condition but only after warming the pipe section to approximately 100 °C. For supplying gentle heat to the pipe use a warm air device or a propane gas flame. Take care not to overheat the pipe.
Heat marks are brown and/or bubbles. Welding torches and soldering lamps are unsuitable and may not be utilised.

Fixing

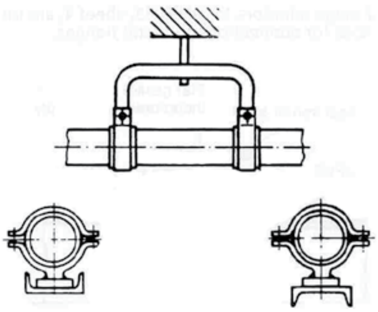
Type of pipe bracket

The inside diameter of the pipe brackets (plastic material or metal) must be bigger than the outside pipe diameter when fixed. Smooth off the inside edges in order to prevent the pipe from being damaged. If pipe brackets incorporating a tape are utilised then this tape should be of the PE-profile type.
Tapes made from plasticized PVC are unsuitable. Characteristic features when fire-testing: PE smells of wax, PVC-U has a sharp odour.

Take care not to use pipe hooks.



Pendulous brackets, suspension arrangements or pipe brackets with welded guide shoes are recommended if it is necessary to accommodate important expansion or contraction. Take care that loose brackets do not interfere with the linear expansion of the pipes.

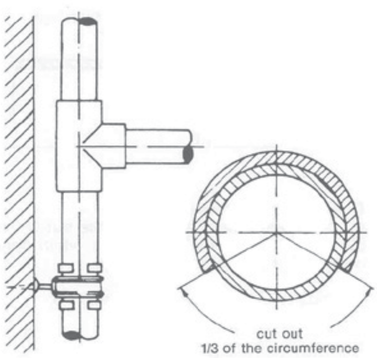


Phone +90 322 999 10 00 | +90 322 346 07 07

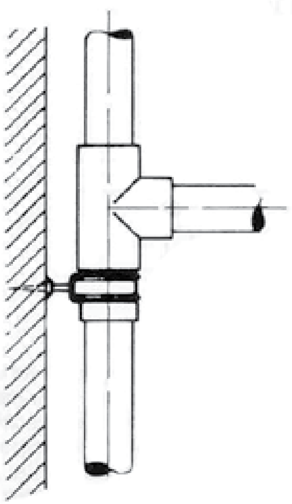
Fixed points

Fixed brackets can be obtained by cementing limit stops on one or both sides of the pipe.

The limit collars can be manufactured from a pipe of the same dimension. Their length is 20-30 mm. Cut out approximately 1/3 of the circumference (see drawing).



A limit stop is also obtained by fixing the pipe brackets near a fitting. A fixed point can only be operative if the pipe bracket is well fitted in a sturdy way. A pendulous bracket is unable to serve as a fixed point.

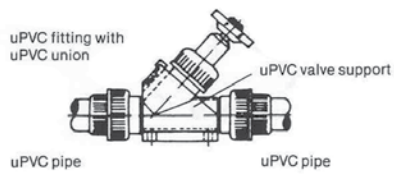


Installing and fixing fittings

General

Install those fittings only which do not increase the flow pressure by more than 2 bar after quick action closing (see also DIN 1988).

The fluid contact gasket must be fabricated from a material suitable for this fluid. Generally loose joints should be selected for installing fittings into a pipe system.

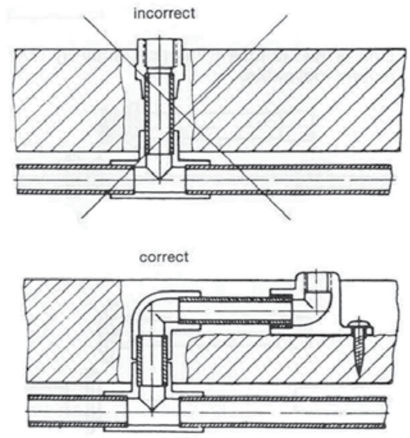


If possible the fittings should be installed directly so that the actuation forces do not affect the pipe system. Special fitting supports or those supports already fixed to the fitting are very suitable. Generally brackets must be placed on both sides of metal fittings. Flanged fittings can also be supported at the flange.

Take care to support heavy fittings by means of a special support or a console. Provide elastic pipe joints. Insert for instance a rubber bellow in order to prevent vibrations or distortions from being transmitted to the system when connecting pipes to booster, circulation or similar plants.

Discharge and flush fittings

Utilise adapter sockets to DIN 8063, sheet 11, for the connection of discharge and flush fittings. Connect discharge valves by means of wall disks to DIN 8063, sheet 10. Take care to fix the wall disks well.



Hydraulic testing

Leave the system unconvered and expel all air in it. For the purpose of a leak test subject the system to a water test pressure of 1.5 times the highest operating pressure, measured at the distributing main, during one hour.

Hydraulic testing may only be carried out after joints have been allowed to dry for at least 15 hours.

Painting

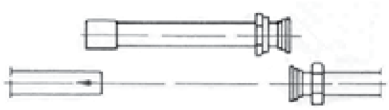
Painting the line is unnecessary and is to be avoided. In case it is absolutely necessary to change the line appearance, take care to utilise only those colouring matters which do not contain agents to which PVC-U is not resistant (see DIN 16929). Nitro dyes are therefore not allowed. Lime, oil or latex paints are however generally recognised as safe. Colour tapes may be utilised for marking different lines.

Subsequent installation of pipe component parts

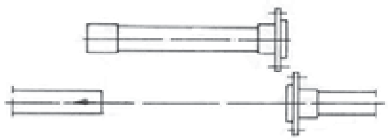
In case it is necessary to install fittings or mountings into an existing system or to replace a pipe section, this can be effected by means of couplers, unions or flanged connections.

Two solvent cement sockets if the line is axially moveable.

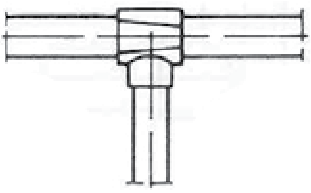
One or two unions if the line is hardly or not axially moveable.



One or two flanged connections or split couplings if the line is hardly or not axially moveable.

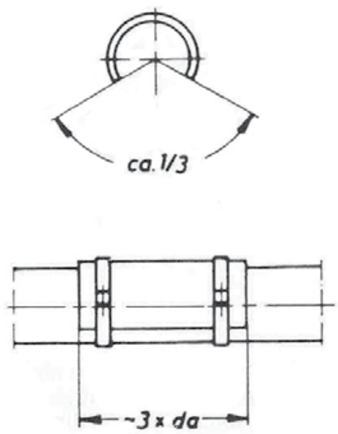


Branches up to DN 50 can also be made by means of PVC-U or metal tapping or adaptor brackets.



Repair of a damaged line

If the pipe has been damaged on one side and in a non-splintered way, e.g. by a nail or by in-advertent boring, the damaged section can be repaired without removing the pipe. First debur using a shaver or a bastard file. For the repair, a pipe of the same diameter and of a length l=3 x d is required. Approximately one third of the circumference is cut out of the pipe section longitudinally. Debur all cut edges. Solvent weld the new section to the pipe and secure with two hose clamps. At least one hour drying time must be allowed before applying working pressure. Take care that the hose clamps are not removed before 24 hours have elapsed after solvent welding.



Connection of Combiflange - Standard for PVC - Non-tensile resistant

Combiflanges are used to connect two pipes or one pipe to valves and fittings with flanges drilled to take PN 10 (or PN 16).
The Combiflange consists of two parts: a cast-iron flange and a rubber gasket. Its area of application is water and neutral liquids at temperatures not exceeding 70°C. The tolerance is ±1 mm.

1) Cut the PVC pipe at right angles using a fine-toothed saw.

2) Remove swarf, soil and other impurities from the pipe end. Do not chamfer.

3) Place the cast-iron flange on the pipe with the small end facing away from the pipe end.

4) Locate the rubber gasket on the pipe so that the large end is flush with the PVC pipe end, i.e. with small end of rubber gasket facing inwards.

5) Apply a thin layer of lubricant to the outer surface of the rubber gasket. Place the pipe end with the flange and rubber gasket in position against the valve or fitting flange.

6) Push the cast-iron flange by hand over the rubber gasket as far as it will go.

7) Locate the bolts and tighten by hand until the parts connect.

8) Ensure that the assembly is correctly aligned.

9) Tighten the bolts using a spanner. Cross-tighten to ensure that the bolts are evenly tightened.

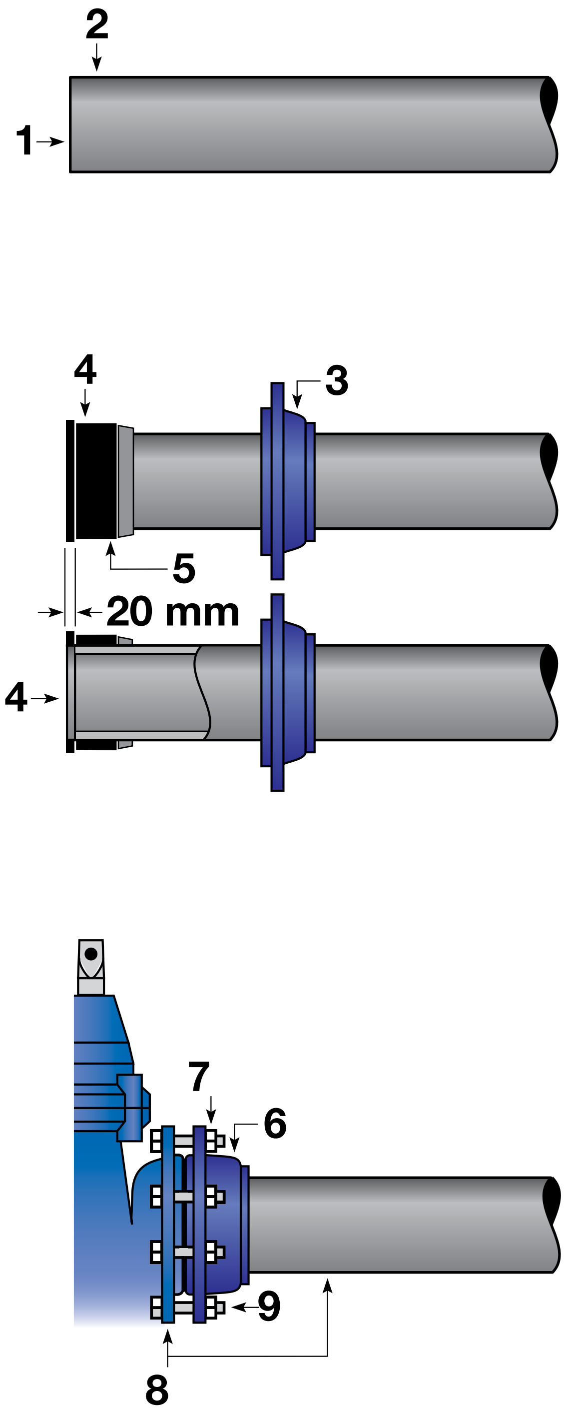


Figure 12: Diagram showing connection of non-tensile resistant Combiflange for PVC.

Connection of Combiflange - Tensile resistant for PVC

Tensile resistant Combiflanges are used to connect two PVC pipes or one PVC pipe to valves and fittings with flanges drilled to take PN 10 (or PN 16).

The Combiflange consists of three parts: a cast-iron flange, a red brass grip ring and a rubber gasket.

Its area of application is water and neutral liquids at temperatures not exceeding 70ºC. The tolerance is ±1 mm.

1) Cut the PVC pipe at right angles using a fine-toothed saw.

2) Remove swarf, soil and other impurities from the pipe end. Do not chamfer.

3) Place the cast-iron flange on the pipe with the small end facing away from the pipe end.

4) Place the red brass grip ring on the pipe with the small end facing away from the pipe end.

5) Locate the rubber gasket on the pipe so that the large end is flush with the PVC pipe end, i.e. with small end of rubber gasket facing inwards.

6) Slide the red brass grip ring back until it connects with the rubber gasket.

7) Apply a thin layer of lubricant to the outer surface of the rubber gasket. Place the pipe end with the flange and rubber gasket in position against the valve or fitting flange.

8) Push the cast-iron flange by hand over the grip ring and rubber gasket as far as it will go.

9) Locate the bolts and tighten by hand until the parts connect.

10) Ensure that the assembly is correctly aligned.

11) Tighten the bolts using a spanner. Cross-tighten to ensure that the bolts are evenly tightened.

NB: The same procedure should be followed when connecting two tensile-resistant Combiflanges. When tightening, two extra-long "auxiliary bolts" will be needed.

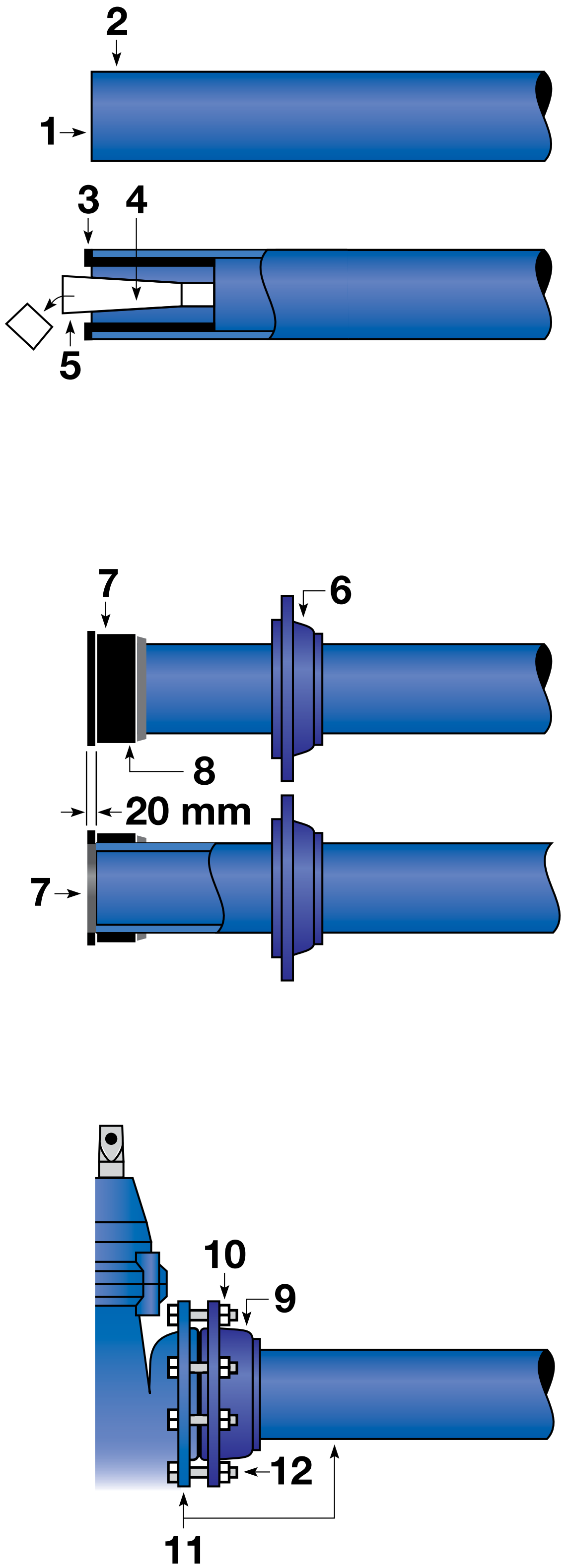
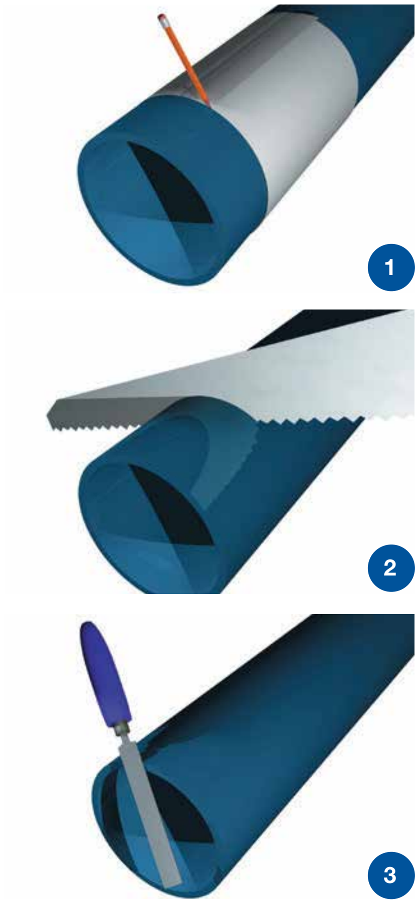


Figure 13: Diagram showing connection of tensile resistant flange for PVC.

Installation of Apollo

Pipe Cutting & Chamfering

All pipe installation work will involve pipe cutting at some stage. Apollo pipe is simple and easy to cut following a few straightforward guidelines. It is important that a square cut is made to ensure jointing is successful.



1. Clearly mark the cutting position on the pipe, ensuring the cut will be square to the axis of the pipe. A piece of paper with square edges can be used for this.

2. Use a fine toothed wood saw to cut the pipe in an even and gradual cut. The cut waste pipe should be supported at all times.

3. Remove all swarf and burs from the cut end and chamfer the pipe with a fine to medium file, providing a chamfer of minimum 15° for half of the pipe wall thickness.

Figure 14: Cutting and Chamfering.

Pipe Jointing

Figure 15: Pipe Jointing.

1. Remove the protective cap and lubricate the sealing ring with an appropriate lubricant (Wavin Medlube). Check the pipe spigot is chamfered and clean.

2. Note the depth of entry mark. Align the spigot and socket.

3. Using a crowbar with a piece of wood across the mouth of the opposing socket push the spigot home, leaving the depth of entry mark just visible.

NB: The natural flexibility of Apollo PVC-O allows Apollo to be jointed above ground and snaked into a narrow trench.

Water mains are generally laid with a minimum 900 mm cover and installed with a granular bed and backfill.

Pea gravel is the ideal bedding material as it is free flowing and self-compacting. Washed sand, crushed stone, sintered pulverised fly ash or air-dried furnace slag are suitable alternatives.

Backfill material above the initial 100 mm of granular material can be either selected as-dug material, providing it can be compacted or, if in the case of a road situation, imported granular material. Alternatively foamed concrete can be used.

No mechanical compaction should be undertaken until there is at least 300 mm cover to the pipe, subsequent layers can be compacted in layers not exceeding 300 mm.

If the depth of cover to the pipe crown is less than 600 mm and the pipe is to be subjected to traffic loading, protection can be provided by a concrete raft which bridges the trench. A 300 mm thick cushion of granular fill should be placed between the pipe and concrete raft.

A full concrete surround should be avoided. If it is unavoidable the pipe should be wrapped a number of times with polythene sheeting for protection.

Cyclic Fatigue

Apollo has been successfully tested against cyclic fatigue. However, field conditions vary for applications involving continuous cyclic loading. For specific installation recommendations under these conditions please contact Wavin.

Water Mains in the UK should be laid in accordance with BS CP 312 Parts 1 & 2 and also the WRc PVC-U Manual (1994).

Anchorage

The Apollo joint is not designed to resist axial loads and therefore any such load needs to be transferred to the surrounding undisturbed ground by means of a thrust block. Thrust blocks are required at all:

- Changes of direction
- Reduction of diameters
- Tees
- Blank Ends
- Closed Valves

The usual method of accommodating thrust in a buried pipeline is by placing concrete between the pipe and the undisturbed trench wall. The pipe should preferably be cradled in concrete rather than surrounded and the pipe should be protected by using polyethylene sheeting or a compressible membrane. This will allow a degree of movement due to creep and prevent abrasion and stress concentrations.

Thrust block design has to take account of factors such as the pipe diameter and maximum internal pressure to calculate the maximum thrust generated. The bearing capacity of the surrounding soil has also to be accounted for in design calculations.

For further information on design and anchorage of PVC-O pipeline structure please contact Wavin.

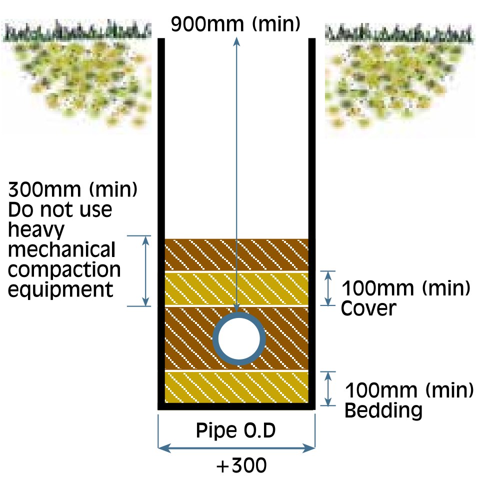
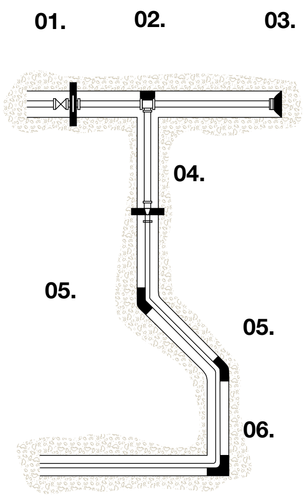


Figure 16: Recommended Trench Construction

Please note: If narrow trenching, a minimum 50 mm either side of the pipe.



Anchor Blocks Placed at:

01. Gate Valve Using Puddle Flange
02. Equal Tee
03. Blank End
04. Reducer
05 & 06. Bends

Figure 17.

Pipe Flexibility

The maximum permissible joint deflection is 5°. Bending should only be carried out manually and not attempted below 5°C. Where greater bending is required, the appropriate pre-formed bend should always be used.

Pressure Testing

The recommended test pressure is 1.5 times the actual working pressure of the pipeline at the lowest point. Higher test pressures are unnecessary and necessitate more expensive anchorage.

Ideally all joints and fittings should be left exposed for examination during testing, and the bulk of the pipe should be back-filled to prevent movement of the pipelines during testing. The basic procedure requires pressuring the main at the test pressure for one hour followed by a further period of one hour with all valves closed and the test pump disconnected.

The success of the test is determined by the amount of water required to restore the original test procedure, dependent on the diameter and length of pipeline. Full testing details are available from Wavin.

Under Pressure Service Connection

The standard service connection is made using a gunmetal mechanical ferrule which is simply bolted around the main. The ferrule has an integral cutter which is used to drill through the Apollo main pipe system whilst under pressure. The construction of the ferrule strap system is designed to minimise the stress on the pipe, however, it is important to take account of the following factors:

- Do not overtighten the ferrule strap on the main.
- Do not try and cut the hole in the main too quickly.
- Do not fit a service connection on a main that is under significant bending.
- Take extra care at a low ambient temperature.

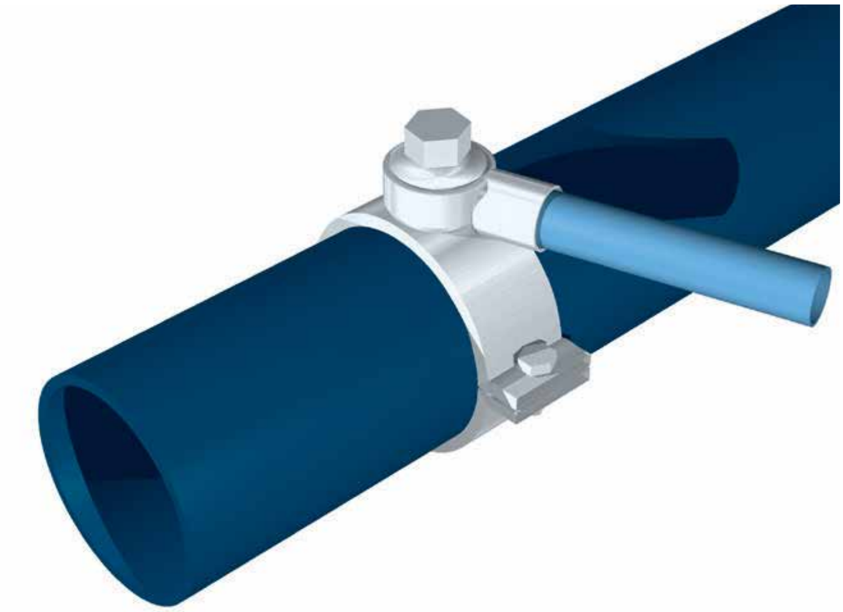


Figure 19: Under Pressure Service Connection.

Figure 18: Pipe Flexibility.

6. Design of water supply pipelines

For fewer than 200 housing units

Here the design water flow (q^d) is determined using DS 439, the DIF (Danish Association of Engineers) code of practice for water installations. DS 439 states that the sum of the predicted water flows can be set at 1.6 l/s per housing unit, which gives a (q^d) of 0.36 l/s per unit.

For more than 200 housing units

Here the design water flow (q^{max}) is determined using DS 442, the DIF code of practice for public water supply systems. DS 442 states that qmax can be determined from the following formula:

Formula 1

$$q^{max} = \frac{Q^{max} \times ft^{max}}{24}$$

where Q^{max} = avarage daily consumption [Qm] x 24-hour factor [fd]

ft^{max} = hour factor

Where normal types of housing are involved, Q^{max} can be set at 200 l/24 hours/pe and *fd* at 2. This gives a Q^{max} of 200 x 2 = 400 l / 24 hours/pe. For normal types of housing ft^{max} is set at 2.5.

For a normal single-family house with tour occupants this gives a design water flow q^{max} of:

$$q^{max} = \frac{400 \text{ l/24 hours/pe} \times 4 \text{ (pe)} \times 2.5}{24}$$

$= 167 \text{ l/hour} = 0.046 \text{ l/s}$

Example of design of water supply pipeline

The example is based upon the following data:

- Pressure at station A is measured at 3.5 bars (35 m Wat.Col.)
- PE 80 pipes PN 10 are used as pipeline material
- Maximum daily water consumption (Q^{max})= 400 l/24 hours/pe
- Maximum consumption per hour = 2,5 x Q^{max}
- Necessary pressure at consumer: 2 bars (20 m Wat.Col.)
- 4 persons per household

Calculations

Water consumption/house:
q^{max} = 167l / hour = 0,046 l/s

Water quantity is calculated for each pipe section for instance:

A - B: (10 + 15 + 8) houses x 0,046 l/s = 1,52 l/s

Pressure loss is found by means of the water flow diagram for PE 80 pressure pipes PN 10, diagram on the next page.

Using the pipe dimensions below the following pressure will be available at the consumer in station D:

35 m Wat.Col. – 13 m Wat.Col. = 22 m Wat.Col. > 20 m Wat.Col. OK

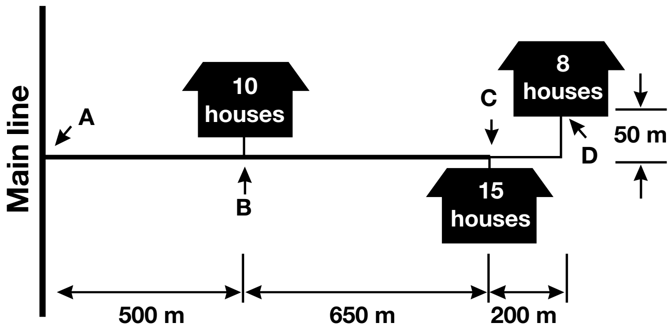
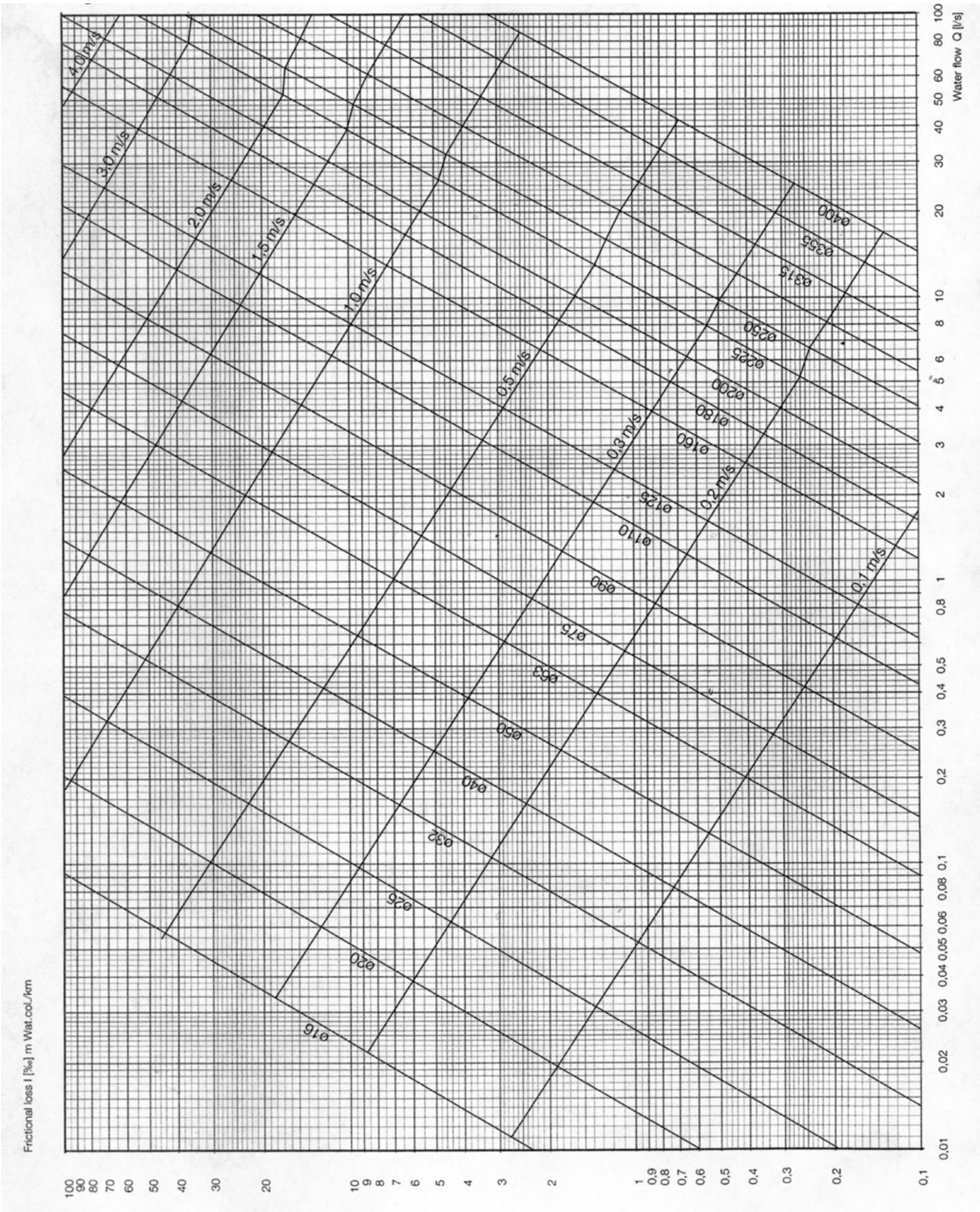


Figure 20: Diagram of pipeline in example.

Section	Quantity of water (l/s)	Length (m)	Pipe-dimension (mm)	Pressure loss M Wat.Col./km)	Pressure loss of section (m Wat.Col.)
A-B	1,52	500	Ø 63	15	7,5
B-C	1,06	650	Ø 63	7	4,6
C-D	0,37	250	Ø 63	3,7	0,9
			Sum	13	

Table: Example of dimensioning diagram for calculation of pressure loss.


Frictional loss I [‰] m Wat.col./km
Water flow Q [l/s]
4,0 m/s
3,0 m/s
2,0 m/s
1,5 m/s
1,0 m/s
0,5 m/s
0,3 m/s
0,2 m/s
0,1 m/s
ø16
ø20
ø25
ø32
ø40
ø50
ø63
ø75
ø90
ø110
ø125
ø160
ø180
ø200
ø225
ø250
ø315
ø355
ø400
0,01
0,02
0,03
0,04
0,05
0,06
0,08
0,1
0,2
0,3
0,4
0,5
0,8
1
2
3
4
5
6
8
10
20
30
40
50
60
80
100
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100

Piping design, pipe arrangement, linear expansion calculation

When laying PVC-U pipes, the following have to be taken into account:

- linear expansion
- pipe clip or bracket arrangement
- wall and ceiling transition
- installed pipe protection
- connection of water heaters

Linear expansion

When calculating linear expansion consider the following conditions:

1. The ambient temperature
2. The lowest and highest pipe wall temperature to be expected

Linear expansion is 0.08 mm per m and per K (Kelvin) change in temperature and can be calculated as follows:
Linear expansion (mm) = pipe length (m) x temperature difference (K) x coefficient of linear expansion (0.08).
$\Delta l = L \times \Delta T \times 0.08$

Example of calculation:

Pipe length: 5m
Lowest pipe wall temperature to be expected: +5°C

Ambient temperature whilst installing: + 10°C
Temperature difference = 5 K

Highest wall temperature to be expected: + 20°C
Temperature difference = 10 K

Maximum shortening to be expected:
$\Delta l1$ = 5 m x 5 K x 0.08 mm/mK = 2 mm
Maximum elongation to be expected:
$\Delta l2$= 5 m x 10 K x 0.08 mm/mK = 4 mm

Determination of the required spring leg length in case of a linear expansion of Δl.

Base your determination of the spring leg length (a) on the higher figure, in this instance 4 mm. The required spring leg length (a) de-pends on the outside pipe diameter (d) and on the linear expansion Δl.

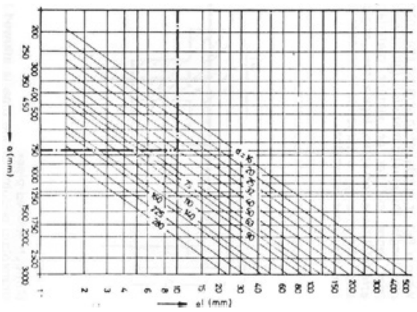
If in our example the outside pipe diameter (d) is 50 mm, the required spring leg length (a) is 500 mm in case of the maximum linear expansion of Δl = 4 mm as can be seen from the table below.

Because of the pipe elasticity the linear expansion Δl can be cushioned by springing of pipe section a.

The values given in the table for the springing resulting from the linear expansion Δl must not be exceeded.

Springing pipeline DN		Linear expansion l (mm)					
10	16	14	31	55	86		
15	20	11	25	44	69		
20	25	9	20	35	55		
25	32	7	15	28	43	62	
32	40	5	12	22	34	50	
40	50	4	10	18	27	40	70
50	63		8	14	22	32	55
65	75		6	12	18	27	47
80	90		5	10	15	22	40
100	110		4	8	12	18	32
125	140			6	9	14	25
150	160			5	8	12	22
200	225			4	6	9	15
Spring leg length a (mm)		500	750	1000	1250	1500	2000

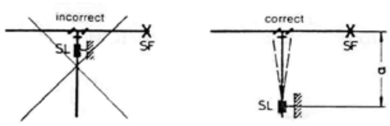
Intermediate data can be seen from the following diagram.

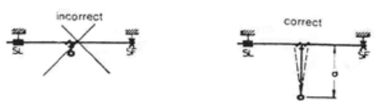


Clip and bracket arrangement

Fix the pipeline in such a way that linear expansion is not interfered with. Arrange the pipe clips, brackets and fittings in such a way that it is possible for the pipe to spring.

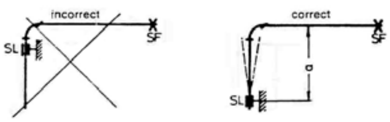
Clip or bracket arrangement in case of branches.
Arrangement of fittings in case of branches.



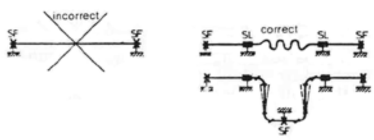


Between two fixed points linear expansion can be absorbed by changes of direction, expansion bends or bellow expansion joints.

Clip or bracket arrangement in case of changes of direction.
Pipe installation between two fixed points.



Use only bellow expansion joints the inherent resistance of which is low.



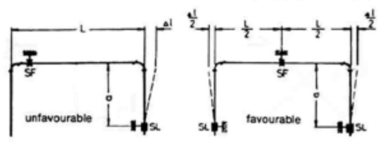
To give an example: rubber bellow expansion joints are suitable. The bellow expansion joint position is dependent on the linear expansion worked out. Observe the clip and bracket centres of the following table in order to prevent the pipeline comprising bellow expansion joints from buckling.

It may be necessary to provide continuos pipe support if the ambient temperatures or the temperatures of the liquids are high.

Steel or aluminium angles or U-profiles as well as sheet metal semi-shells are suitable.

Splitting up the linear expansion

By providing fixed points in case of longer pipe sections linear expansion can be split up and thus - related to the single sections - better absorbed.



Clip and bracket centres in cm for horizontal and vertical installations at temperatures of 20 to 60 °C.

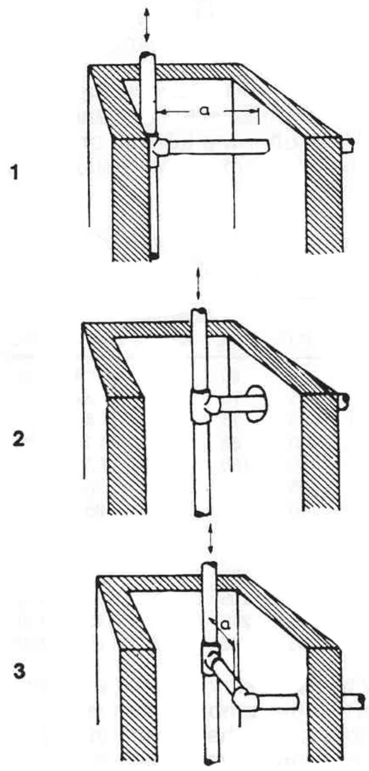
		Horizontal					
DN	d	20 °C	30 °C	40 °C	50 °C	60 °C	vertical
10	16	75	60	40	Continuous		80
15	20	85	70	50	support		90
20	25	90	75	55	45	30	100
25	32	100	85	65	50	35	120
32	40	110	100	80	60	40	140
40	50	125	115	95	70	45	160
50	63	140	130	110	85	55	180
65	75	150	140	120	95	60	200
80	90	165	155	135	105	70	220
100	110	185	175	155	120	80	240
125	140	215	205	185	160	110	250
150	160	225	215	200	170	130	250
200	225	250	240	225	200	160	250

Wall and ceiling ducts

Pay attention to DIN 1988.

Well laying

In case of rising mains passing through wells take care to allow for the branch pipe of floor branches to spring sufficiently. This can be ensured by suitably placing the rising mains in the well (1), by providing a sufficiently di-mensioned branch liner (2) or by installing a spring leg (3).



Installation of buried floor pipes

Upholstered pipes

Wrap a felt or similar strip around the entire pipe length. Put elastic materials (glass wool, rock wool, cellular or similar materials) around fittings and spring legs at tees, angles and other changes of direction in order to allow free linear expansion.

Not upholstered pipes

Immediate bedding of the pipe is allowed if the change of temperature during service does not exceed 10 K.

Take care that the pipe is well bedded and that hollow spaces are avoided. The mortar must not be too lean (cement mortar mixture 1:3 to 1:4) so that forces occurring due to temperature changes can be led off into the wall without causing plaster gaps. The people in charge of the bedding should be instructed accordingly. Examine whether this method of installation is feasible within housing spaces for reasons of noise control (DIN 4109).

Installed pipe protection

Protect exposed pipes from impact and shocks. When installing potable water pipes ensure that the pipe wall temperature does not exceed 30 °C. This is particularly important if there are parallel or crossing warm water or heating pipes. Industrial pipes are to be protected from out-side heat. If welding, burning or soldering works are being carried out near the pipe system, protect it by means of asbestos sheet, for example.

Connection to water heaters

A thermal resistant pipe of a minimum length of 0.5 m must be fitted to the water heater safety group.

Longitudinal expansion and contraction of plastic pipes

Plastics have a comparatively high coefficient of linear heat expansion, which should be taken into account when laying plastic pipes.

Pipe with socket joints do not normally require special measures to be taken regarding expansion caused by temperature changes, as each socket acts as an expansion piece.

However, in the case of a long section of adhesive-jointed PVC pipes, the whole section will behave as a single long pipe. Expansion or contraction will thus be concentrated and the whole section will expand or contract.

Formula 2

$\Delta L = \Delta t \times L \times \alpha$

where ΔL = longitudinal expansion/contraction [m]

$\Delta t = T_1 - T_2$ [°C]

T_1 = stable soil temperature
T_2 = temperature of pipe when laid
L = length of section [m]
α = coefficient of linear heat expansion

Use of plastic pipes at temperatures exceeding 20°C

Where circumstances require that the normal maximum operating temperature of a pipe be exceeded, the reduction in pressure necessary to obtain the same service life as at a 20°C operating temperature can be calculated from the diagram below.

Formula 3

PN_t = PN x C_t

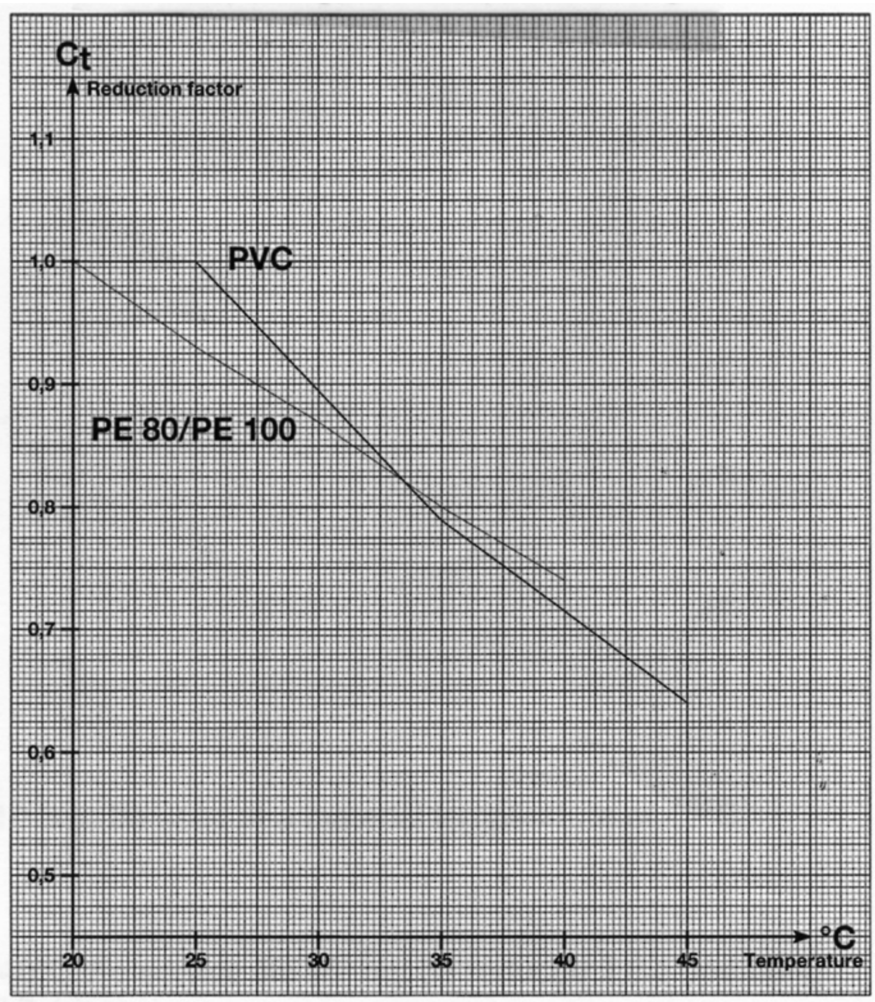


Diagram – Permissible operating pressure at temperatures exceeding 20°C

Hydraulic Flow: Frictional Losses

Formula

Water flow diagrams are calculated according to the Colebrook-White formula:

Formula 4

0.74 k

Q = -6.95 x log (+) x D_i 2 x √ D_i x I

D_i x √ D_i x I x 106

3.71 x D_i

Q = water discharge [m3/s]

D_i = internal pipe diameter [m]

I = frictional loss [m/m] [number]

k = frictional resistance [m]

for diameter ≤ 200 mm

k = 0.00001 m

for diameter > 200 mm

k = 0.00005 m

The curves are designated by trade name (external diameter) but calculated according to the internal pipe diameter making it possible to read the capacity of the pipes direct without having to interpolate between the curves.

From the diagrams the frictional loss of the plastic pipe itself appears. Individual resistances such as bends, valves, reducers, tees, inlet and outlet taps etc. are not taken into account.

For most water supply projects the different individual resistances will normally not be calculated. In such a case 2 - 5% is added to the frictional loss of the pipeline.

High Water Velocity

For projects with much higher water velocity or projects for which a detailed calculation of different individual resistances is desirable the following formula can be used:

Formula 5

$$\Delta H = \zeta \times \frac{v^2}{2^g}$$

where ΔH = pressure head loss(m)

ζ = resistance (number)

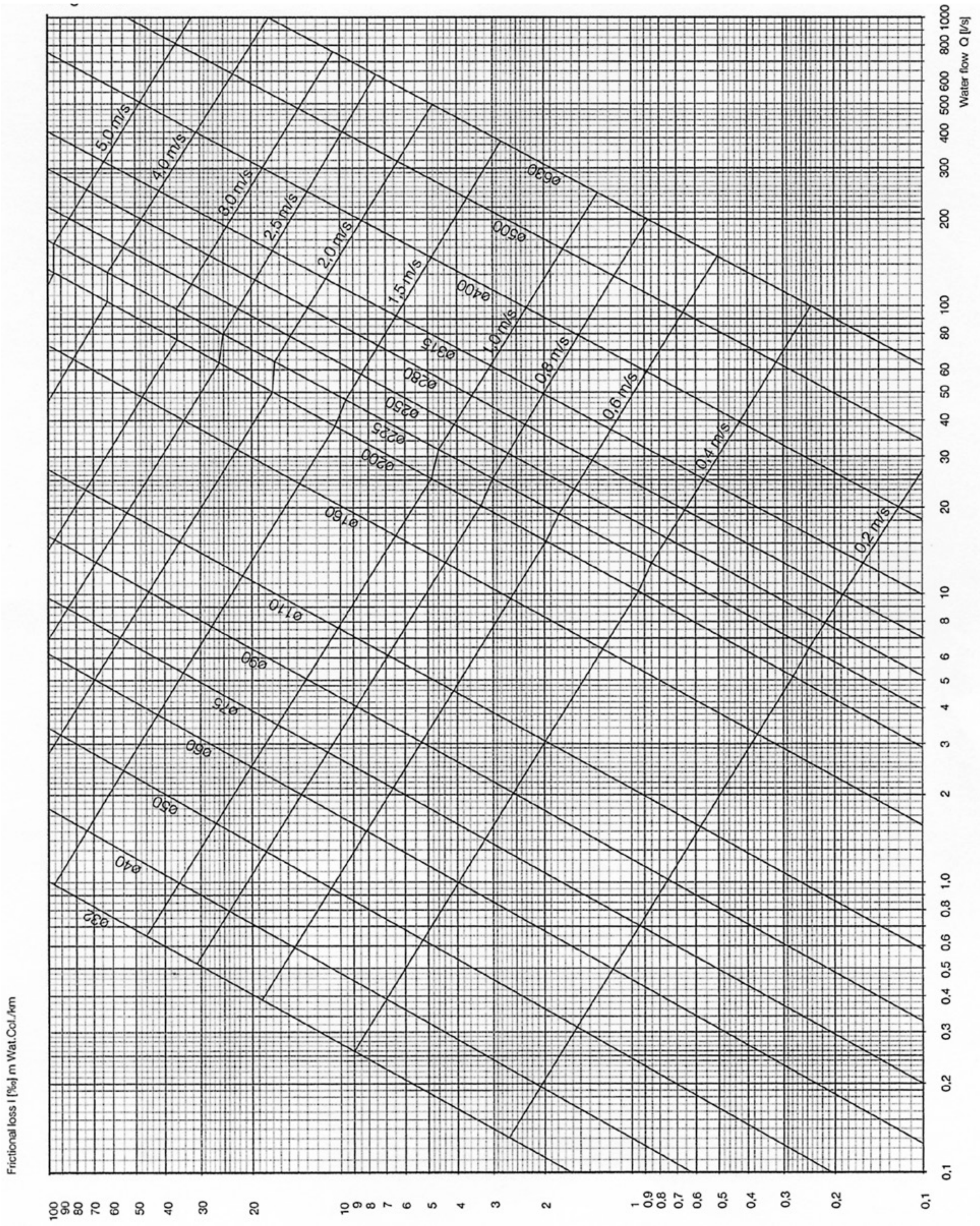
v = velocity (m/s)

g = gravity = (9.81 m/s²)

If the ζ -values of our products are required please contact Wavin.

Water Flow Diagram for Wavin PVC Pressure Pipes PN10

The curves are calculated according to the inside diameter of the PVC pipes.



Pressure Variations

Water Hammer

Each time the rate of flow in a pipe system changes, a pressure wave is created. This can result in such large variations in pressure as to cause a water hammer, which may exceed the permissible load on the pipes (force acting upon it).

In pump systems changes in the rate of flow can occur in the case of e.g. power cut, sudden blockages, rapid closing of valves etc. If this takes place at one end of a long pipe line, the pressure waves will rebound from the other end and may cause damage when they return to their point of origin - particularly if this end is completely shut off and the increased pressure cannot escape. The risk of water hammer may necessitate the installation of devices to minimize the effect of the pressure waves and will often require special operating nstructions.

There is ample technical literature available on the subject. Comprehensive guidance is given on calculation methods but these are both complicated and time-consuming. However, data programs have been produced which are able to solve even the most complicated problems. In compiling these programs, information concerning the special characteristics of the pump, pressure head and torque, the valve closure, the air valves and various designs of the longitudinal profile etc. has been included. As a result there is a risk of pressure variations, rates of flow, vibration frequencies, volumes of air valve and pressure changes along the pipe line as a function of time.

Rapid filling of a pressure pipe line and variations between trapped air masses may also cause sharp rises in pressure. Pipe lines should therefore be designed to allow bleeding wherever required and filling speeds should be kept low.

The speed of the pressure wave depends on the pipe material, wall thickness and the substance carried by the pipe.

Pressure class PN	PVC a [m/s]
16	444
10	362
8	327
6.3	-
6	288
5	263
4	237

The following pressure wave speed values a [m/s] apply for water carrying (incl. waste water) Wavin pipes:

All known materials show to a varying degree a tendency to suffer fatigue when subjected to dynamic forces. Incidences of water hammer will therefore reduce the service life of the pipes - the extent of such reduction depending upon the composition of the dynamic forces i.e.:

- The duration of the pressure rise
- The maximum value of the above compared with the level of the static mean stress
- The time interval between rises in pressure (frequency) etc.

The following permissible pressure rises apply for pressure pipes used in water supply systems:

Where pressure rises occur infrequently, e.g. pressure testing, power failure etc., the permissible maximum pressure may exceed the nominal pressure by 50%.

For PVC pipes it furthermore applies that where pressure rises occur frequently (maximum 10^6 instances in a 50-year period) the permissible maximum pressure may exceed the nominal pressure by 25%, but such pressure rises must not result in a pressure amplitude higher than 30%.

In case of doubt please contact Wavin.

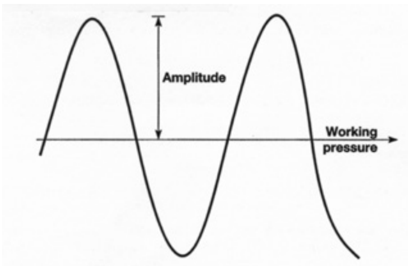


Figure 21: Example of variation in pressure.

7. Laying instructions

European standard EN 1452-6 "Plastic piping systems for water supply" guidance for installation applies for the laying of pressure pipes.

The standard lays down that a pipeline should be located at such a distance from other pipelines and installations that it causes no damage to these and allows the repair of other installations. Reference should be made to the standard for the distances in question. Requirements are also attached to the design of the pipe trench. The levelling layer must be laid or loosened and subsequently levelled so that the pipes are evenly supported.

The side fill layer must provide adequate side support for the pipes and it is therefore important that this layer is compacted, e.g. by stamping with the foot.

The materials employed for the levelling layer and the side tilt must meet the following criteria:

- The particle size must not exceed 16 mm
- The content of particles of between 8 and 16 mm must not exceed 10%
- The material must not be frozen
- Sharp flints or other crushed material must not be employed

The back fill must conform with the requirements placed upon it by the type of construction (road, pavement or the like) above the pipeline.

The standard states that the soil covering (hd) must not be less than 0.6 m where the pipeline will be exposed to traffic load, unless special measures are taken. In view of the requirement that pipelines are laid in frost-free soil, pipelines carrying, e.g. potable water, are normally laid with a 1.1 m soil cover.

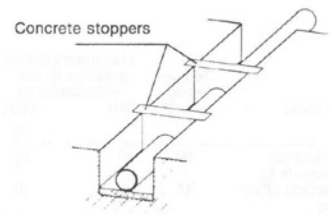
Pipe trench

The depth of pipe trench should be such that all pipe component parts can be perfectly laid below the frost line (minimum depth of cover 1.0-1.8 m according to climate and soil conditions). It the ground is rocky or stony the trench bottom should be lowered by at least 0.15 m and the excavated earth replaced by a stonefree layer (sand, fine gravel).

The pipe trench is to be in accordance with DIN 18300, DIN 18303, DIN 4124 sheet 1 and DIN 19630.
In case of stony or rocky ground: provide a stonefree layer of 0.15m.

In case of descending gradients the stonefree layer must be prevented from being washed away by concrete or clay stoppers. Drainage might also be advisable.

Concrete stoppers



In case of changing layers and consequently changing soil bearing capacity of the trench bottom, provide an adequate fine gravel or sand filling (approximately 10xd) at the points of transition. Should there be parallel or crossing other pipe conveying warm liquids, then care must be taken that the PVC-U pipe's surface temperature does not rise above 20˚C.

Back-filling

Filling of the trench is to be done in layers up to a depth of approximately 0.30 m above the top of the pipe, utilising stonefree soil and stamping carefully by hand. If necessary, suitable soil must be procured.

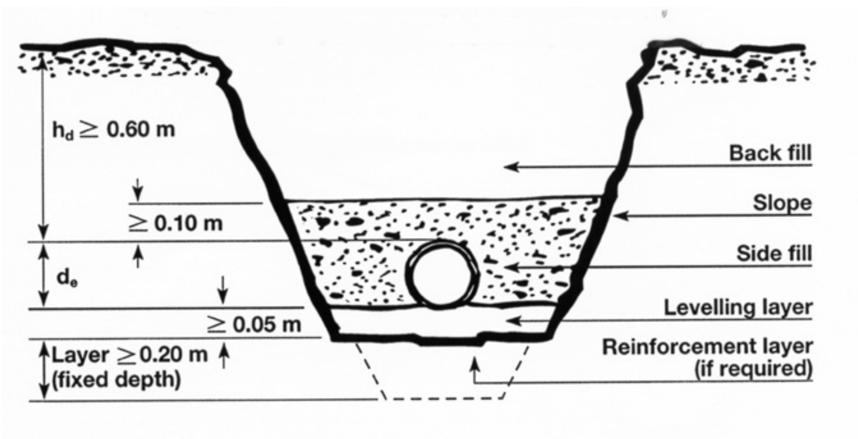


Figure 22. Diagram of trench design

			a in m for pipe	
	D1)	R	lengths of	
DN	(mm)	M	6 m	12 m
50	63	18,9	0,94	3,69
65	75	22,5	0,80	3,13
80	90	27,0	0,66	2,63
100	110	33,0	0,54	2,16
125	140	42,0	0,43	1,70
150	160	48,0	0,38	1,49
200	225	67,5	0,27	1,07
250	280	84,0	0,22	0,86
300	315	94,5	0,19	0,76
400	450	135,0	0,13	0,54

1) Outside pipe diameter.

If the pipe temperature is considerably higher than the trench temperature due to solar radiation, then put first a thin layer of stonefree soil on to the pipe prior to final back-filling in order to achieve stressfree laying. Pay attention to pipe movement resulting from temperature differences.

Final back-filling is then to be effected. Mechanical rammers can be used after the prescribed dumping height has been reached.

Special measures

If district heating pipelines are crossed, the PVC-U pipes must be protected from heat. DIN 19630 refers.

8.1 Pressure Testing

Pressure Testing of PVC-U Pressure Lines

It is possible to pressure test a PVC-U pressure line, before it is put into service (taken over by the client).

Pressure testing is carried out according to DS 455. It pressure testing is requested, it should form part of the project, and here the following conditions should be observed:

1) The longitudinal profile should be projected with a slight upward incline for ventilation purposes.
2) A form of ventilation (manual - automatic) should be installed in all summits - correct installation of ventilation: In the direction of flow a little below exact summit.
3) Barring procedures should be established enabling pressure testing of the line by stages.
4) It should be possible to connect a filter socket in the lowest point and ventilation (air escape) in the summit to the starting and end points of the line respectively.
5) Bends, tees, reducers, valves, end caps etc. should be anchored for the increased testing pressure.
6) The demands placed by the owner on possible pressure testing should appear from the project description enabling the contractor to take the necessary measures for pressure testing.
7) Choice of pipe and fitting material should be made under reference to EN1555/12201/1452

When the above conditions have been fulfilled the next step is the practical accomplishment of the job, and here the following points may contribute to problem-free pressure testing:

- Correct transport, storage and handling of pipes and fittings
- Correct excavation, laying, filling and compaction
- Correctly used jointing components and methods

It is highly important that above mentioned rules are observed as they will influence the final result of the project.

Procedure for Pressure Testing of Pipe Systems

Below is the procedure for pressure testing of pipe systems. The procedure is in accordance with the standard of the Danish Engineers Union: 'Tightness of underground sewer systems" DS 455, 1st edition, January 1985.

Before pressure testing the following must be observed:

1) End caps are mounted on all ends of the system. The end cap can be an end socket or a blank flange. A 90˚C bend, a ball valve and a 32 mm tensile resistant coupler are mounted on the end cap, for mounting of a 32 mm PE pipe.
2) All end caps must be anchored.
3) The system must be filled with water at least 24 hours prior to the start of the pressure test. Ensure that the system is entirely ventilated.
4) During the first 6 hours the pressure in the system must be 1.3 x the nominal pressure class. This is very important in order that the result of the test is not misleading. This part of the test must be documentable to the inspection authorities.
5) There must be access to water on the testing site.
6) Pressure testing against a valve is at your own risk.

During pressure testing the following is to be observed:

1) The actual pressure is measured and water is added to the system if required.
2) The system is exposed to a pressure corresponding to 1.3 x the nominal pressure class (testing pressure).
3) This pressure is maintained for 2 hours. Supplementary filling of water is allowed.

4) During the following 60 minutes water must not be added.
5) After 60 minutes the pressure is measured and water is added until the pressure is again 1.3 x the nominal pressure class (testing pressure).
6) The fall in pressure and the amount of water added must not exceed the following limits:

Formula 6

a) pressure drop in percentage of initial pressure = 2%
b) water quantity in litres/metres = $0.02d_i - 0.001 + \Delta V$

$\Delta V = 0.05 \times d^2$ for PVC pipes
$\Delta V = 0.08 \times d^2$ for PE pipes
d_i = inside diameter

After pressure testing the end caps are demounted.

The following table takes into account the test pressure of 1.5x nominal pressure.
Axial forces P and resultant forces R for 10 bar working pressure pipelines.

	D1)	P			R(N)		
DN	(mm)	(N)	11°	22°	30°	45°	90°
50	63	4579	882	1765	2353	3530	6472
65	75	6492	1225	2500	3383	4952	9218
80	90	9365	1765	3579	4854	7207	13238
100	110	13974	2696	5393	7256	10787	19809
125	140	22653	4364	8678	11767	17455	31969
150	160	29518	5687	11277	15396	22653	41776
200	225	58447	11179	22359	30302	44718	82375
250	280	90515	17357	34617	46973	69627	128467
300	315	114541	21966	43737	59428	87769	162790
400	450	233888	45895	91201	121602	179461	331464

1) Outside pipe diameter

Axial forces P and resultant forces R for 16 bar working pressure pipelines.

	D1)	P			R(N)		
DN	(mm)	(N)	11°	22°	30°	45°	90°
50	63	7325	1412	2824	3765	5648	10355
65	75	10385	1961	4001	5413	7923	14749
80	90	14984	2824	5727	7766	11532	21182
100	110	22359	4314	8629	11611	17259	31695
125	140	36245	6982	13886	18828	27929	51151
150	160	47228	9100	18044	24634	36245	66842
200	225	93516	17887	35774	48484	71549	131801
250	280	144824	27772	55387	75158	111403	205547
300	315	183266	35147	69980	95085	140431	260464
400	450	374221	73432	145922	194563	287138	530343

1) Outside pipe diameter

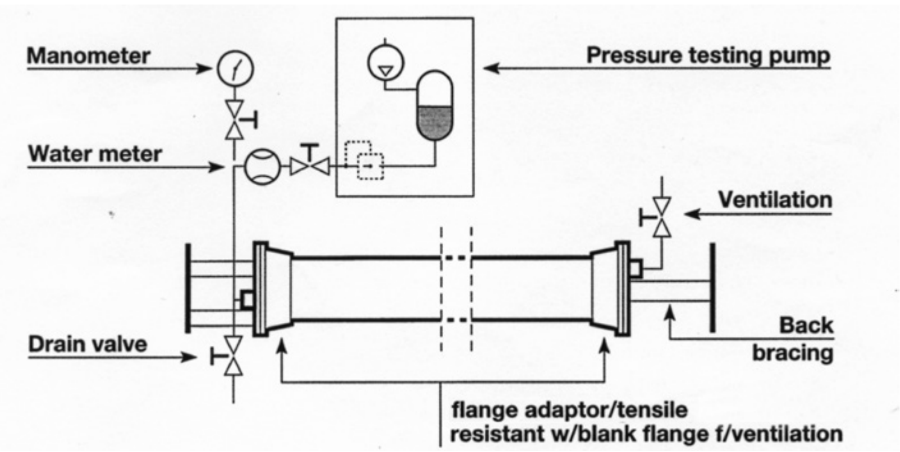


Figure 23. Diagram of pressure testing of pipeline.

8. Anchorage

The size of the axial force depends on the dimension and working pressure (testing pressure) of the pipe line and is calculated as follows:

Formula 7

$$N = \frac{\pi \times dy^2 \times p}{10^4 \times 4}$$

where N = axial force [kN]
dy = external pipe diameter [mm]
p = max. pressure occurring in pipeline [bar] possibly testing pressure

Anchorage of tees, end caps and valves

Fittings exposed to shearing forces caused by internal water pressure, e.g. bands, tees, end caps, reducers and valves must be anchored. The shearing force which the anchorage is intended to withstand can be easily calculated by using the figures in the below table in the following simplified formula:

Outside diameter [mm]	Axial force at 1 bar N1 [kN]
40	0.13
50	0.20
63	0.32
75	0.45
90	0.64
110	0.95
125	1.23
140	1.54
160	2.00
200	3.15
225	4.00
250	4.90
280	6.16
315	7.80
400	12.60
500	19.60
630	31.20

Formula 8

$N = p \times N_1$

where N_1 = axial force at 1 bar [kN]

p = max. pressure occurring in pipeline [bar] possibly testing pressure

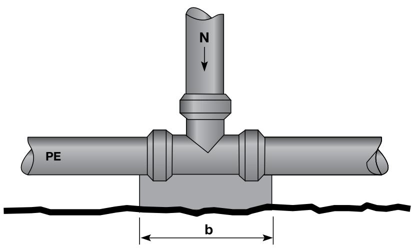


Figure 24: Diagram showing anchorage of tee.

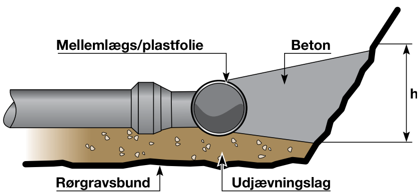


Figure 25: Diagram showing anchorage of tee.

Anchorage of bends

The resulting force for bends can be calculated as follows:

Formula 9

$$R = 2 \times N_1 \times p \times \sin \frac{\alpha}{2}$$

where N_1 = axial force at 1 bar [kN] (table 7)

p = max. pressure occurring in pipeline [bar] possibly testing pressure

α = angle of bend [degrees]
R = resulting force [kN]

Angle α	11°	22°	30°	45°	60°	90°
k	0.19	0.38	0.52	0.77	1.00	1.41

Table of angle constants.

The resulting shearing force which the anchorage is intended to withstand can be easily calculated by using the figures in the tables in the following simplified formula:

Formula 10

$R = k \times p \times N_1$

Where k = constant for resulting force (see table of angle constants)

p = max. pressure occurring in pipeline [bar] possibly testing pressure

N_1 = axial force at 1 bar [kN]

Anchorage block

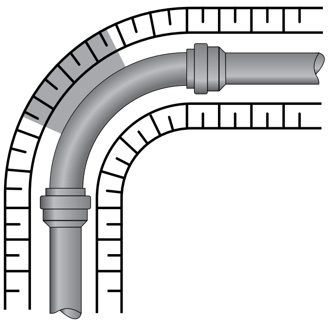


Figure 26: Diagram of anchorage of bend.

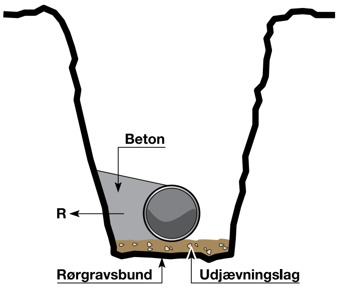


Figure 27: Diagram of anchorage of bend.

When calculating the area necessary for the determination of the size of the anchorage, due consideration has to be paid to the permissible earth pressure, which in each individual case has to be determined by geotechnical surveys. In most cases it is sufficient to use the following formula:

σ earth = 200 (kN/m^2)
The person in charge of the project should always make an appraisal of the relevance of this value.

This width of an anchorage can then be calculated by means of the following formula:

Formula 11

$$b = \frac{R}{h / \sigma \text{ earth}}$$

where b = width of anchorage [m]

h = height of anchorage [m]

R = resulting force [kN]

σ earth = permissible earth pressure [200 kN/m^2]

It is a condition for the strength of the anchorage that the concrete is cast against a solid wall of the pipe trench. It may, however, sometimes be necessary to cast against carefully compacted fill. In such case account should be taken in the calculations of the lower strength of the fill. The fitting in question must be protected from the damage by the concrete by an intermediate layer of e.g. plastic film before casting takes place.

Example of anchorage of bend

Conditions:

- Ø 200 x 45° PVC pressure pipe bend
- Testing pressure (maximum pressure) 9 bar

Formula 10 is applied as follows:

$R = k \times p \times N_1$

where k = 0.77 according to table of angle constants

p = 9 bar

N_1 = 3.15 according to table of the previous page

The resulting force will then be:

$R = 0.77 \times 9 \times 3.15 = 21.83$ kN

Now the size of the concrete block can be calculated by using formula 11:

$$b = \frac{R}{h \times \sigma \text{ earth}}$$

σ earth is estimated at [kN/m^2]
The height is estimated at:
h = 0.2 (height of pipe)

The minimum width must then be:

$$b = \frac{21.83}{0.2 \times 200} = 0.55 \text{ m}$$

Anchorage of reducer

The axial force for reducer is found by means of formula 12:

Formula 12

$$N = \frac{\pi \times (dy^2_1 \times dy^2_2) \times p}{10^4 \times 4}$$

where dy^2_1 = the outside diameter [mm] of the largest pipe

dy^2_2 = the outside diameter [mm] of the smallest pipe

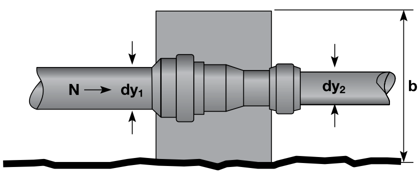


Figure 28: Diagram of anchorage of reducer.

Example of anchorage of reducer

Conditions:

- Ø 200/110 PVC reducer
- Testing pressure (maximum pressure) 9 bar

which is inserted in formula 12:

$$N = \frac{\pi \times (200^2 - 110^2) \times 9}{10^4 \times 4}$$

N = 19.72 kN

The anchorage (concrete block) is calculated as follows:

h = (is estimated at) 0.2m

σ earth = (is estimated at) 200kN/m^2

$$b = \frac{N}{h \times \sigma \text{ earth}}$$

$$b = \frac{19.72}{0.2 \times 200}$$

b = 0.49 m

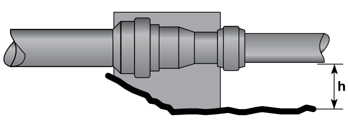


Figure 29. Diagram of anchorage of reducer.

9. Handling and Storage

Handling plastic piping systems

Wavin pressure pipes are supplied in pre-packed bundles to ensure adequate protection during transport and storage. The pipes are supplied with end caps protecting the pipes effectively from dirt entering the pipes.

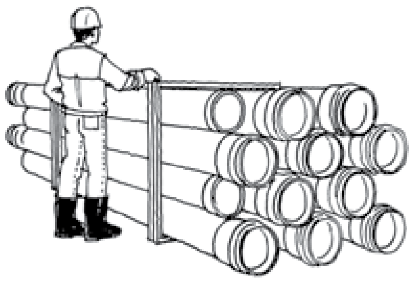
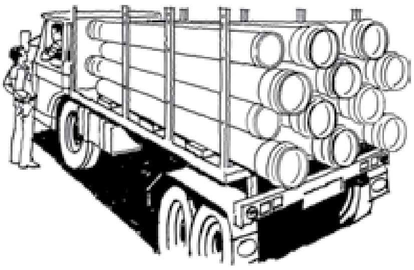


Figure 30: Pipes should be handled and stored in bundles as delivered from Wavin for as long as possible.

Transport

Vehicles for transporting pipes should be selected in such a way that the pipes lie completely on the floor of the vehicle, without jutting out of the vehicle. Sagging is to be prevented. Impacts are to be avoided under all circumstances, particularly at temperatures near the freezing point. To protect the pipes and fittings from damage, they should not grind against the load area of the vehicle or against the floor of the vehicle during transportation. Pipes and fittings should be loaded and unloaded with extreme caution and care. If hoists are used, then pipe components may not be thrown from the vehicle into the storage area.

Figure 31
Bearers must be placed on the truck body.
Support the full length of the load.
Always load and unload properly.
Do not tip or throw the pipes from the carrier.



Handling on site

Figure 32
Small-diameter pipes can easily be carried without the use of auxiliary equipment.

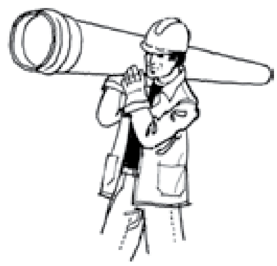


Figure 33
Do not drag the pipes across the ground and avoid sharp edges.

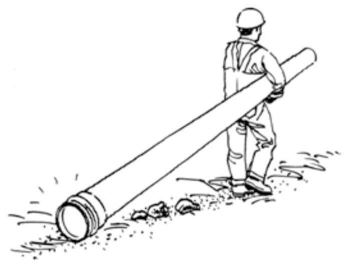


Figure 34
Small-diameter pipes can be manually placed in the trench.

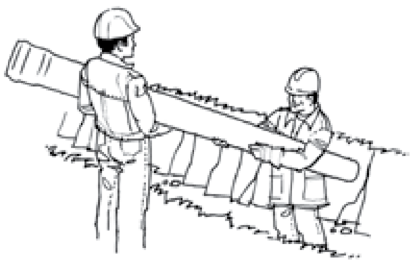


Figure 35
Pipes in larger diameter may necessitate slings. Always use at least 2 slings.

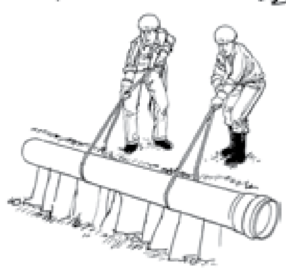
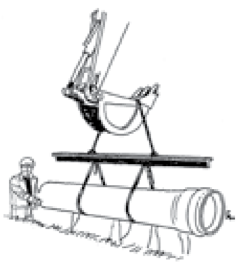


Figure 36
Larger diameters may necessitate a special lifting bar.



Storage

Storage areas for pipes should be without gravel and plain. Storage and stock heights should be selected in such a way, as to avoid damages or permanent deformations. Pipes with large diameters and small wall thickness should be equipped with circular stiffeners. Point and line supports for the pipes should be avoided.

The recommendation for the permitted stacking height for PE pipes not stored on pallets is 1 m. Pipes should be stacked in layers with sockets placed at alternate ends of the stack to ensure their support along the entire length.

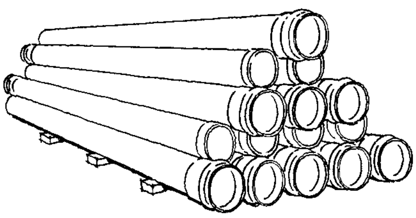


Figure 37. Loose pipes with sockets must be stored socket end/ spigot end alternately to prevent pipes from resting on the sockets.

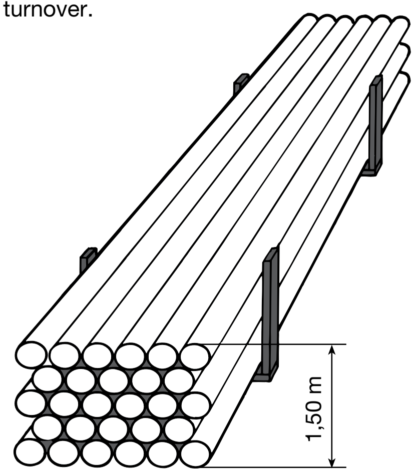
If the pipes are stacked on pallets and are secured against lateral movements, the stacking height can be increased to 1.5 m. When spacing the pipes the bearing width of the supports and timbers respectively must be at least 7.5 cm. The distance between the supports and timbers respectively should be 1-2 m. The outer supports and timbers respectively are to be arranged 0.5-1.0 m from the stack end.

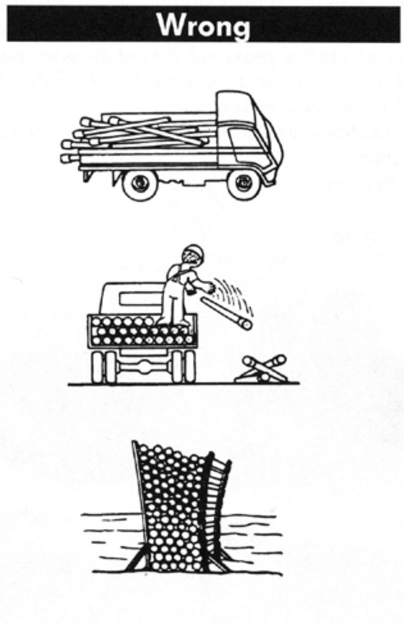
The area where pipe components are stored should provide as much protection as possible. Pipes should be completely protected from the effects of oil, solvents and other chemical substances during the storage period. The area where the pipes are to be placed should be covered with sheeting or cardboard (including the side supports) in order to avoid damage caused by protruding rivets and nails.

The influence of weather on stored pipe components should be kept to a minimum, i.e. the pipe components should be kept in a warehouse. If the pipes are stored in the open (construction sites), then they should be covered with coloured or black sheeting to protect them from the influence of weather (for example, UV rays). Wavin PE fittings and valves are packed in PE plastic bags to protect them from ultraviolet radiation and dust. We recommend removing the pipes from the packing only shortly before installation.

Moreover, one-sided heat exposure caused by sunshine can lead to deformations in the pipes.

Maximum permitted storage periods should be adhered to (for example, DVGW). The pipe components should be used in the order of their manufacture and delivery to ensure appropriate stock turnover.





Note 1: PE pipes should read PVC pipes.

Note 2: Rubber rings will be supplied in plastic bags

10. Notes

This document gives units of the international system (SI), e.g. the unit for force Newton (N) instead of pond (p) and the unit of power Watt (W) instead of kcal/h.

Conversion:

1 kp = 9.80665 N
or 1 kp ≈ 10 N

1 Mp = 9806.65 N
or 1 Mp ≈ 10 kN
and 1 Mp/m = 10 kN/m

1 kp/cm^2 = 9.80665 N/cm^2 =
0.0980665 N/mm^2 =
0.0980665 Mpa or
1 kp/cm^2 ≈ 0.1 N/mm^2

1 m of water column
= 0.0980665 bar or 1 m of water column ≈ 0.1 bar

1 kcal/m h degree
= 1.16 W/mK (Thermal conductivity) or 1 kcal/m h degree ≈ 1.2 W/mK

The thermal conductivity is given in W/mK. One gets here identical figures for K and °C respectively as it is a matter of temperature differences. In this sense, 1 W/m °C is identical to 1 W/mK.

K (Kelvin) is the SI unit for the temperature. The Celsius temperature (t) differs from the Kelvin temperature (T) by 273.15 K.

t (°C) = T – To = T – 273.15 K.

In this document, g is supposed to be 10 m/s, the fault of approximately 2% being neglected. DN means nominal diameter, PN is nominal pressure.

Dimensions and units

Dimensions are indicated in mm and/or inches and are specified as nominal or standard sizes.

d, d1, d2, d3, d4 Diameter
DN Nominal diameter
SC Size of hexagonal bolts
AL Number of screw holes
s Width across flats of hexagonal bolts
g Weight in grams
SP Quantity per standard pack
GP Quantity per large pack
e Pipe wall thickness
PN Nominal pressure
Rp Parallel internal pipe thread to ISO 7-1
R Conical external pipe thread to ISO 7-1
ppm Parts per million
1 bar = 0.1 N/mm^2
= 0.1 Mpa (Megapascal)
= 14.504 psi
C Design factor
S Pipe series
SDR Standard Dimension Ratio
MFR Melt Flow Rate
According to ISO 4440

SDR

SDR **S**tandard **D**imension **R**atio:
OD / SDR = WT
OD / WT = SDR

OD = Outside Diameter
WT = Wall Thickness

Pressure system dimensions

DN = Nominal Diameter
OD = Outside Diameter

DIN			DIN/ISO/EN	
DN	versus	OD	versus	Inch
4		6		
5		8		
6		10		
8		12		1/4''
10		16		3/8"
15		20		1/2"
20		25		3/4"
25		32		1"
32		40		1 1/4"
40		50		1 1/2"
50		63		2"
65		75		2 1/2"
80		90		3"
100		110		4"
125		125		5"
125		140	DIN	5"
150		160		6"
150		180 GAS		6"
200		200		8"
200		225	DIN	8"
250		250		10"
250		280	DIN	10"
300		315		12"
350		355		14"
400		400		16"
400		450	DIN	18"
500		500		20"
500		560	DIN	22"
600		630		24"

PSI	BAR (PN)	Mpa	Kpa
87,08	6	0,6	600
91,44	6,3	0,63	630
108,85	7,5	0,75	750
116,11	8	0,8	800
145,14	10	1	1000
181,42	12,5	1,25	1250
232,22	16	1,6	1600
290,28	20	2	2000

Explanations of abbreviations

PB	Polybutylene
PE	Polyethylene
PE-X	Cross-linked polyethylene
PP	Polypropylene
PVC	Polyvinylchloride
PVC-C	Rechlorinated polyvinylchloride (increased chloride content)
PVC-U	Unplasticised polyvinylchloride
PVC-O	Oriented polyvinylchloride

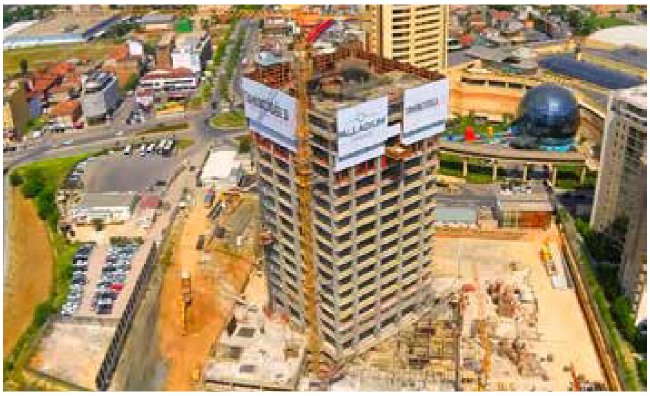
Our Certificates

11. Some References

Name of Project	Region	Type of Construction	Size of Construction
Opet Filling Facility	Tarsus	Industrial Facility	
Teknopark Research&Development Buildings	İstanbul	Sevice Building	720.000 m^2
Sakarya Drinking Water	Sakarya	Bellow Ground	
Ataköy Sewage Plant	İstanbul	Municipality	
Africa Oyala Municipality Building	S.Africa	Sevice Building	3.830 m^2
Ülker Arena Sports Facility Pool	İstanbul	Sport Facility	
35. Sokak	İzmir	Residence	257 Apartments
Myworld Europe	İstanbul	Residence	
Cratos Hotel Aquapark	KKTC	Hotel	
Club Alibey Belek Aquapark	Antalya	Hotel	
La Blanche 2 Hotel	Muğla	Hotel	

Ağaoğlu Andromeda - İstanbul / TURKEY

Antepia Residence - Gaziantep / TURKEY



Palladium Tower - İstanbul / TURKEY

Royal Hotel / Algeria

Electrogaz - Republic of Rwanda

Notes

Notes

Discover our broad portfolio at wavin.com

Water management
Heating and cooling
Water and gas distribution
Waste water drainage

orbia
Advancing life together

Wavin is part of Orbia, a community of companies working together to tackle some of the world's most complex challenges. We are bound by a common purpose:
To Advance Life Around the World.

Wavin TR Plastik Sanayi A.Ş. | Güzelevler Mah.Girne Bulvarı No: 294/A Yüreğir / Adana
Web www.wavin.com.tr | E-mail wavin.tr.info@wavin.com