Product Guide

Amiantit Fiberglass Industries Limited (AFIL)

AMIANTIT PIPE SYSTEMS

1 Introduction

Amiantit - Group of Companies

The Amiantit Group is a leading industrial organization that was established in Dammam, Saudi Arabia in the year 1968. Today, the Group has global strength and a track record of growth-oriented success in manufacturing various kinds of pipes, joints, fittings, tanks, rubber and insulation products and related accessories. Strategic planning has made Amiantit an integral part of dynamic developments in countries across the globe and has put Amiantit on the world map with a name that is internationally recognized for manufacturing excellence and superior services.

Amiantit has proactively taken steps to strengthen operations and diversify activities, and has invested strongly in new technologies, products and applications, in order to meet global challenges in its markets that extend throughout the Kingdom of Saudi Arabia, the Middle and Far East, Europe, North and South America.

The Group has entered into a new era of growth and development through geographic expansion of manufacturing facilities, research, development and application of advanced technologies, consultancy, engineering and operation services for water management projects, aimed at exploiting the available market opportunities and maintaining industry leadership. With its competitive position, the quality and commitment of its people, and its excellent performance record, the Amiantit Group looks forward to achieving its vision of global leadership.

Our Vision

To be the leader in the manufacturing, engineering & after sales services of GRP (FRP) piping and tank systems.

The above can only be achieved by our commitment toward the following:

- Fulfill the customer's satisfaction and expectation
- Ensure continuous improvement in all aspects.
- Enhancing "Safety" as our first priority.

Recent Situation

The world's infrastructure is aging. Millions of kilometers of water and sewer pipe need rehabilitation.

This dilemma is a worldwide problem. And where an aging infrastructure is not a problem, it's generally because there are no infrastruture - it remains to be constructed in many developing countries. However, these nations, too, are faced with difficult decisions about how to build and what materials to use in order to avoid what happened in the developed countries.

Who's the culprit? For the most part, corrosion is responsible for this problem.

- Internally unprotected concrete sewer pipes are rapidly deteriorated by the presence of sulfuric acid in a sanitary sewer system, which generated through the hydrogen sulfide cycle.

- Externally, soil conditions and stray electrical currents will deteriorate underground pipes. Poorly coated metallic pipes can corrode when placed in poorly aerated and poorly drained soils. The presence of sulphate-reducing bacteria will accelerate corrosion.

- These problems can be significantly reduced, if not eliminated, by the careful selection of materials resistant to corrosion protection, only to learn a few years later of the consequences. Where as corrosion is not a reversible process. The remedy to this situation is very simple. Amiantit fiberglass (FLOWTITE) brand of pipes.

Amiantit fiberglass is a glass-reinforced plastic (GRP) pipe produced on the continuously advancing mandrel process, ensuring a consistently uniform product meter to meter. Immune to galvanic and electrolytic corrosion, Amiantit fiberglass pipe is the ideal pipe choice for water supply systems. It's proven resistance to the acidic environment found in a sanitary sewer speaks well for it's use in waste water applications too. In fact, for more than 30 years now Amiantit fiberglass pipe has been the material of choice in many Middle East sewers, known to be the most aggressive in the world.

About AFIL

Amiantit **F**iberglass **I**ndustries **L**imited (AFIL) was established in 1977 as a limited liability company between the Saudi Arabian Amiantit Company (SAAC) 70% and FLOWTITE AS 30%.

The Amiantit Fiberglass Ind. Ltd. (AFIL) is part of the Saudi Arabian Amiantit Group of Companies offering water and wastewater related products. The Amiantit Group is the leading pipe manufacturing, technology and service supplier to the civil engineering and industrial community in the Middle East region.
In addition to glass-reinforced pipes using both epoxy and polyester resin systems, the Saudi Arabian Amiantit Company also provides:

- Ductile iron pipes
- Concrete pressure pipes
- Reinforced concrete pipes
- Plastic pipes, including PVC and HDPE
- Rubber sealing (gaskets) products
- Water management services
- Trading services

Lightweight, corrosion resistant and manufactured under strict quality standards, AFIL-Flowtite pipes are available in over size pressure classes and three stiffness classes. Diameters from 80 mm to 4000 mm can be supplied and lengths up to 18 meters.

Growing awareness of the operational cost savings and superior corrosion resistance offered by glass-reinforced plastic pipe systems manufactured by AFIL operations has resulted in its widespread application for the following:

- Water transmission and distribution (potable & raw water)
- Sanitary sewerage collection systems & treated water
- Storm sewers
- Sea water intake and cooling water lines
- Circulating water, make-up and blowdown lines for power plants & desalination
- Industrial and chemical wastes
- Irrigation
- Fire fighting

In replacing other materials, AFIL-Flowtite pipe deliver long, effective service life with low operating and maintenance costs. And AFIL pipe is usually the lowest cost option upfront too!

2 Product Benefits and Performance Standards

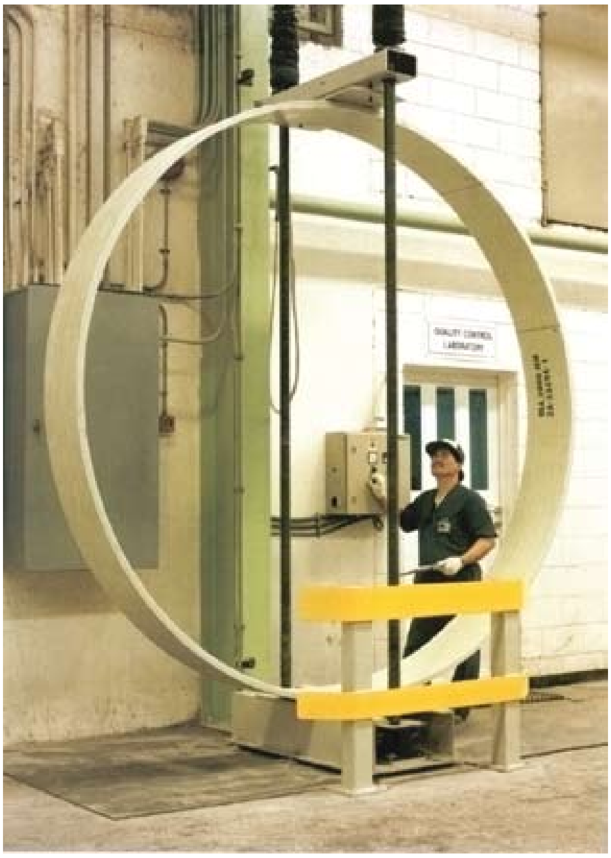
2.1 Product Benefits

AFIL has been able to bring a product to market that can provide the low cost, long-term piping solution to customers around the world. The long list of features and benefits add up to provide the optimum installed and life cycle cost system.

Features	Benefits
Corrosion-resistant materials	Long, effective service life. No need for linings, coatings, cathodic protection, wraps or other forms of corrosion protection. Low maintenance costs. Hydraulic characteristics essentially constant overtime.
Light weight (1/4 weight of ductile iron 1/10 weight of concrete)	Low transport costs (nestable). Eliminates need for expensive pipe handling equipment.
Long standard lengths (6, 12 and 18 meters)	Fewer joints reduce installation time. More pipe per transport vehicle means lower delivery cost.
Extremely smooth bore	Low friction loss means less pumping energy needed and lower operating costs. Minimum slime build-up can help lower cleaning costs.
Precision FLOWTITE AFIL coupling with elastomeric REKA gaskets	Tight efficient joints designed to eliminate infiltration and exfiltration. Ease of joining, reducing installation time. Accommodates small changes in line direction without fittings.
Flexible manufacturing process	Custom diameters can be manufactured to provide maximum flow volumes with ease of installation for rehabilitation lining projects.
High technology pipe design	Lower wave celerity than other piping materials can mean less cost when designing for surge and water hammer pressures.
High technology pipe manufacturing system producing pipe that complies to stringent performance standards (AWWA, ASTM, BS, SASO, etc...)	High and consistent product quality worldwide which ensures reliable product performance.

2.2 Performance Standards

Standards developed by ASTM, AWWA, BS, SASO and ISO are applied to a variety of fiberglass pipe applications including conveyance of sanitary sewage, water and industrial waste. A thread common to all of the product performance based documents. This means that all the requried performance and testing of the pipe is specified.



ASTM

Currently, there are several ASTM Product Standards in use which apply to a variety of fiberglass pipe applications. All product standards apply to pipe with diameter ranges of 200 mm to 3600 mm and require the flexible, joints to withstand hydrostatic testing in configurations (per ASTM D4161) that simulate exaggerated in-use conditions. These standards include many tough qualification and quality control tests. AFIL pipe is designed to meet all of these ASTM standards.

ASTM	D3262	Gravity Sewer
ASTM	D3517	Pressure Pipe (Water)
ASTM	D3754	Pressure Sewer

ISO and EN Standards

The International Standards Organization (ISO) and the Committee for European Normalization (CEN) are actively drafting product standards and corresponding test methods. Flowtite / Amiantit Technology is participating in the development of these standards, thereby ensuring performance requirements in reliable products.

AWWA

AWWA C950 is one of the most comprehensive product standards in existence for fiberglass pipe. This standard for pressure water applications has extensive requirements for pipe and joints, concentrating on quality control and prototype qualification testing. Like ASTM standards, this is a product performance standard. AFIL pipe is designed to meet the performance requirements of this standard. AWWA has issued a new standards manual, M-45, which includes several chapters on the design of GRP pipe for buried and aboveground installations.

AWWA	C950	Fiberglass Pressure Pipe
AWWA	M45	Fiberglass Pipe Design Manual

SASO

Recently, Saudi Arabian Standards Organization (SASO) approved the following standards for the application of GRP Pipes

SASO-1577	Gravity Sewer
SASO-1578	Pressure Sewer

3 Control and Qualification Testing

Raw Materials

Raw materials are delivered with vendor certification demonstrating their compliance with AFIL quality requirements. In addition, all raw materials are sample tested prior to their use. These tests ensure pipe materials' compliance with the stated specifications.

Finished Pipe

All pipes are subjected to the following control checks:

- Visual inspection
- Barcol hardness
- Wall thickness
- Section length
- Diameter
- Hydrostatic leak tightness test to 1.5 times rated pressure (only PN6 and above)

Physical Properties

The manufactured pipes' hoop and axial load capacities are verified on a routine basis. In addition, pipe construction and composition are confirmed.

On a sampling basis, the following control checks are performed:

- Pipe stiffness
- Deflection without damage or structural failure
- Axial and circumferential tensile load capacity
- Loss of Ignition (LOI)

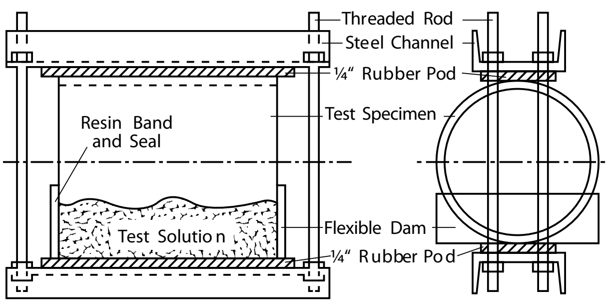


Figure 3-1 Strain Corrosion test apparatus

A common element shared by all standards is the need for a pipe manufacturer to demonstrate compliance with the standards' minimum performance requirements. In the case of GRP pipe, these minimum performance requirements fall into both short-term and long-term requirements. The most important of these, and generally specified at the same level of performance in all the previously defined standards is joint, initial ring deflection, long-term ring bending, long-term pressure and strain corrosion capability. AFIL pipe has been rigorously tested to verify conformance to the ASTM D3262, ASTM D3517, AWWA C950 and DIN 16868 requirements.

Strain Corrosion Testing

A unique and important performance requirement for GRP gravity pipe used in sewer applications is the chemical testing. of the pipe in a deflected or strained condition. This strain corrosion testing is carried out in accordance with ASTM D3681, and requires a minimum of 18 ring samples of the pipe to be deflected to various levels and held constant. These strained rings are then exposed at the invert of the interior surface to 1.0N (5% by weight) sulfuric acid ***(see Figure 3-1)***. This is intended to simulate a buried septic sewer condition. This has been shown to be representative of the worst sewer conditions including those found in the Middle East, where many AFIL pipes have been successfully installed. The time to failure (leakage) for each test sample is measured. The minimum extrapolated failure strain at 50 years, using a least square regression analysis of the failure data, must equal the values shown for each stiffness class. The value achieved is then relatable to the pipe design to enable prediction of safe installation limitations for GRP pipe used for this type of service. Typically this is 5% in-ground long-term deflections.

Stiffness Class	Scv. Strain, %
SN 2500	.49 (t/d)
SN 5000	.49 (t/d)
SN 10000	.49 (t/d)

Table 3-1 Minimum Strain corrosion value

Hydrostatic Design Basis - HDB

Another important qualification test is the establishment of the Hydrostatic Design Basis -HDB. This test is carried out in accordance with ASTM D2992 Procedure B and requires hydrostatic pressure testing to failure (leakage) of many pipe samples at a variety of very high constant, pressure levels. As in the previously described strain corrosion test, the resulting data is evaluated on a log-log basis for pressure (or hoop tensile strain) vs. Time to failure and then extrapolated to 50 years. The extrapolated failure pressure (strain) at 50 years, referred to as the hydrostatic design basis (strain) or HDB, must be at least 1.8 times the rated pressure class (strain at the rated pressure) ***(see Figure 3.2)***. In other words, the design criteria requires that the average pipe be capable of withstanding a constant pressure of 1.8 times the maximum operating condition for 50 years. Due to combined loading considerations, that is the interaction of internal pressure and external soil loads; the actual long-term factor of safety against pressure failure alone is higher than 1.8. This qualification test helps assure the long-term performance of the pipe in pressure service.

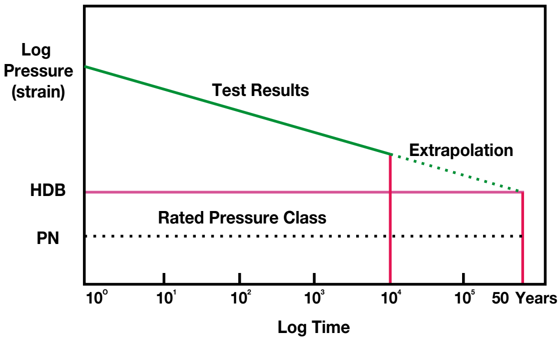


Figure 3-2 Test Results evaluation -ASTM Test procedure B

Joint Testing

This important qualification test is conducted on joint prototypes for elastomeric gasket sealed couplings. This is a severe test carried out in accordance with ASTM D4161. It incorporates some of the most stringent joint performance requirements in the piping industry for pipe of any material within the pressure and size ranges of AFIL pipe. ASTM D4161 requires these flexible joints to withstand hydrostatic testing in configurations that simulate every severe in-use conditions. Pressures used are twice those rated mid 100kPa (1 bar) is used for gravity flow pipe. Joint configurations include straight alignment, maximum angular rotation and differential shear loading. A partial vacuum test and some cyclical pressure tests are also included.

Initial Ring Deflection

All pipes must meet the initial ring deflection levels of no visual evidence of cracking or crazing (Level A) and no structural damage to the pipe wall (Level B) when vertically deflected between two parallel flat plates or rods.

Deflection Level	Stiffness Class SN		
	2500	5000	10000
A	15%	12%	9%
B	25%	20%	15%

Table 3-2 Initial ring deflection

Long-Term Ring Bending

A GRP pipe's long-term (50 year) ring deflection or ring bending (strain) capability, when exposed to an aqueous environment and under a constant load, must meet the Level A deflection level specified in the initial ring deflection test. AWWA C950 requires the test to be carried out, with the resulting 50-year predicted value used in the pipes' design. AFIL pipe is tested using the guidelines of ASTM D5365 "Long-Term Ring Bending Strain of Fiberglass Pipe" and meets both requirements.

Potable Water and Fire Fighting System Approvals

AFIL pipe has been tested and approved for the conveyance of potable water meeting many of the world's leading authorities' and testing institutes' criteria, including NSF (National Sanitation Foundation) Standard No.61. Additionally, AFIL pipe has been tested and approved for the conveyance of fire fighting system by FM (Factory Mutual Research).

4 Product Scope - Technical Data

Diameters

AFIL pipe can be supplied in the following nominal diameters* (mm)

80	350	800	1800	2800	3400	4000
100	400	900	2000	2900	3500	
150	450	1000	2400	3000	3600	
200	500	1200	2500	3100	3700	
250	600	1400	2600	3200	3800	
300	700	1600	2700	3300	3900	

*Other pipe ranges are available, consult Amiantit Fiberglass Ind. Ltd.

Table 4-1 Standard diameter range AFIL pipes

Lengths

The standard length of AFIL pipe is 12 meters for diameters over 300 mm. Lengths of 6 and 18 meters are also available. Smaller diameters are only available in 6-meter standard lengths.

Load Capacity Values

For design purposes the following values can be used for hoop tensile and axial tensile load capacity.

Hoop Tensile Load Capacity

Minimum initial hoop (circumferential) load, N per mm of length. As shown in the ***Table 4-3***.

Axial Tensile Load Capacity

Minimum initial axial (longitudinal) load, N per mm of circumference. As shown in the ***Table 4-4***.

Fittings And Accessories

All commonly used fittings or accessories can be supplied such as bends, tees, wyes, (gravity only) and reducers.

Stiffness Class

Flowtite pipe can be supplied to the following specific initial stiffness (EI/D^3) (STIS).

Stiffness Class SN	Stiffness (N/m^2)	Stiffness (ASTM) (psi)
2500	2500	18
5000	5000	36
10000	10000	72

Table 4-2 Standard stiffness classes

Hoop Tensile Load Capacity (N/mm)							
DN	PN1	PN6	PN10	PN16	PN20	PN25	PN32
80	N/A	89	178	238	269	N/A	N/A
100	N/A	119	238	318	358	N/A	N/A
150	N/A	178	357	477	538	N/A	N/A
200	N/A	238	476	636	717	N/A	N/A
250	N/A	297	595	795	896	N/A	N/A
300	N/A	357	714	950	1076	N/A	N/A
350	70	420	400	1120	1400	1750	2240
400	80	480	800	1280	1600	2000	2560
450	90	540	900	1440	1800	2250	2880
500	100	600	1000	1600	2000	2500	3200
600	120	720	1200	1920	2400	3000	3840
700	140	840	1400	2240	2800	3500	4480
800	160	960	1600	2560	3200	4000	5120
900	180	7080	1800	2880	3600	4500	5760
1000	200	1200	2000	3200	4000	5000	6400
1200	240	1440	2400	3840	4800	6000	7680
1400	280	1680	2800	4480	5600	7000	8960
1600	320	1920	3200	5120	N/A	N/A	N/A
1800	360	2160	3600	5760	N/A	N/A	N/A
2000	400	2400	4000	6400	N/A	N/A	N/A
2400	480	2880	4800	7680	N/A	N/A	N/A
2500	500	3000	5000	8000	N/A	N/A	N/A

Table 4-3 Hoop tensile load capacity (N/mm)

Axial Tensile Load Capacity (N/mm)							
DN	PN1	PN6	PN10	PN16	PN20	PN25	PN32
80	N/A	89	178	238	269	N/A	N/A
100	N/A	119	238	318	358	N/A	N/A
150	N/A	178	357	477	538	N/A	N/A
200	N/A	238	476	636	717	N/A	N/A
250	N/A	297	595	795	896	N/A	N/A
300	N/A	357	714	950	1076	N/A	N/A
350	70	420	400	1120	1400	1750	2240
400	80	480	800	1280	1600	2000	2560
450	90	540	900	1440	1800	2250	2880
500	100	600	1000	1600	2000	2500	3200
600	120	720	1200	1920	2400	3000	3840
700	140	840	1400	2240	2800	3500	4480
800	160	960	1600	2560	3200	4000	5120
900	180	7080	1800	2880	3600	4500	5760
1000	200	1200	2000	3200	4000	5000	6400
1200	240	1440	2400	3840	4800	6000	7680
1400	280	1680	2800	4480	5600	7000	8960
1600	320	1920	3200	5120	N/A	N/A	N/A
1800	360	2160	3600	5760	N/A	N/A	N/A
2000	400	2400	4000	6400	N/A	N/A	N/A
2400	480	2880	4800	7680	N/A	N/A	N/A
2500	500	3000	5000	8000	N/A	N/A	N/A

Table 4-4 Axial tensile load capacity (N/mm)

Pressure

Pressure classes of AFIL pipe shall be selected from the series listed below. Not all pressure classes are available in all diameters and stiffnessess.

Pressure Class PN	Pressure Rating* Bar	Upper Diameter Limit, mm
1 (Gravity)	1	4000
6	6	4000
10	10	3700
16	16	2000
20	20	1400
25	25	1400
32	32	1400

* other pressure ratings are available, please consult AFIL

Table 4-5 Available pressure classes per diameter

The pipe's pressure ratings have been established in accordance with the design approach outlined in AWWA M-45, Fiberglass Pipe Design Manual. Pipes are pressure rated at full operating pressure even when buried to the maximum depth recommended. To insure the long service life for which AFIL pipe is designed, the following capabilities should be noted and observed in service.

Hydrotesting	
Standard Factory Test Pressure	DN $\leq$ 1500 = 1.5 x PN DN > 1500 = 1.0 x PN
Maximum Field Test Pressure	1.5 x PN

Table 4-6 Hydrotesting pressure testing

Surge	
Allowable Surge Pressure	1.4 x PN (Pressure Class)

Table 4-7 Surge pressure testing

Flow Velocity

Maximum recommended flow velocity is 3.0 m/s. Velocities of up to 4 m/s can be used if the water is clean and contains no abrasive material.

UV Resistance

There is no evidence to suggest that ultraviolet degradation is a factor that affects the long-term service life of AFIL pipes. The outermost surface will be affected with discoloring of the surface observed. If so desired, the installing contractor may paint the exterior surface of AFIL pipe with a two-part urethane paint compatible with GRP. However, this will then become an item requiring future maintenance.

Poisson's Ratio

Poisson's ratio is influenced by the pipe construction. For AFIL pipe, the ratio for hoop (circumferential) loads and axial response ranges from 0.22 to 0.29. For axial loading and circumferential response Poisson's ratio will be slightly less.

Thermal Coefficient

The thermal coefficient of axial expansion and contraction for AFIL pipe is 24 to 30 x 10^{-6} cm/cm°C.

Hydraulic Characteristics

Amiantit Fiberglass Ind. Ltd. (AFIL) produces GRP pipes by continuous filament winding machines, by reproducible processes. All these pipes are provided with resin rich interior layers, providing very smooth inner surfaces. This smooth interior surface results in very low fluid resistance.

For hydraulic analysis of the every piping system, pipe roughness is the concern. One of the FAQ by the Hydraulic Engineers / Consultants / Contractors / Clients is what the value of GRP pipe roughness is.

This roughness is being used in various forms in various equations of hydraulic analysis. Find below the summary of the mean value based on the experimental studies.

These values are based on the experimental studies carried out by Owens Corning and SINTEFF from Norway. Complete report is available upon request.
In fact AWWA C-950 also recommends for the usage of

similar values. This confirms that above values are in good agreement even with the international standards.

Apart from above, the interior pipe surfaces, typically remains smooth over time, in most fluid services. Therefore, fluid resistance will not increase with age. This has been demonstrated, when few GRP pipes under operation over the decade were inspected and evaluated. Certificate from respective authorities is available upon request confirming no deterioration.

AFIL is capable of carrying out Hydraulic Calculations using state of the art commercially available software PIPENET. As guide lines to designer ***Figures 4-1*** and ***4.2*** will provide typical head losses for LDP and SDP.

Please consult AFIL for any additional Hydraulic Requirements and clarifications and AFIL is happy to assist you in any way to suite your requirements.

Abrasion Resistance

Abrasion resistance can be related to the effects that sand or other similar material may have on the interior surface of the pipe.
While there is no widely standardized testing procedure or ranking method, FLOWTITE AFIL pipe has been evaluated by using the Darmstadt Rocker method. Results will be highly influenced by the type of abrasive material used in the test.
Using gravel which was obtained from the same source as that used at Darmstadt University, the average abrasion loss of AFIL pipe is 0.34 mm at 100,000 cycles.

Flow Rate (m^3/hr)	Colebrook - White ε or K (mm)	Manning M ($m^{1/3}$/s)	Hazen - Williams C ($10^{-1.38}m^{0.37}$/s)
1410-2860	0.029	104	146

Table 4-8 Roughness Parameters (mean values)

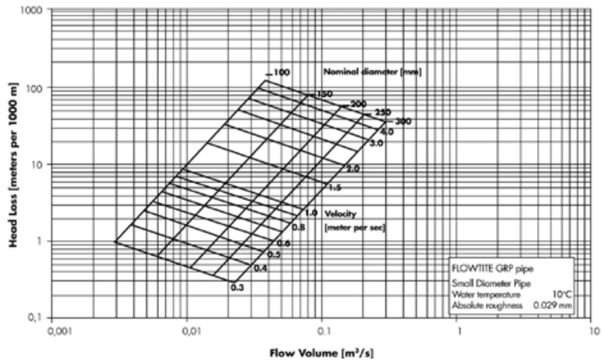


Figure 4-1 Head Loss – Small Diameters

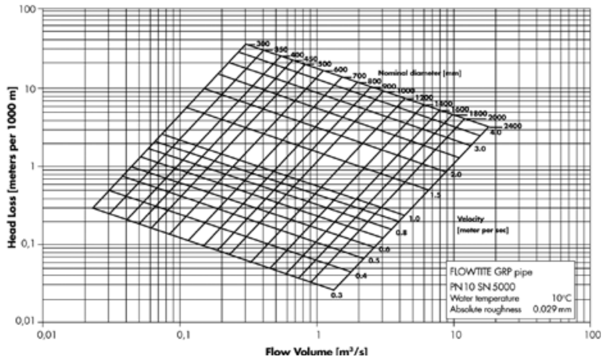


Figure 4-2 Head Loss – Large Diameters

5 Production Process

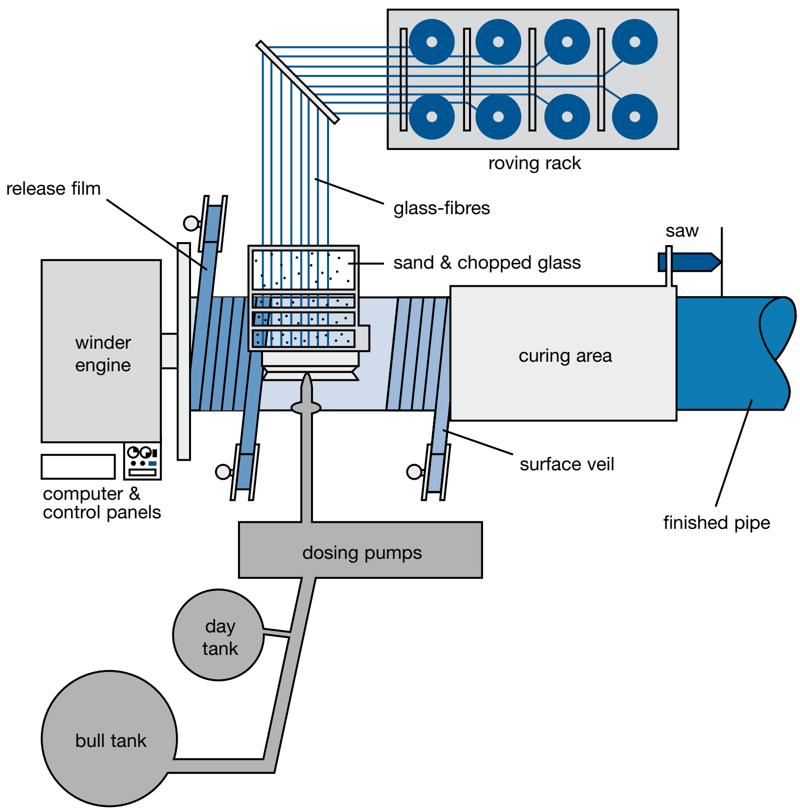
FLOWTITE pipes are manufactured using the continuous advancing mandrel process which represents the state of the art in GRP pipe production. This process allows the use of continuous glass fibre reinforcements in the circumferential direction. For a pressure pipe or buried conduit the principle stress is in the circumferential direction, thus incorporating continuous reinforcements in this direction yields a higher performing product at lower cost. Using technology developed by material specialists, a very compressed laminate is created that maximizes the contribution from the three basic raw materials. Both continuous glass fibre rovings and choppable roving are incorporated for high hoop strength and axial reinforcement. A sand fortifier is used to provide increased stiffness by adding extra thickness, placed near the neutral axis in the core. With the FLOWTITE dual resin delivery system, the equipment has the capability of applying a special inner resin liner for severely corrosive applications while utilising a standard type resin for the structural and outer portion of the laminate.

Taking advantage of the winding process, other materials such as a glass veil or a polyester veil can be used to enhance the abrasion, the chemical resistance and the finishing of the pipe. To assure a consistently high level of product quality, it is essential that the method of fabrication be accurately controlled.

The FLOWTITE filament winding machine represents the most advanced state-of-the-art technology in use, and is the foremost method of manufacturing glass fibre pipe. Simply put, this manufacturing machine consists of a continuous steel band mandrel supported by beams in a cylindrical shape.

As the beams turn, friction pulls the steel band around and a roller bearing allows the band to move longitudinally so that the entire mandrel moves continuously in a spiral path towards the exit assembly. As the mandrel rotates, all composite materials are metered onto it in precise amounts. Electronic sensors provide continuous production parameter feedback so that the various feeding systems apply the right amount of material. This ensures that the amount of material needed to build the different layers is applied throughout the manufacturing stage. Firstly, mould-release film, followed by various forms and patterns of glass fibres, embedded in a polyester resin matrix. The structural layers are made of glass and resin only, whereas the core layer includes pure silica. It is the continuous application of these materials onto the mandrel which forms the pipe.

After the pipe has been formed on the mandrel, it is cured and later cut to the required length. The ends of the pipe section are calibrated to fit the coupling.



6 Surge & Water Hammers

Water hammer or pressure surge is the sudden rise or fall in pressure caused by an abrupt change in the fluid velocity within the pipe system. The usual cause of these flow changes is the rapid closing or opening of valves or sudden starting or stopping of pumps such as during a power failure. The most important factors which influence the water hammer pressure in a pipe system are the change in velocity of the fluid, rate of change of the velocity (valve closing time), compressibility of the fluid, stiffness of the pipe in the circumferential “hoop” direction and the physical layout of the pipe system.

The water hammer pressure expected for FLOWTITE pipe is approximately 50% of that for steel and ductile iron pipe under similar conditions. FLOWTITE pipe has a surge pressure allowance of 40% of the nominal pressure. An approximate relationship for the maximum pressure variation at a given point in a straight pipeline with negligible friction loss can be calculated with the formula:

$$\Delta H = (w \Delta v)/g$$

where:

ΔH = change in pressure (m)

w = surge wave celerity (m/s)

Δv = change in liquid velocity (m/s)

g = acceleration due to gravity (m/s^2)

Note: There has been some rounding, within 2%, in the above values. Please contact your FLOWTITE supplier if more accurate values are required for a transient analysis.

DN	300-400	450-800	900-2500	2800-3000
		SN 2500		
PN 6	365	350	340	330
PN 10	435	420	405	390
PN 16	500	490	480	470
		SN 5000		
PN 6	405	380	370	360
PN 10	435	420	410	
PN 16	505	495	480	
PN 25	575	570	560	
		SN 10000		
PN 6	420	415	410	400
PN 10	435	425	415	
PN 16	500	495	485	
PN 25	580	570	560	
PN 32	620	615	615	

Table 6-1 Surge Wave Celerity for FLOWTITE Pipes (m/s)

DN	100	125	150	200	250
			SN 10000		
PN 6	580	560	540	520	500
PN 10	590	570	560	540	520
PN 16	640	620	610	600	590

Table 6-2 Surge Wave Celerity for Small Diameter Pipes (m/s)

7 Pipe Classification

Stiffness

The stiffness of AFIL pipe is selected from one of the three stiffness classes listed below. The stiffness class represents the pipe's minimum initial specific stiffness (EI/D^3) in N/m^2. Other stiffness classes (12500 Pa) are available upon request.

Stiffness Class SN	Stiffness (N/m^2)	Stiffness (ASTM) (psi)
2500	2500	18
5000	5000	36
10000	10000	72

Table 7-1 Standard stiffness classes

Stiffness is selected according to two parameters. These are:

1. burial conditions, which include native soil, type of backfill, cover depth and
2. negative pressure, if it exists.

The native soil characteristics are rated according to ASTM D1586 Standard Penetration Test. Some typical soil blow count values relative to soil type and density are given in ***Table 7-2***. A wide range of backfill soil type are offered in ***Table 11-2*** to allow each installation to be customized providing the most economical installation. In many instances, the native trench soils can be used as pipe zone backfill. Assuming standard trench construction, and an allowable long-term deflection of 5% for pipe diameters 300 mm and larger, and 4% for smaller diameters, the maximum allowable cover depths, with consideration for traffic loads, for the three different stiffness classes in the six native soil groups are given in ***Table 11-3*** (page 28). The correlation between the backfill soil modulus and different backfill soil types at four different levels of relative compaction may be found in ***Table 11-4***. The second parameter for pipe stiffness class selection is negative pressure, if it exists. ***Table 11-7*** shows which stiffness to select for various amounts of negative pressure and burial depths for average native and backfill soil conditions. The stiffness selected should be the higher of that determined to suit negative pressure and burial conditions.

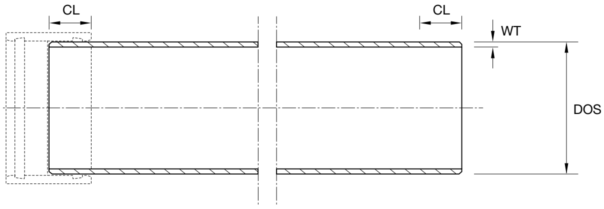
Installation Types

The illustrations on Page 32 show the standard installation types commonly used with AFIL pipe. Alternate installations to accommodate a specific field condition include wider trenches, sheet piles, soil stabilization, geotextiles, etc. The Pipe Installation Instructions for Buried Pipe should be consulted for additional details. Amiantit fiberglass pipe can be installed in a number of different situations including above ground, sub-aqueous, trenchless and sloped applications. These applications can require more initial planning and more care than the standard buried pipe installation and therefore Amiantit Fiberglass has developed specific instructions for these methods. Please contact Amiantit fiberglass for these detailed instructions.

			Non-Cohesive Soils		Cohesive Soils	
Native Soil Group	Blow Counts	E'n value (MPa)	Description	Friction Angle (degrees)	Description	Unconfined Comp Strength (kpa)
1	>15	34.5	compact	33	very stiff	192-384
2	8-15	20.7	slightly compact	30	stiff	76-192
3	4-8	10.3	loose	29	medium	48-96
4	2-4	4.8	very loose	28	soft	24-48
5	1-2	1.4	very loose	27	very soft	12-24
6	0-1	0.34	very, very loose	26	very, very soft	0-12

Table 7-2 Native soil group classification

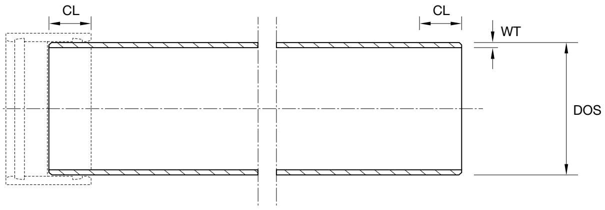
8 Pipe Dimensions



Nom. Diameter (mm)	DOS Min (mm)	DOS Max (mm)	3 bar (mm)	6 bar (mm)	9 bar (mm)	10 bar (mm)	12 bar (mm)	15 bar (mm)	16 bar (mm)	20 bar (mm)	25 bar (mm)	32 bar (mm)	Weight (kg/m)
80	98.9	99.4	-	-	-	-	-	-	-	-	-	-	2.22
100	118.9.	119.4	-	-	-	-	-	-	-	-	-	-	2.68
150	170.9	171.4	-	-	-	-	-	-	-	-	-	-	5.12
200	222.3	222.8	-	-	-	-	-	-	-	-	-	-	7.46
250	273.6	274.1	-	-	-	-	-	-	-	-	-	-	11.20
300	325.2	325.7	-	-	-	-	-	-	-	-	-	-	15.46
350	378	379	4.72	4.72	4.62	4.55	4.47	4.42	4.41	4.44	-	-	11.50
400	412	413	5.14	5.14	4.95	4.92	4.82	4.75	4.74	4.77	-	-	13.76
450	463	464	5.78	5.78	5.47	5.45	5.32	5.23	5.27	5.25	-	-	17.59
500	514	515	6.44	6.44	6.04	5.95	5.82	5.77	5.76	5.73	-	-	21.95
600	616	617	7.84	7.84	7.07	6.97	6.82	6.74	6.72	6.68	-	-	32.05
700	718	719	9.02	9.02	8.14	8.01	7.85	7.71	7.68	7.63	-	-	43.20
800	820	821	10.08	10.08	9.20	9.07	8.85	8.67	8.64	8.57	-	-	56.05
900	922	923	11.26	11.26	10.30	10.11	9.83	9.63	9.59	9.52	-	-	70.71
1000	1024	1025	12.46	12.46	11.38	11.14	10.83	10.59	10.54	10.46	-	-	87.15
1100	1126	1127	13.66	13.66	12.40	12.16	11.81	11.55	11.50	11.40	-	-	105.27
1200	1228	1229	14.78	14.78	13.46	13.18	12.80	12.50	12.45	12.35	-	-	124.46
1300	1330	1331	15.98	15.98	14.54	14.20	13.80	13.46	13.40	13.29	-	-	146.05
1400	1432	1433	17.12	17.12	15.56	15.23	14.77	14.42	14.36	14.23	-	-	168.64
1500	1534	1535	18.20	18.20	16.61	16.22	15.75	15.38	15.31	15.17	-	-	192.34
1600	1636	1637	19.43	19.43	17.65	17.28	16.74	16.34	16.26	16.11	-	-	219.26
1700	1738	1739	20.76	20.76	18.69	18.29	17.72	17.28	17.21	17.06	-	-	249.15
1800	1840	1841	21.91	21.91	19.76	19.31	18.71	18.25	18.17	18.00	-	-	278.73
1900	1942	1943	23.03	23.03	20.78	20.31	19.71	19.20	19.12	18.94	-	-	309.35
2000	2044	2045	24.21	24.21	21.83	21.36	20.69	20.16	20.06	19.88	-	-	342.54
2100	2146	2147	25.37	25.37	22.90	22.38	21.68	21.12	21.02	20.82	-	-	377.20
2200	2248	2249	26.54	26.54	23.91	23.39	22.65	22.08	21.97	21.76	-	-	413.43
2300	2350	2351	27.70	27.70	25.00	24.43	23.65	23.03	22.92	22.70	-	-	451.42
2400	2452	2453	28.86	28.86	26.05	25.42	24.63	23.99	23.87	23.65	-	-	491.09
2500	2554	2555	29.97	29.97	27.09	26.46	25.61	24.95	24.82	24.59	-	-	531.21
2600	2656	2657	31.20	31.20	28.13	27.50	26.60	25.91	25.80	25.53	-	-	565.80
2700	2758	2759	32.40	32.40	29.15	28.50	27.58	26.87	26.70	26.47	-	-	609.80
2800	2860	2861	33.50	33.50	30.23	29.50	28.55	27.82	27.70	27.41	-	-	654.10
2900	2962	2963	34.60	34.60	31.28	30.50	29.55	28.77	28.60	28.35	-	-	701.70
3000	3064	3065	35.90	35.90	32.33	31.60	30.54	29.73	29.60	29.29	-	-	751.70
3100	3166	3167	36.90	36.90	33.40	32.55	31.52	30.69	30.54	-	-	-	800.00
3200	3268	3269	38.10	38.10	34.40	33.59	32.52	31.65	31.48	-	-	-	852.90
3300	3370	3371	39.30	39.30	35.50	34.62	33.49	32.61	32.43	-	-	-	907.50
3400	3472	3473	40.40	40.40	36.50	35.65	34.49	33.55	33.39	-	-	-	962.00
3500	3574	3575	41.60	41.60	37.50	36.65	35.47	34.52	34.34	-	-	-	1019.50
3600	3676	3677	42.80	42.80	38.60	37.70	36.45	-	-	-	-	-	1078.70
3700	3778	3779	44.00	44.00	39.60	38.70	37.42	-	-	-	-	-	1139.00
3800	3880	3881	45.10	45.10	40.70	39.73	38.42	-	-	-	-	-	1198.80
3900	3982	3983	46.30	46.30	41.80	40.76	39.40	-	-	-	-	-	1263.80
4000	4084	4085	47.50	47.50	42.80	41.76	40.39	-	-	-	-	-	1330.10

Table 8-1 Pipe Thickness 2,500 STIS

! **Note:** Measurements in mm unless otherwise noted.
Pipe weights are based primarily on Class PN6, which is the heaviest product.

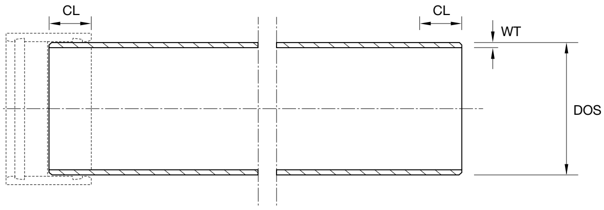


Nom. Diameter (mm)	DOS Min (mm)	DOS Max (mm)	3 bar (mm)	6 bar (mm)	9 bar (mm)	10 bar (mm)	12 bar (mm)	15 bar (mm)	16 bar (mm)	20 bar (mm)	25 bar (mm)	32 bar (mm)	Weight (kg/m)
80	98.9	99.4	-	-	-	-	-	-	-	-	-	-	2.22
100	118.9	119.4	-	-	-	-	-	-	-	-	-	-	2.68
150	170.9	171.4	-	-	-	-	-	-	-	-	-	-	5.12
200	222.3	222.8	-	-	-	-	-	-	-	-	-	-	7.46
250	273.6	274.1	-	-	-	-	-	-	-	-	-	-	11.20
300	325.2	325.7	-	-	-	-	-	-	-	-	-	-	15.46
350	378	379	5.93	5.93	5.88	5.78	5.60	5.46	5.41	5.35	5.3	-	14.75
400	412	413	6.49	6.49	6.33	6.19	6.02	5.88	5.83	5.81	5.9	-	17.69
450	463	464	7.29	7.29	7.01	6.94	6.70	6.50	6.46	6.42	6.5	-	22.50
500	514	515	8.11	8.11	7.70	7.62	7.33	7.11	7.14	7.02	7.1	-	27.95
600	616	617	9.63	9.63	9.15	8.94	8.63	8.45	8.38	8.23	8.2	-	40.08
700	718	719	11.12	11.12	10.56	10.32	10.03	9.69	9.63	9.43	9.3	-	54.17
800	820	821	12.54	12.54	11.54	11.64	11.35	10.95	10.86	10.64	10.5	-	70.08
900	922	923	14.01	14.01	13.39	13.16	12.63	12.18	12.09	11.84	11.7	-	88.26
1000	1024	1025	15.44	15.44	14.80	14.53	13.95	13.42	13.33	13.04	12.9	-	108.20
1100	1126	1127	16.92	16.92	16.32	15.89	15.27	14.69	14.55	14.25	14.1	-	130.71
1200	1228	1229	18.32	18.32	17.77	17.28	16.56	15.92	15.78	15.45	15.3	-	154.55
1300	1330	1331	19.92	19.92	19.15	18.63	17.86	17.15	17.02	16.65	16.50	-	182.27
1400	1432	1433	21.36	21.36	20.56	19.97	19.17	18.42	18.26	17.85	17.70	-	210.66
1500	1534	1535	22.88	22.88	22.01	21.35	20.45	19.66	19.48	19.05	18.84	-	242.13
1600	1636	1637	24.30	24.30	23.37	22.74	21.74	20.91	20.71	20.25	20.02	-	274.47
1700	1738	1739	25.80	25.80	24.83	24.09	23.05	22.16	21.95	21.45	21.21	-	309.86
1800	1840	1841	27.28	27.28	26.21	25.45	24.38	23.38	23.17	22.65	22.39	-	347.05
1900	1942	1943	28.71	28.71	27.62	26.82	25.66	24.63	24.40	23.85	23.58	-	385.71
2000	2044	2045	30.14	30.14	29.07	28.18	26.97	25.88	25.65	25.05	24.76	-	426.38
2100	2146	2147	31.62	31.62	30.43	29.53	28.26	27.14	26.87	26.25	25.95	-	469.96
2200	2248	2249	33.10	33.10	31.89	30.90	29.57	28.37	28.10	27.45	27.13	-	515.52
2300	2350	2351	34.51	34.51	33.27	32.31	30.84	29.61	29.33	28.65	28.32	-	562.12
2400	2452	2453	35.97	35.97	34.68	33.66	32.19	30.86	30.57	29.85	29.50	-	611.55
2500	2554	2555	37.49	37.49	36.13	35.03	33.46	32.11	31.79	31.05	-	-	664.33
2600	2656	2657	38.90	38.90	36.29	36.40	34.79	33.33	33.00	32.25	-	-	706.10
2700	2758	2759	40.30	40.30	37.75	37.70	36.06	34.60	34.30	33.45	-	-	759.90
2800	2860	2861	41.80	41.80	39.13	39.10	37.39	35.83	35.50	34.65	-	-	817.60
2900	2962	2963	43.30	43.30	40.54	40.50	38.67	37.09	36.70	35.85	-	-	877.20
3000	3064	3065	44.80	44.80	41.99	41.80	39.98	38.32	38.00	37.05	-	-	937.60
3100	3166	3167	46.20	46.20	44.54	43.24	41.28	39.56	39.19	-	-	-	1000.20
3200	3268	3269	47.70	47.70	46.01	44.58	42.61	40.81	40.42	-	-	-	1065.30
3300	3370	3371	49.10	49.10	47.39	45.97	43.91	42.06	41.64	-	-	-	1133.10
3400	3472	3473	50.60	50.60	48.79	47.29	45.20	43.31	42.89	-	-	-	1203.10
3500	3574	3575	52.00	52.00	50.25	48.71	46.51	44.55	44.12	-	-	-	1272.90
3600	3676	3677	53.50	53.50	51.60	50.06	47.80	-	-	-	-	-	1345.00
3700	3778	3779	*55.00	*55.00	53.07	51.44	49.12	-	-	-	-	-	1423.00
3800	3880	3881	*56.50	*56.50	54.45	52.81	50.40	-	-	-	-	-	1500.30
3900	3982	3983	*57.90	*57.90	*55.85	54.17	51.72	-	-	-	-	-	1579.00
4000	4084	4085	*59.40	*59.40	*57.30	*55.51	52.99	-	-	-	-	-	1660.80

Table 8-2 Pipe Thickness 5,000 STIS

*An appropriate design shall be considered based on the constraints.

! **Note:** Measurements in mm unless otherwise noted.
Pipe weights are based primarily on Class PN6, which is the heaviest product.



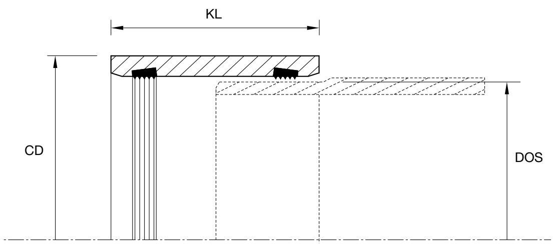
Nom. Diameter (mm)	DOS Min (mm)	DOS Max (mm)	3 bar (mm)	6 bar (mm)	9 bar (mm)	10 bar (mm)	12 bar (mm)	15 bar (mm)	16 bar (mm)	20 bar (mm)	25 bar (mm)	32 bar (mm)	Weight (kg/m)
80	98.9	99.4	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	-	-	2.22
100	118.9	119.4	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	-	-	2.68
150	170.9	171.4	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	-	-	5.12
200	222.3	222.8	5.30	5.30	5.30	5.30	5.30	5.30	5.30	5.30	-	-	7.46
250	273.6	274.1	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	-	-	11.20
300	325.2	325.7	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	5.70	5.70	15.46
350	378	379	7.16	7.16	7.16	7.16	7.16	6.91	6.81	6.65	6.50	6.50	17.88
400	412	413	7.84	7.84	7.84	7.84	7.80	7.45	7.36	7.20	7.30	7.20	21.47
450	463	464	8.78	8.78	8.78	8.78	8.67	8.26	8.18	8.02	8.10	8.00	27.17
500	514	515	9.78	9.78	9.78	9.78	9.55	8.94	9.02	8.81	8.90	8.70	33.78
600	616	617	11.71	11.71	11.71	11.71	10.83	10.85	10.73	10.36	10.10	10.00	48.82
700	718	719	13.68	13.68	13.68	13.68	13.02	12.49	12.34	11.93	11.70	11.50	66.83
800	820	821	15.53	15.53	15.53	15.53	14.89	14.14	13.95	13.48	13.20	13.00	86.90
900	922	923	17.32	17.32	17.32	17.32	16.64	15.78	15.61	15.05	14.70	14.50	109.24
1000	1024	1025	19.25	19.25	19.25	19.25	18.43	17.45	17.23	16.60	16.20	16.00	135.04
1100	1126	1127	21.15	21.15	21.15	21.15	20.18	19.08	18.86	18.17	17.70	17.50	163.49
1200	1228	1229	22.95	22.95	22.95	22.95	21.89	20.74	20.49	19.72	19.30	19.00	193.72
1300	1330	1331	24.82	24.82	24.82	24.82	23.67	22.42	22.08	21.29	20.80	20.40	227.15
1400	1432	1433	26.65	26.65	26.65	26.65	25.41	24.06	23.74	22.86	22.30	21.90	262.86
1500	1534	1535	28.43	28.43	28.43	28.43	27.21	25.71	25.37	24.42	23.80	23.43	300.52
1600	1636	1637	30.33	30.33	30.33	30.33	28.91	27.36	26.99	25.98	25.31	24.92	342.32
1700	1738	1739	32.12	32.12	32.12	32.12	30.71	29.02	28.61	27.54	26.83	26.41	385.24
1800	1840	1841	33.99	33.99	33.99	33.99	32.47	30.65	30.26	29.10	28.34	27.90	431.84
1900	1942	1943	35.83	35.83	35.83	35.83	34.22	32.31	31.86	30.65	29.86	-	480.87
2000	2044	2045	37.60	37.60	37.60	37.60	35.97	33.97	33.49	32.20	31.39	-	531.21
2100	2146	2147	39.46	39.46	39.46	39.46	37.71	35.60	35.11	33.77	32.90	-	585.60
2200	2248	2249	41.30	41.30	41.30	41.30	39.43	37.25	36.74	35.32	34.42	-	642.25
2300	2350	2351	43.10	43.10	43.10	43.10	41.22	38.93	38.39	36.89	35.94	-	700.82
2400	2452	2453	44.90	44.90	44.90	44.90	42.99	40.56	40.01	38.43	37.45	-	762.00
2500	2554	2555	46.79	46.79	46.79	46.79	44.72	42.19	41.64	40.02	-	-	827.58
2600	2656	2657	48.60	48.60	48.65	48.60	46.47	43.88	43.20	41.55	-	-	880.70
2700	2758	2759	50.50	50.50	50.50	50.50	48.23	45.53	44.90	43.13	-	-	948.90
2800	2860	2861	52.30	52.30	52.31	52.30	49.99	47.16	46.50	44.69	-	-	1020.50
2900	2962	2963	54.10	54.10	54.10	54.10	51.77	48.81	48.10	46.25	-	-	1092.30
3000	3064	3065	*56.00	*56.00	*55.95	*56.00	53.52	50.47	49.80	47.81	-	-	1169.70
3100	3166	3167	*57.80	*57.76	*57.76	*57.76	*55.24	52.11	51.36	-	-	-	1247.90
3200	3268	3269	*59.60	*59.63	*59.63	*59.63	*57.01	53.78	53.01	-	-	-	1330.10
3300	3370	3371	*61.50	*61.49	*61.49	*61.49	*58.76	*55.44	54.65	-	-	-	1414.80
3400	3472	3473	*63.20	*63.25	*63.25	*63.25	*60.56	*57.08	*56.27	-	-	-	1499.40
3500	3574	3575	*65.20	*65.16	*65.16	*65.16	*62.26	*58.74	*57.89	-	-	-	1590.40
3600	3676	3677	*66.90	*66.94	*66.94	*66.94	*64.06	-	-	-	-	-	1680.80
3700	3778	3779	*68.70	*68.74	*68.74	*68.74	*65.81	-	-	-	-	-	1774.00
3800	3880	3881	*70.60	-	-	-	-	-	-	-	-	-	1873.00
3900	3982	3983	*72.40	-	-	-	-	-	-	-	-	-	1971.00
4000	4084	4085	*74.30	-	-	-	-	-	-	-	-	-	2073.50

Table 8-3 Pipe Thickness 10,000 STIS

*An appropriate design shall be considered based on the constraints.

! Note: Measurements in mm unless otherwise noted.
Pipe weights are based primarily on Class PN6, which is the heaviest product.

9 Coupling Dimensions



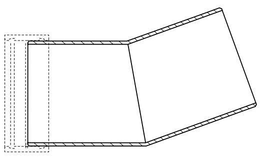
		CD						KL					
Diameter (mm)	DOS Min (mm)	6 bar (mm)	12 bar (mm)	18 bar (mm)	20 mm (mm)	25 bar (mm)	32 bar (mm)	6 bar (mm)	12 bar (mm)	18 bar (mm)	20 bar (mm)	25 bar (mm)	32 bar (mm)
80	99.4	121.2	121.2	123.2	-	-	-	150	150	150	-	-	-
100	119.4	141.2	141.2	143.2	-	-	-	150	150	150	-	-	-
150	171.4	193.2	193.2	195.2	-	-	-	150	150	150	-	-	-
200	222.8	249.4	249.4	259.0	-	-	-	150	150	150	-	-	-
250	274.1	307.2	307.2	310.8	-	-	-	175	175	175	-	-	-
300	325.7	358.8	358.8	362.0	-	-	-	175	175	175	-	-	-
350	379	420.3	421.9	423.7	421.9	421.9	421.9	270	270	270	270	270	270
400	413	454.1	456.1	458.1	459.7	461.1	465.5	270	270	270	270	270	270
450	464	504.9	506.5	508.7	510.3	511.5	516.1	270	270	270	270	270	270
500	515	555.7	557.5	559.3	560.7	561.9	567.9	270	270	270	270	270	270
600	617	664.1	665.9	668.1	670.3	673.3	680.3	330	330	330	330	330	330
700	719	765.9	768.3	772.5	775.3	778.5	788.7	330	330	330	330	330	330
800	821	867.7	871.7	876.7	879.9	881.1	893.3	330	330	330	330	330	330
900	923	970.7	975.1	980.9	981.9	986.1	980.9	330	330	330	330	330	330
1000	1025	1073.5	1078.5	1084.7	1086.3	1095.3	1084.7	330	330	330	330	330	330
1100	1127	1176.3	1181.5	1188.3	1190 3	1188 3	1188.3	330	330	330	330	330	330
1200	1229	1278.9	1284.5	1289.9	1296.3	1289.9	1289.9	330	330	330	330	330	330
1300	1331	1381.3	1387.3	1393.3	1404.1	1393.3	1393.3	330	330	330	330	330	330
1400	1433	1483.9	1490.1	1497.5	1497.5	1497.5	1497.5	330	330	330	330	330	330
1500	1535	1586.3	1592.9	1602.7	-	-	-	330	330	330	-	-	-
1600	1637	1688.7	1695.5	1707.3	-	-	-	330	330	330	-	-	-
1700	1739	1791.1	1798.3	-	-	-	-	330	330	330	-	-	-
1800	1841	1893.5	1900.9	-	-	-	-	330	330	330	-	-	-
1900	1943	1995.9	2003.3	-	-	-	-	330	330	330	-	-	-
2000	2045	2098.3	2105.9	-	-	-	-	330	330	330	-	-	-
2100	2147	2200.5	2208.9	-	-	-	-	330	330	330	-	-	-
2200	2249	2302.9	2311.9	-	-	-	-	330	330	330	-	-	-
2300	2351	2405.3	2414.7	-	-	-	-	330	330	330	-	-	-
2400	2453	2507.5	2517.9	-	-	-	-	330	330	330	-	-	-
2500	2555	2628.4	-	-	-	-	-	330	330	330	-	-	-
2600	2657	2730.5	-	-	-	-	-	330	330	330	-	-	-
2700	2759	2833.1	-	-	-	-	-	330	330	330	-	-	-
2800	2861	2935.9	-	-	-	-	-	330	330	330	-	-	-
2900	2963	3038.5	-	-	-	-	-	330	330	330	-	-	-
3000	3065	3141.1	-	-	-	-	-	330	330	330	-	-	-
3100	3167	3247.4	-	-	-	-	-	330	330	330	-	-	-
3200	3269	3349.8	-	-	-	-	-	330	330	330	-	-	-
3300	3371	3452.4	-	-	-	-	-	330	330	330	-	-	-
3400	3473	3554.8	-	-	-	-	-	330	330	330	-	-	-
3500	3575	3657.2	-	-	-	-	-	330	330	330	-	-	-
3600	3677	3759.6	-	-	-	-	-	330	330	330	-	-	-
3700	3779	3862	-	-	-	-	-	330	330	330	-	-	-
3800	3881	3964.4	-	-	-	-	-	330	330	330	-	-	-
3900	3983	4066.8	-	-	-	-	-	330	330	330	-	-	-
4000	4085	4168.8	-	-	-	-	-	330	330	330	-	-	-

Table 9-1 Coupling Dimensions

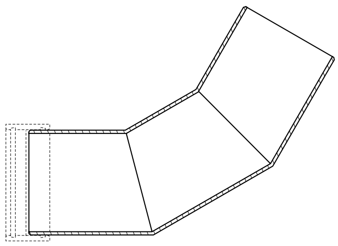
! **Note:** All the above values are Nominal values only and might subject to change. Please contact Amiantit Fiberglass for further details.

10 Fittings

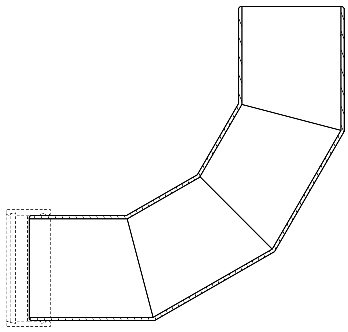
Amiantit fiberglass has created a standardized line of GRP fittings that are molded or fabricated using the same materials that are used to produce Amiantit fiberglass pipe. One of the benefits of Flowtite AFIL pipe is the ability to fabricate a wide assortment of fittings, standard as well as non standard. The following table shows the standard dimensions of standard fittings with different ends configuration.



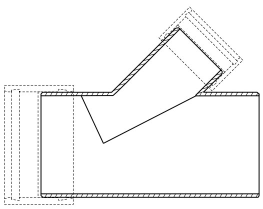
1 segmented bend



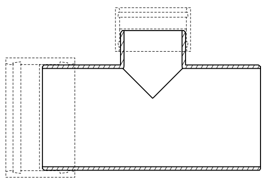
2 segmented bend



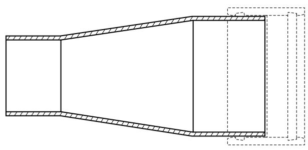
3 segmented bend



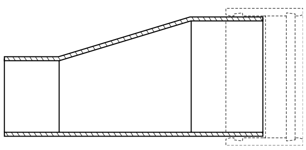
Branches



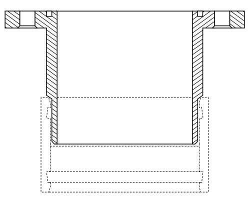
Tees



Concentric reducers

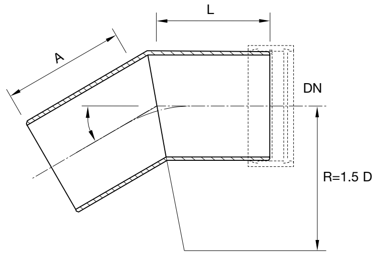


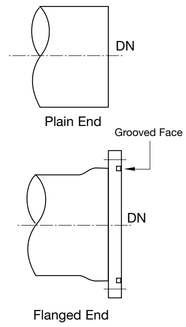
Eccentric reducers

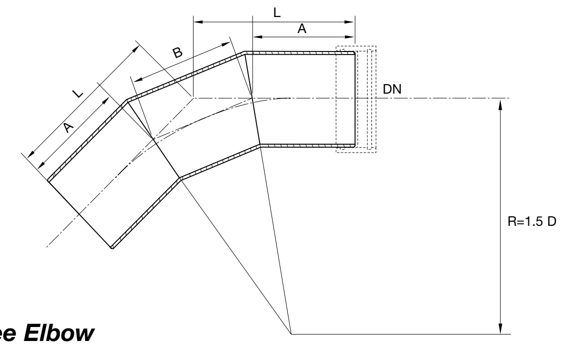


Fix Flanges Type A

10.1 Segmented Elbows







30 degree Elbow

Nominal Diameter DN (mm)	A (mm)	L (mm)
80	400	400
100	400	400
150	400	400
200	400	400
250	400	400
300	400	400
350	400	400
400	400	400
450	400	400
500	450	450
600	500	500
700	550	550
800	600	600
900	650	650
1000	650	650
1100	650	650
1200	700	700
1300	750	750
1400	800	800
1500	900	900
1600	950	950
1700	1000	1000
1800	1050	1050
1900	1150	1150
2000	1200	1200
2100	1250	1250
2200	1300	1300
2300	1350	1350
2400	1400	1400
2500	1500	1500
2600	1700	1700
2700	1700	1700
2800	1700	1700
2900	1700	1700
3000	1700	1700
3100	1800	1800
3200	1800	1800
3300	1800	1800
3400	1800	1800
3500	1800	1800
3600	1900	1900
3700	1900	1900
3800	1900	1900
3900	1900	1900
4000	1900	1900

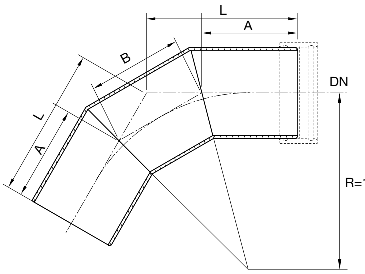
Table 10-1 30 Degree Elbow

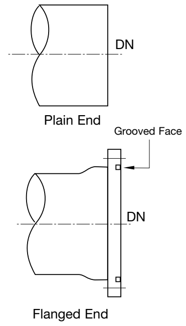
! **Note:** All small diameters from 80 mm to 300 mm flanges will be flat faces.

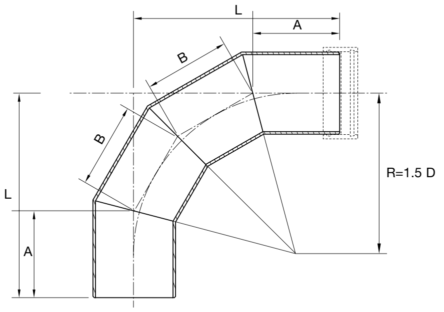
45 degree Elbow

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	400	48	426
100	400	60	432
150	400	90	449
200	400	120	465
250	400	149	481
300	400	179	497
350	400	209	513
400	400	239	529
450	400	269	546
500	450	299	612
600	500	358	694
700	550	418	776
800	600	478	859
900	650	537	941
1000	700	597	1023
1100	750	657	1106
1200	800	716	1188
1300	850	776	1270
1400	900	836	1352
1500	950	895	1434
1600	1000	955	1517
1700	1050	1015	1599
1800	1100	1074	1681
1900	1200	1134	1814
2000	1250	1194	1896
2100	1300	1253	1978
2200	1350	1313	2061
2300	1400	1373	2143
2400	1450	1432	2225
2500	1500	1492	2308
2600	1500	1552	2340
2700	1500	1611	2372
2800	1500	1671	2404
2900	1500	1731	2437
3000	1500	1790	2469
3100	1500	1850	2501
3200	1500	1910	2533
3300	1500	1969	2566
3400	1500	2029	2598
3500	1500	2089	2630
3600	1500	2148	2663
3700	1500	2208	2695
3800	1500	2268	2727
3900	1500	2327	2760
4000	1500	2387	2792

Table 10-2 45 Degree Elbow







60 degree Elbow

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	400	65	438
100	400	81	447
150	400	121	470
200	400	161	493
250	400	201	516
300	400	242	540
350	400	281	562
400	400	322	586
450	400	362	609
500	450	402	682
600	500	482	778
700	550	563	875
800	600	643	971
900	650	724	1068
1000	700	804	1164
1100	750	884	1260
1200	800	965	1357
1300	900	1045	1503
1400	1000	1126	1650
1500	1100	1206	1796
1600	1200	1286	1943
1700	1300	1367	2089
1800	1400	1447	2235
1900	1500	1527	2382
2000	1600	1608	2528
2100	1650	1688	2625
2200	1750	1769	2771
2300	1850	1849	2918
2400	1900	1929	3014
2500	2000	2010	3160
2600	2000	2090	3207
2700	2000	2170	3253
2800	2000	2251	3299
2900	2000	2331	3346
3000	2000	2412	3392
3100	2000	2492	3439
3200	2000	2572	3485
3300	2000	2653	3532
3400	2000	2733	3578
3500	2000	2813	3624
3600	2000	2894	3671
3700	2000	2974	3717
3800	2000	3055	3764
3900	2000	3135	3810
4000	2000	3215	3856

Table 10-3 60 Degree Elbow

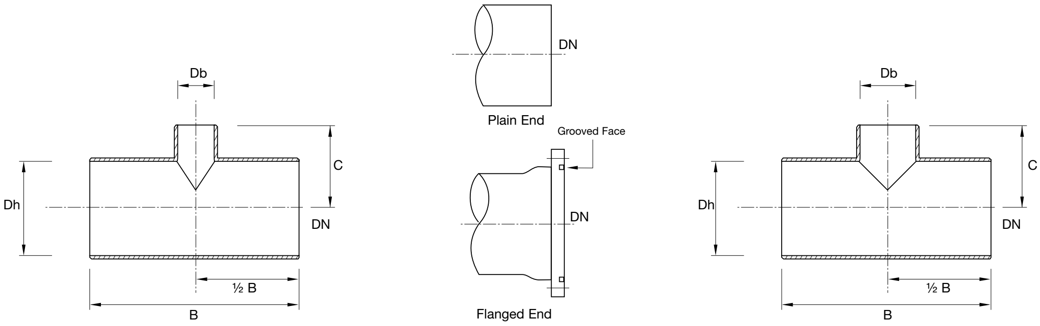
Note: All small diameters from 80 mm to 300 mm flanges will be flat faces.

90 degree Elbow

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	400	65	489
100	400	81	511
150	400	121	565
200	400	161	620
250	400	201	675
300	400	242	731
350	400	281	784
400	400	322	840
450	400	362	895
500	450	402	999
600	500	480	1158
700	550	563	1319
800	600	643	1478
900	650	724	1639
1000	700	804	1798
1100	750	884	1958
1200	800	965	2118
1300	900	1045	2328
1400	1000	1126	2538
1500	1100	1206	2747
1600	1200	1286	2957
1700	1300	1367	3167
1800	1400	1447	3377
1900	1500	1527	3586
2000	1600	1608	3797
2100	1650	1688	3956
2200	1750	1769	4167
2300	1850	1849	4376
2400	1900	1929	4535
2500	2000	2010	4746
2600	2000	2091	4857
2700	2000	2171	4966
2800	2000	2252	5076
2900	2000	2332	5186
3000	2000	2413	5296
3100	2000	2493	5406
3200	2000	2573	5516
3300	2000	2654	5626
3400	2000	2734	5735
3500	2000	2815	5845
3600	2000	2895	5955
3700	2000	2975	6065
3800	2000	3056	6175
3900	2000	3136	6285
4000	2000	3217	6395

Table 10-4 90 Degree Elbow

10.2 Segmented Tees 90º



90º TEE (D_b < 1/2 D_h)

Nominal Diameter DN (mm)	B (mm)	C (mm)
350	1000	560
400	1000	570
450	1050	650
500	1080	670
600	1220	760
700	1350	850
800	1480	940
900	1650	1030
1000	1750	1130
1100	1880	1220
1200	2020	1310
1300	2150	1402
1400	2300	1490
1500	2420	1590
1600	2550	1680
1700	2700	1770
1800	2850	1860
1900	3000	1950
2000	3100	2050
2100	3210	2140
2200	3400	2230
2300	3500	2320
2400	3750	2420
2500	3800	2510
2600	3850	2575
2700	3900	2625
2800	3950	2675
2900	4000	2725
3000	4050	2775
3100	4100	2825
3200	4150	2875
3300	4200	2925
3400	4250	2975
3500	4300	3025
3600	4350	3075
3700	4400	3125
3800	4450	3175
3900	4500	3225
4000	4550	3275

Table 10-5 **90º TEE (D_b < 1/2 D_h)**

! Note: All small diameters from 80 mm to 300 mm flanges will be flat faces.

90º TEE (D_b > 1/2 D_h)

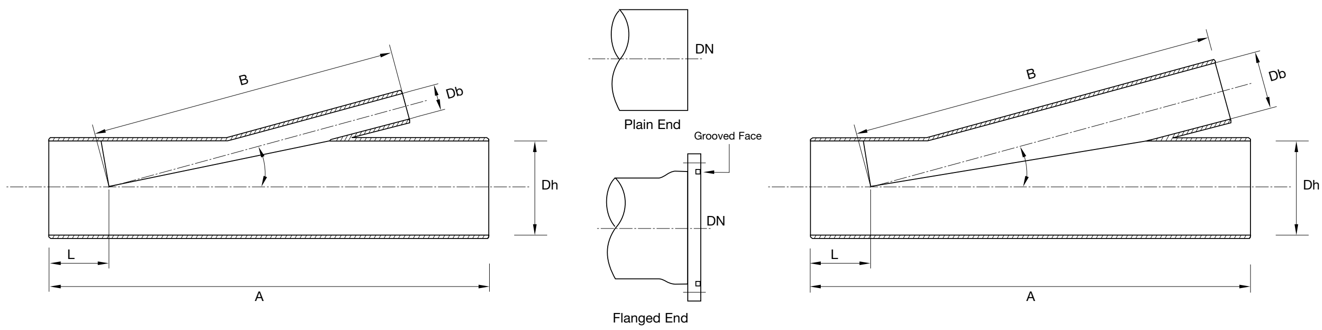
Nominal Diameter DN (mm)	B (mm)	C (mm)
350	1300	650
400	1400	700
450	1500	750
500	1600	800
600	1800	900
700	2050	1025
800	2300	1150
900	2550	1275
1000	2800	1400
1100	3050	1525
1200	3300	1650
1300	3550	1775
1400	3800	1900
1500	4050	2025
1600	4300	2150
1700	4550	2275
1800	4800	2400
1900	5050	2525
2000	5300	2650
2100	5550	2775
2200	5800	2900
2300	6050	3025
2400	6300	3150
2500	6550	3275
2600	6650	3325
2700	6750	3375
2800	6850	3425
2900	6950	3475
3000	7050	3525
3100	7150	3575
3200	7250	3625
3300	7350	3675
3400	7450	3725
3500	7550	3775
3600	7650	3825
3700	7750	3875
3800	7850	3925
3900	7950	3975
4000	8050	4025

Table 10-6 **90º TEE (D_b > 1/2 D_h)**

Nominal Diameter DN (mm)	B (mm)	C (mm)
80 X 80	800	500
100 X 100	900	500
150 X 150	1100	500
200 X 200	1200	600
250 X 250	1250	625
300 X 300	1300	650

Table 10-7 **90º TEE**

10.3 Segmented Branches



15° WYE (D_b < 1/2 D_h)

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	1500	1200	300
100	1600	1300	300
150	1700	1350	350
200	1700	1400	350
250	1800	1450	400
300	1900	1500	400
350	2200	1700	500
400	2500	1900	600
450	2800	2100	700
500	3100	2300	800
600	3550	3650	900
700	4000	3000	1000
800	4500	3400	1100
900	4900	3800	1200
1000	5100	4200	1300
1100	5700	4550	1400
1200	6200	4950	1500
1300	6700	5300	1600
1400	7200	5500	1700
1500	7700	5806	1800
1600	8350	6000	1900
1700	8850	6300	2000
1800	9300	6700	2100
1900	9800	7100	2200
2000	10300	7300	2300
2100	10750	8000	2400
2200	11250	8300	2500
2300	11700	8500	2600
2400	12200	8700	2700
2500	12650	8900	2800

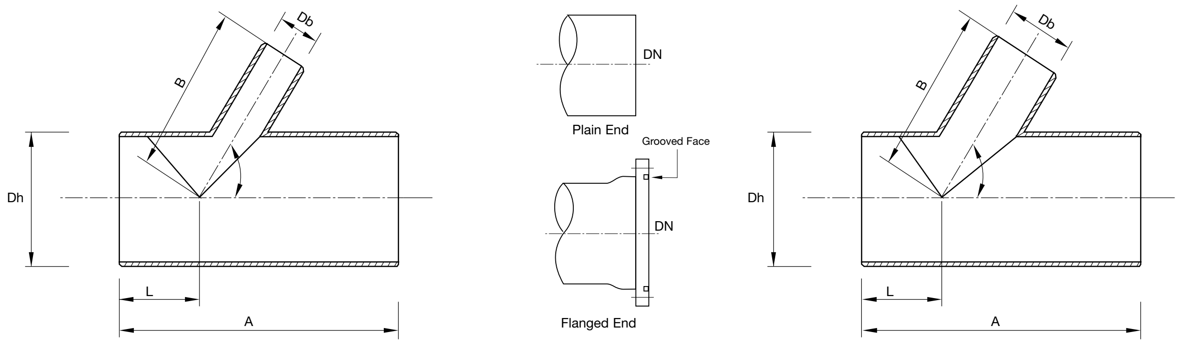
Table 10-8 **15° WYE (D_b < 1/2 D_h)**

15° WYE (D_b > 1/2 D_h)

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	2100	900	240
100	2200	1000	280
150	2400	1100	300
200	2600	1300	330
250	2800	1500	350
300	2900	1700	400
350	3200	2700	500
400	3500	2900	600
450	3800	3100	700
500	4100	3300	800
600	4550	3650	900
700	5000	4000	1000
800	5500	4400	1100
900	6000	4800	1200
1000	6500	5200	1300
1100	6950	5550	1400
1200	7450	5950	1500
1300	7900	6300	1600
1400	8400	6700	1700
1500	8900	7100	1800
1600	9350	7450	1900
1700	9850	8580	2000
1800	10300	9200	2100
1900	10800	9600	2200
2000	11300	10000	2300
2100	11750	10350	2400
2200	12250	10750	2500
2300	12700	11100	2600
2400	13200	11500	2700
2500	13650	11850	2800

Table 10-9 **15° WYE (D_b > 1/2 D_h)**

! **Note:** All small diameters from 80 mm to 300 mm flanges will be flat faces.



45° and 60° WYE ($D_b < 1/2\ D_h$)

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	600	480	240
100	700	530	250
150	750	600	250
200	800	700	280
250	850	800	300
300	900	900	300
350	1300	850	450
400	1550	1000	550
450	1700	1100	600
500	1800	1150	650
600	2050	1300	750
700	2350	1500	850
800	3650	1700	950
900	3950	1900	1050
1000	3250	2100	1150
1100	3550	2300	1250
1200	3850	2500	1350
1300	4150	2700	1450
1400	4450	2900	1550
1500	4750	3100	1650
1600	5050	3300	1750
1700	5350	3500	1850
1800	5650	3700	1950
1900	5950	3900	2050
2000	6250	4100	2150
2100	6550	4300	2250
2200	6850	4500	2350
2300	7150	4700	2450
2400	7450	4900	2550
2500	7750	5100	2650

Table 10-10 **45° and 60° WYE ($D_b < 1/2\ D_h$)**

Note: All small diameters from 80 mm to 300 mm flanges will be flat faces.

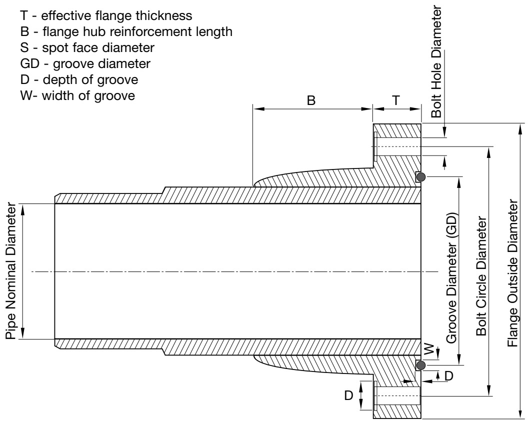
45° and 60° WYE ($D_b > 1/2\ D_h$)

Nominal Diameter DN (mm)	A (mm)	B (mm)	L (mm)
80	850	500	300
100	900	600	300
150	900	700	350
200	950	800	350
250	1000	900	350
300	1000	1000	400
350	1000	800	300
400	1250	850	400
450	1500	900	500
500	1600	950	550
600	1750	1100	600
700	2050	1300	700
800	2350	1400	800
900	2550	1600	850
1000	2660	1700	900
1100	2950	1800	950
1200	3250	2000	1050
1300	3550	2200	1150
1400	3760	2400	1200
1500	3950	2600	1250
1600	4100	2700	1300
1700	4300	2800	1350
1800	4600	2900	1450
1900	4800	3000	1500
2000	5000	3100	1550
2100	5300	3200	1650
2200	5500	3300	1700
2300	5700	3400	1750
2400	5850	3600	1800
2500	6100	3700	1850

Table 10-11 **45° and 60° WYE ($D_b > 1/2\ D_h$)**

CONTACT MOLDED FLANGE

T - effective flange thickness
B - flange hub reinforcement length
S - spot face diameter
GD - groove diameter
D - depth of groove
W- width of groove



Nominal Diameter		Flange Thickness	Flang OD 'FOD'	Groove Diameter	Drilling Standard								
					AWWA Class 'D'			ANSI B 16.1 Class 125			ISO 2084/ BS 4504 -PN10		
(inch)	(mm)	T (mm) +6-0	+10-0	GD(mm) ±3	No. of Bolts	Bolt Hole Dia. ±1.5	Bolt Circle Dia.	No. of Bolts	Bolt Hole Dia. ±1.5	Bolt Circle Dia.	No. of Bolts	Bolt Hole Dia. ±1.5	Bolt Circle Dia.
14	350	45	537	399.3	12	31.6	476.3	12	31.6	476.3	16	25	460
16	400	47	601	434.3	16	34.8	539.8	16	31.6	539.8	16	29	515
18	450	52	645	485.3	16	34.8	577.9	16	34.8	577.9	20	29	565
20	500	53	703	536.3	20	34.8	635.0	20	34.8	635.0	20	29	620
24	600	57	823	638.3	20	37.8	749.3	20	37.8	749.3	20	33	725
28	700	66	937	743.9	28	37.8	863.6	-	-	-	24	33	840
32	800	72	1064	845.9	28	44.1	977.9	-	-	-	24	36	950
36	900	78	1172	947.9	32	44.1	1085.9	32	44.1	1085.9	28	36	1050
40	1000	83	1287	1049.9	36	44.1	1200.2	-	-	-	28	39	1160
44	1100	93	1401	1155.8	40	44.1	1314.5	-	-	-	-	-	-
48	1200	98	1509	1257.8	44	44.1	1422.4	44	44.1	1422.4	32	42	1380
52	1300	104	1636	1359.8	44	50.5	1536.7	-	-	-	-	-	-
60	1500	115	1858	1563.8	52	50.5	1759.0	52	50.5	1758.9	-	-	-
66	1700	130	2030	1771.7	52	50.5	1930.4	-	-	-	-	-	-
72	1800	136	2194	1873.7	60	50.5	2095.5	60	50.5	2095.5	44	51	2020
78	2000	147	2373	2077.7	64	56.8	2260.6	-	-	-	48	51	2230
84	2100	155	2537	2182.3	64	56.8	2425.7	64	56.8	2425.7	-	-	-
90	2300	167	2715	2386.3	68	63.3	2590.8	-	-	-	-	-	-
96	2400	174	2880	2488.3	68	63.3	2755.9	68	63.3	2755.9	56	59	2650
102	2600	184	3048	2692.3	-	-	-	-	-	-	60	59	2850
108	2700	190	3219	2794.3	72	63.5	3067.1	-	-	-	-	-	-
112	2800	196	3307	2896.3	-	-	-	-	-	-	64	59	3070
114	2900	201	3391	2996.3	-	-	-	-	-	-	-	-	-
120	3000	207	3562	3098.3	76	76	3371.9	-	-	-	68	65	3290

Table 10-12 **Standard Flange Dimension (complying with AWWA-ANSI B16.1-ISO)**

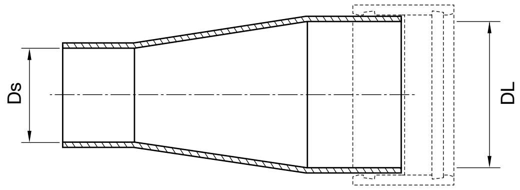
! Note: All the above values are nominal values only and might subject to change based on project requirements.

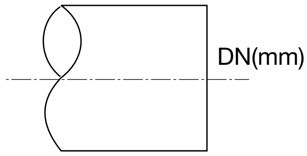
For larger diameter and other drilling standards, please consult Amiantit Fiberglass Ind. Ltd.

10.5 Reducers

Standard Reducer Dimensions

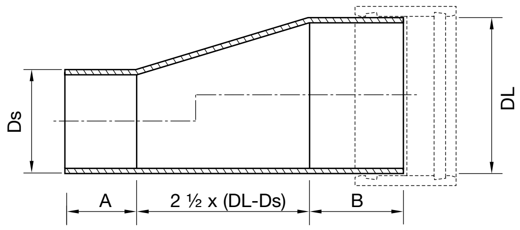
For Small Pipe Diameter
< or = 300
Concentric Reducer (Spigot Ends)

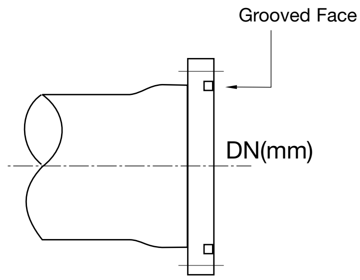




(Plain End)

Eccentric Reducer (Spigot Ends)

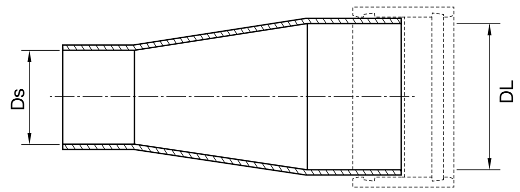


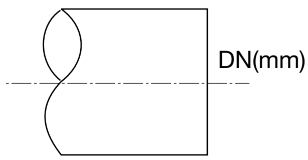


(Flanged End)

! Note: A = 500mm or Ds whichever is greater.
B = 500mm or DL whichever is greater.

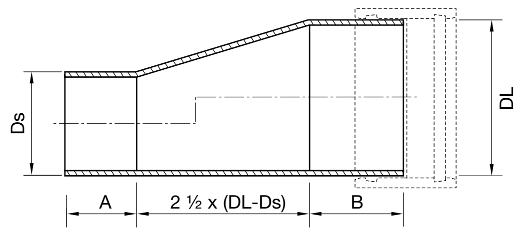
For Large Pipe Diameter
> or = 350
Concentric Reducer (Spigot Ends)

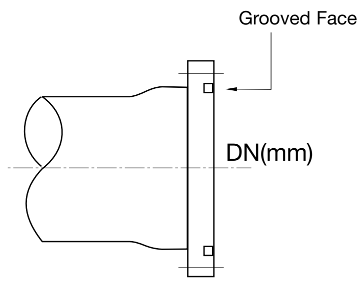




(Plain End)

Eccentric Reducer (Spigot Ends)



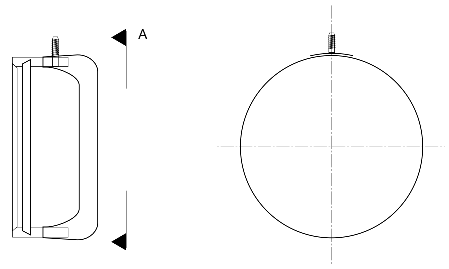


(Flanged End)

10.6 Misc. Fittings

End Caps

- End caps are used to close the end of the line for testing purposes.
- They are available in all AFIL pipe sizes.
- End caps should be restrained to eliminate axial forces on pipes.

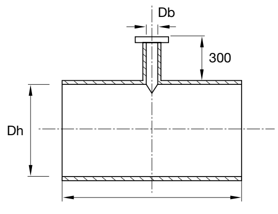


End Cap With Steel Threaded Nozzle

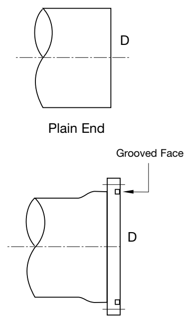
End View A-A

Flanged Nozzles

- Flanged nozzles are available in diameters range 4”,6”,8” and 10”.
- Flanged nozzles are drilled to ANSI B 16.5.150lb.OR as required.
- Pipe Header diameter could vary from 300mm to 4000 mm.



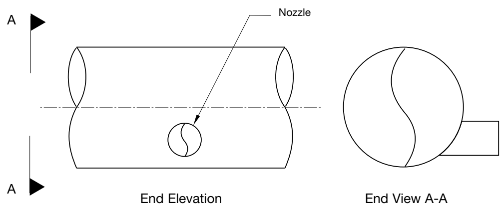
Spigot Ends



Flanged End

Eccentric Tees

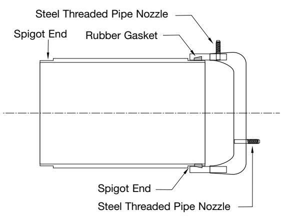
- Eccentric Tees can be manufactured upon request.
- The overall dimensions should be as per customer requirement but not less than wyes dimensions table.
- It can be Plain end, Spigot end, or Flanged end.
- Flanged Eccentric tees can be fabricated as per required drilling.

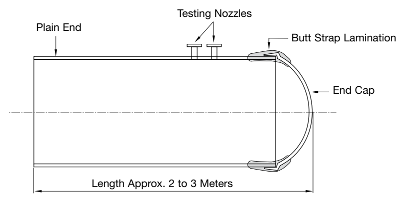


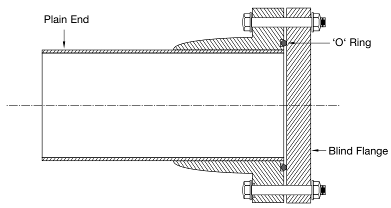
End Elevation

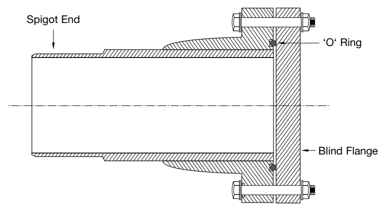
End View A-A

Hydrotest Spools









11 General Installation

Introduction

Long life and the good performance characteristics of AFIL pipe can only be achieved by proper handling and installation of the pipe. It is important for the owner, engineer and contractor to understand that glass-reinforced plastic (GRP) pipe is designed to utilize the bedding and pipe zone backfill support that will result from recommended installation procedures. Engineers have found through considerable experience that properly compacted granular materials are ideal for backfilling GRP pipe. Together, the pipe and embedment material form a high-performance "pipe-soil system" For complete installation instructions, consult the AFIL Pipe Installation instructions for Buried Pipe. The following Information is a partial review of installation procedures; it is not intended to replace the installation instructions which must be followed for any project.

Trenching

Details of a standard trench installation are shown to the right. The trench must always be wide enough to permit placement and compaction of the pipe zone backfill materials and provide proper pipe support. The depth of cover charts presented in this brochure are based on an assumed trench width 1.75 times the pipe's nominal diameter. Widths down to 1.5 times DN may be achievable, however the burial limits will be affected. Consult Amiantit fiberglass if your conditions will vary from these assumptions.

Bedding

The trench bed of suitable material should provide uniform and continuous support for the pipe.

Backfill Materials

To ensure a satisfactory pipe-soil system, correct backfill material must be used. Most coarse grained soils (as classified by the Unified Soils Classification System) are acceptable bedding and pipe zone backfill material. Where the instructions permit the use of native soil as backfill, care should be taken to ensure that the material does not include rocks, soil dumps, debris, frozen or organic material. ***Table 11-2*** identifies acceptable backfill soils.

Standard Trench Details

Minimum Width Trench
Dimension " A " is a minimum of. 75* DN/2 shall not be less than 150.

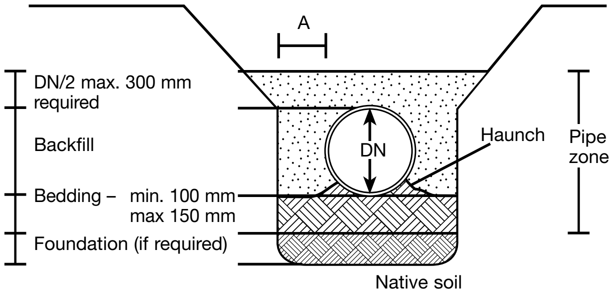


Figure 11-1 Standard trench Details

1. Where rock, hard pan, soft, loose, unstable or highly expansive soils are encountered in the trench, it may be necessary to increase the depth of the bedding layer to achieve adequate longitudinal support.

2. Dimension "A" must allow for adequate space to operate compaction equipment and ensure proper placement of backfill in the haunch region. This may require a wider trench than the minimum specified above, particularly for smaller diameters.

Checking The Installed Pipe

After installation of each pipe, the maximum diametrical vertical deflection must be checked. With Amiantit FIBERGLASS pipe this procedure is fast and easy.

Installed Diametrical Deflection

The maximum allowable initial diametrical deflection (typically vertical) shall be as follows:

DN > 300	DN < 300
3%	2.5%

Table 11-1 Maximum Initial deflection

The maximum allowable long-term diametrical deflection shall be 5% for diameters 300 mm and larger, and 4% for smaller diameters. These values will apply to all stiffness classes.

Bulges, flat areas or other abrupt changes of pipe wall curvature are not permitted. Pipe installed outside of these limitations may not perform as intended.

Backfill Soil Type	Description	Unified Soil Classification Designation, ASTM D2487
A	Crushed stone and gravel, <12% fines	GW, GP, GW-GM, GP-GM
B	Gravel w/ sand, sand, 12-35% fines	GW, GP, GC, SW, SP, SW-SM SP-SM, SW-SC, SP-SC
C	Silty gravel and sand, 12-35% fines, LL< 40%	GM, GC, GM-GC, SM, SC, SM-SC
D	Silty, clayey sand, 35-50% fines, LL < 40%	GM, GC, GM-GC, SM, SC, SM-SC
E	Sandy, clayey silt, 50%-70% fines, LL<40%	CL, ML, CL-ML
F	Low plasticity fine-grained soils, LL<40%	CL, ML, CL-ML

Table 11-2 Backfill soil classification

E'b MPa	1	2	3	4	5	6
2500 STIS						
20.7	23.0	15.0	11.0	7.0	NA	NA
13.8	18.0	15.0	10.0	6.0	NA	NA
10.3	15.0	13.0	9.0	5.5	NA	NA
6.9	11.0	10.0	7.5	5.0	NA	NA
4.8	8.5	7.5	6.0	4.0	NA	NA
3.4	6.0	5.5	5.0	3.5	NA	NA
2.1	3.5	3.5	3.0	NA	NA	NA
1.4	NA	NA	NA	NA	NA	NA
5000 STIS						
20.7	23.0	18.0	12.0	7.0	3.0	NA
13.8	18.0	15.0	10.0	6.5	2.4	NA
10.3	15.0	13.0	9.0	6.0	2.4	NA
6.9	11.0	10.0	8.0	5.0	NA	NA
4.8	8.5	5.75	6.5	4.5	NA	NA
3.4	6.0	6.0	5.0	4.0	NA	NA
2.1	4.0	4.0	3.5	3.5	NA	NA
1.4	2.4	2.4	2.2	NA	NA	NA
10000 STIS						
20.7	24.0	19.0	12.0	8.0	3.5	NA
13.8	19.0	16.0	11.0	7.0	3.5	NA
10.3	15.0	13.0	10.0	6.5	3.0	NA
6.9	12.0	10.0	8.5	5.5	3.0	NA
4.8	9.5	8.5	7.0	5.0	2.5	NA
3.4	7.0	6.5	5.5	4.5	NA	NA
2.1	4.5	4.5	4.0	3.5	NA	NA
1.4	3.0	3.0	3.0	2.8	NA	NA

* For more information, please refer to ***Table 7.2***.
1. American Association of State Highway Officials.

Table 11-3 Native soil STIS

Backfill Type	E'b Values (MPa) at Relative Compaction 80%	85%	90%	95%
A	16	18	20	22
B	7	11	16	19
C	6	9	14	17
D	3	6	9	10**
E	3	6	9	10**
F	3	6	9**	10**

* 100% relative compaction defined as maximum Standard Proctor Density at optimum moisture content.
** Values typically difficult to achieve, included as reference.

Table 11-4 Backfill Modulus of Passive Resistance (Non-Saturated)

Backfill Type	E'b Values (MPa) at Relative Compaction 80%	85%	90%	95%
A	12	13	14	15
B	5	7	10	12
C	2	3	4	4
D	1.7	2.4	2.8	3.1
E	NA***	1.7	2.1	2.4
F	NA***	1.4	1.7	2.1

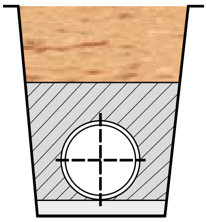
* 100% relative compaction defined as maximum Standard Proctor Density at optimum moisture content.
** Values typically difficult to achieve, included as reference.
*** Not recommended for use.

Table 11-5 Backfill Modulus of Passive Resistance (Saturated)

Load Type	KN	Traffic (Wheel) Load Lbs. Force	Minimum* Burial Depth Meters
AASHTO H20 (C)	72	16,000	1.0
BS 153 HA (C)	90	20,000	1.5
ATV LKW 12 (C)	40	9,000	1.0
ATV SLW 30 (C)	50	11,000	1.0
ATV SLW 60 (C)	100	22,000	1.5
Cooper E80	Railroad		3.0

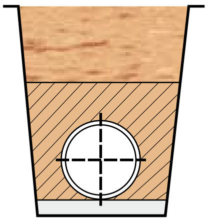
* Based on a minimum pipe zone backfill soil modulus of 6.9 MPa.

Table 11-6 Minimum Surface Loads



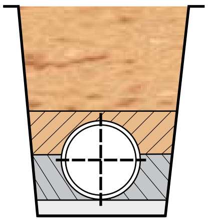
Installation Type 1

- Carefully constructed bed
- Backfill 70% relative Density Gravel
- Backfill compacted gravel to 300 mm over pipe crown



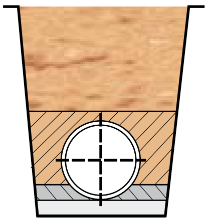
Installation Type 2

- Carefully constructed bed
- Backfill 90% Standard Proctor Sand
- Backfill compacted sand to 300 mm over pipe crown



Installation Type 3

- Backfill to 70% of pipe diameter with gravel or sand (primary pipe zone)
- Backfill from 70% to pipe crown with compactable native soil compacted to 90% Standard Proctor



Installation Type 4

- Prepare pipe bed and haunching with sand or gravel compacted to 90% Standard Proctor or 70% Relative density
- Backfill from 30% of pipe diameter to pipe crown with compacted native soil compacted to 90% Standard Proctor

Traffic

All backfill grade materials should be compacted when continuous traffic loads are present. Minimum cover restrictions may be reduced with special installations such as concrete encasement, concrete cover slabs, casings, etc. (See ***Table 11-6***).

Depth Limits (m) (Dry Conditions)			
Voc (bars)	**SN 2500**	**SN 5000**	**SN10000**
-0.25	10.0	10.0	11.0
-0.50	8.5	10.0	11.0
-0.75	6.5	10.0	11.0
-1.00	4.0	10.0	11.0
Depth Limits (m) (Wet Conditions)			
-0.25	5.5	5.5	6.0
-0.50	4.0	5.5	6.0
-0.75	1.8	5.5	6.0
-1.00	NA	4.0	6.0

Table 11-7 Native Soil Group 3 (E'n=10.3MPa) Backfill Type C at 90% Spd (E'b=4MPa) Water Table at Grade Standard Trench Installation

Negative Pressure

Allowable negative pressure is a function of pipe stiffness, burial depth, native soil and type of installation. In ***Table 11-7*** maximum burial depths for four level of negative vacuum, based on average native soil and backfill soil conditions are given. Please refer to the AFIL Pipe Installation Instructions for Buried Pipe if your conditions vary from those assumed below.

High Pressure

High pressure (>16 bar) may require deeper burial to prevent uplift and movement. Pipes of DN 800 and larger should have a minimum burial of 1.2 meters, and 0.8 meters for smaller diameters. Consult the pipe supplier for further details.

High Water Table

A minimum of 0.75 diameter of earth cover (minimum dry soil bulk density of 1900 kg/m^3) is required to prevent an empty submerged pipe from floating. Alternatively, the installation may proceed by anchoring the pipes. If anchoring is proposed, restraining straps must be a flat material, minimum 25 mm wide, placed at maximum 4.0 meter intervals. Consult the manufacturer for details on anchoring and minimum cover depth with anchors.

12 Joining Pipes

Flowtite pipe sections are typically joined using Flowtite couplings. Pipe and couplings may be supplied separately or the pipe may be supplied with a coupling installed on one end. If the couplings are not delivered pre-mounted, it is recommended that they be mounted at the storage yard or at the trench side before the pipe is lowered to the trench bed.

The couplings may be supplied with or without a rubber centre stop register. If a centre register is not supplied a home-line will be marked on the pipe as an aid for Jointing.
Other joining system such as flanges, mechanical couplings and lay-up joints may also be used for joining Flowtite pipes.

12.1 Flowtite Double Bell Couplings

Flowtite Pressure Coupling (FPC)

The following steps (1-5) are meant for Flowtite Pressure Couplings.

Step 1 Foundation and Bedding
The bed must be over-excavated at each joint location to ensure that the pipe will have continuous support and does not rest on the couplings. The coupling area must be properly bedded and backfilled after the joint assembly is completed.

Step 2 Cleaning Coupling
Thoroughly clean double bell coupling grooves and rubber gasket rings to make sure no dirt or oil is present ***(Figure 12–1).***

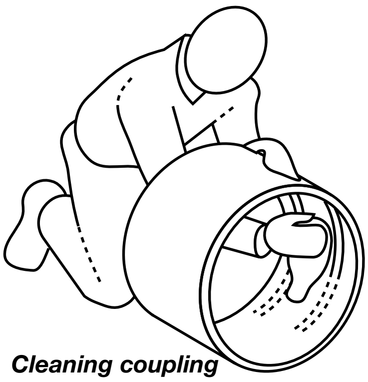


Figure 12–1 Cleaning coupling

Step 3 Install Gaskets
Insert the gasket into the groove leaving loops (typically two to four) of rubber extending out of the groove.
Do not use any lubricant in the groove or on the gasket at this stage of assembly. Water may be used to moisten the gasket and groove to ease positioning and insertion of the gasket ***(Figure 12–2)***.

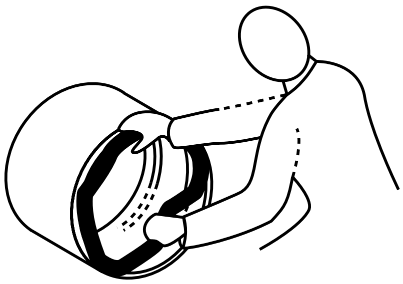


Figure 12–2 Installing gasket

With uniform pressure, push each loop of the rubber gasket into the gasket groove. When installed, pull carefully in the radial direction around the circumference to distribute compression of the gasket. Check also that both sides of the gasket protrude equally above the top of the groove around the whole circumference. Tapping with a rubber mallet will be helpful to accomplish the above.

Step 4 Lubricate Gaskets
Next, apply a thin layer of lubricant to the rubber gaskets ***(Figure 12-3)***. See Appendix B for normal amount of lubricant consumed per joint ➔.

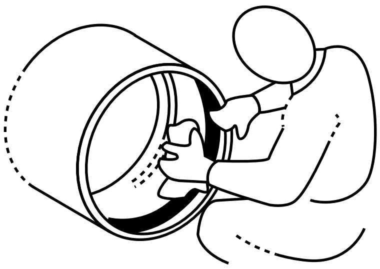


Figure 12–3 Lubricant gaskets

Step 5 Clean and Lubricate Spigots
Thoroughly clean pipe spigots to remove any dirt, grit, grease, etc. Inspect spigot sealing surface for possible damage. Apply a thin layer of lubricant to the spigots from the end of the pipe to the black alignments stripe. After lubricating, take care to keep the coupling and spigots clean ***(Figure 12–4)***. It has been found that placing a cloth or plastic sheet, approximately one meter square, under the jointing area will keep the spigot ends and gasket clean.

! Caution: It is very important to use only the correct lubricant. The supplier provides sufficient lubricant with each delivery of couplings. If for some reason you run out, please contact the supplier for additional supply or advice on alternative lubricants. Never use a petroleum based lubricant.

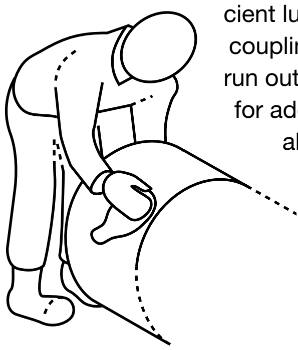


Figure 12–4 Cleaning spigot

Jointing

If the coupling is not pre-mounted it should be mounted on the pipe in a clean, dry place before the pipes are joined. This is accomplished by placing a clamp or a sling around the pipe at a distance of 1 to 2 m from the spigot on to which the coupling will be mounted. Make sure the pipe spigot is resting at least 100 mm above the ground surface to keep away from dirt. Push the coupling on to the pipe spigot end manually and place a 100 x 50 mm timber across the coupling. Use two come-along jacks connected between the timber and the clamp and pull the coupling into position i.e. until the coupling is aligned with the "home line" or until the spigot touches the centre register ***(see Figure 12–5)***.

The following steps (6 to 8) apply to joining pipes using clamps or slings and "come-along jacks". Other techniques may also be used providing the general objectives outlined here are met. In particular, insertion of the spigot ends of the pipe should be limited to the home-line and any damage to the pipe and coupling avoided.

Step 6 **Pipe Placement**
The pipe with the coupling mounted is lowered onto the trench bed. In the location of the joint the trench should be over-excavated to ensure that the pipe will have a continuous support and does not rest on the couplings.

Step 7 **Fixing of Clamps**
Clamp (or sling) A is fixed anywhere on the first pipe or left in position from the previous joint. Fix Clamp (or sling) B on the pipe to be connected in a convenient position ***(Figure 12–6)***.

! **Note:** Clamp contact with the pipe shall be padded or otherwise protected to prevent damage to the pipe and to have high friction resistance with the pipe surface. If clamps are not available, nylon slings or rope may be used, but care must be taken in the alignment of the coupling.

Step 8 **Join Coupling**
Come-along jacks are placed one on each side of the pipe and connected to the clamps. The pipe is pulled into position into the coupling until it reaches the home-line or touches the centre register. Clamp A is then moved onto the next pipe to be joined.

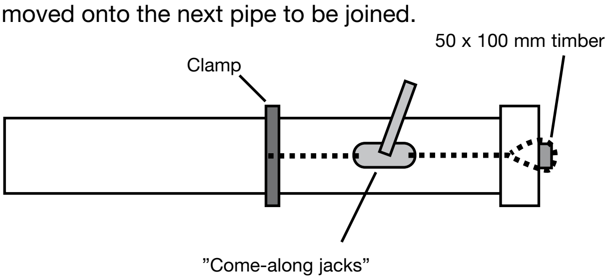


Figure 12–5 Mounting of coupling on pipe

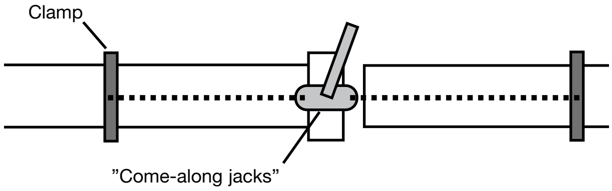


Figure 12–6 Pipe joining using clamps

The pipes can also be mounted by an excavator shovel or a crowbar (up to DN 300). The spigot ends are to be protected from any damage. The approximate mounting force can be calculated as follows:
Mounting forces in tons = (DN in mm / 1000) x 2

Angular Deflection of Double Bell Couplings:

Maximum angular deflection (turn) at each coupling joint must not exceed the amounts given in ***Table 12-1***. The pipes should be joined in straight alignment and thereafter deflected angularly as required ***(Figure 12-7)***.

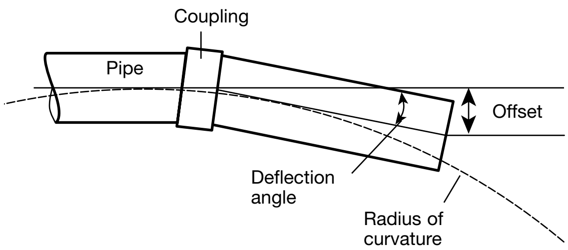


Figure 12–7 Flowtite coupling, angular joint deflection

Nominal Pipe Diameter (mm)	Angle of Deflection (Degree)	Nominal Offset (mm) Pipe Length			Nominal Radius Curvature (m) Pipe Length		
		3m	6m	12m	3m	6m	12m
80≤DN≤300	3	157	314	-	57	115	-
350≤DN≤600	3	157	314	628	57	115	229
700≤DN≤800	2.5	130	261	523	69	237	257
900≤DN≤1000	2	104	209	419	86	172	344
1100≤DN≤1300	1.5	78	157	314	115	229	458
1400≤DN≤1600	1.25	65	130	261	138	275	550
1800≤DN≤2500	1	52	104	209	172	344	688
2600≤DN≤3700	0.5	26	52	104	344	688	1375

1 For high pressure, classes (Pc > 15 bar), avoid using the maximum angular deflection at double bell coupling joint given in the table. Contact Amiantit fiberglass for further details.
2 Adequate stable soil cover shall be provided at the angularly deflected double bell coupling joints to ensure joint stability at the test and operating pressures. This is more critical for vertical angular deflections, lower pipe length and higher pressures.

Table 12-1 Angular Deflection at Double Bell Coupling Joint[1,2]

GRP Flange Joining Procedure

GRP flanges with diameter 350 mm and larger should be jointed according to the following procedure: ***(Figure 12-8)***.

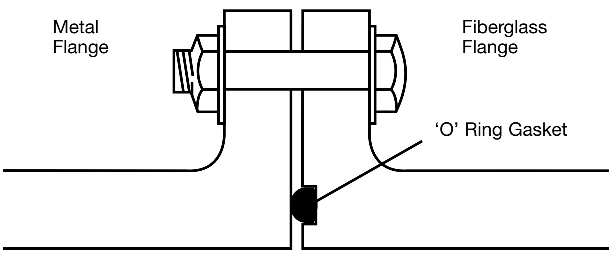


Figure 12–8 Flanged Joints (for DN ≥ 350)

1 Thoroughly clean the flange face and the 'o' ring groove with any clean rags and avoid any oil contact for both the groove and the 'o' ring.

2 Ensure the 'o' ring gasket is clean and undamaged. Do not use defective gaskets.

3 Position the 'o' ring in the groove and secure in position, if necessary, with small strips of adhesive tape at intermittent locations.

4 Make sure that the two flanges or connecting flange with valve or expansion joint is well aligned with GRP flanges. Any misalignment could lead to high stress at flange neck and could cause damage.

5 Insert bolts, washers and nuts. All hardware must be clean and lubricated to avoid incorrect tightening. Washers must be used on all GRP flanges.

6 Using a torque wrench, tighten all bolts to 35 N-m torque, following standard flange bolt tightening sequences shown in ***Figure 12-9***.

7 Repeat this procedure, raising the bolt until the flanges almost touch at their inside edges with a gap of 2-3 mm or maximum bolt torque of 100 N-m. Do not exceed this torque without consulting Amiantit fiberglass for advice. If done so, this may cause permanent damage to the GRP flange.

8 Uniform pressure should be established over the flange face by tightening bolts in 7 N-m (5lb-ft) increments according to the sequence shown in ***Figure 12-9***. For flanges with more than 20 bolts, similar alternating bolt tightening sequences shall be used. (As per ASTM D4024-00)

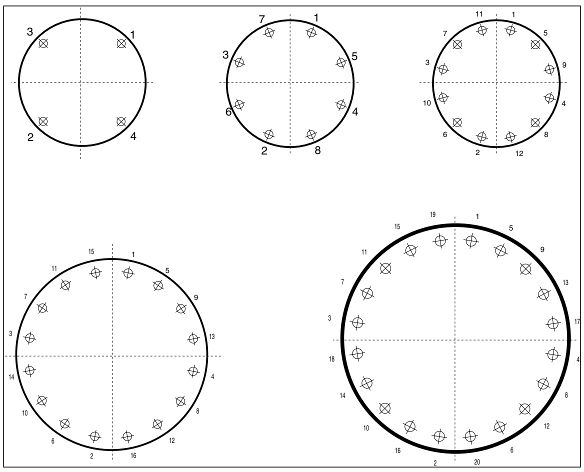


Figure 12–9 Bolt Torquing Sequences

9 Check bolt torque one hour later and adjust as seen necessary to 100 N-m.

10 The maximum torque, in any case, should not be more than 110 to 130 Nm. Care should be exercised while increasing the torque uniformly.

11 The above procedure is applicable for all diameters.

Note: When connecting two GRP flanges, only one flange should have a gasket groove in the face.

Other Joining Methods

1 **Flexible Steel Couplings:**
(Straub, Tee Kay, etc. - See ***Figure 12-10***)
These couplings can be used for joining as well as for repair. The coupling consists of a steel mantle with an interior rubber, sealing sleeve.

Three grades are available:

- Epoxy or PVC-coated steel mantle.
- Stainless steel mantle.
- Hot dip galvanized steel mantle.

Control of bolting torque with these couplings is most important. After initial bolt up, the coupling should be rapped with a rubber mallet to help seat and flow the gasket. Bolt torque should then be adjusted up to proper levels.
Depending on coupling size, this procedure may need to be repeated several times. Do not over torque as this may over stress the bolts. Follow the manufacturer's recommended assembly instructions.

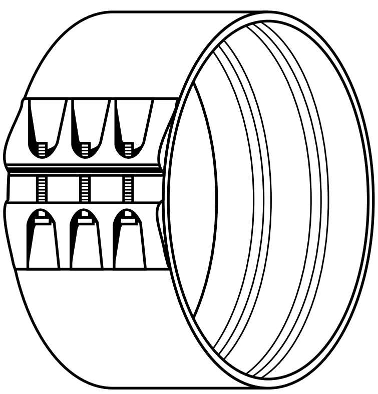


Figure 12–10 Flexible Steel Coupling

2 **Mechanical Steel Coupling:**
(Viking Johnson, Dresser etc. -See ***Figure 12-11***)
These couplings can be used for joining, typically to other types of pipe or to rigid items.

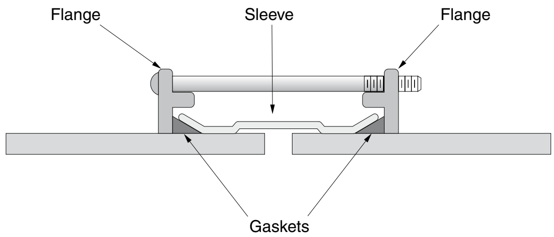


Figure 12–11 Mechanical Steel Coupling

Bolting torque must be controlled to not exceed the manufacturer's maximum recommended values. Excess torque could damage the pipe.

12 Field Hydrotest

Under Ground Piping System - Coupling Joints

Field hydrotest could be conducted in segments or as a complete piping system.

Segment Hydrotesting

Certain lengths shall be chosen according to site conditions to test the installed piping system in segments. A clearance of 4 meters minimum shall be maintained between the segments which could be later installed as Make-up pipe piece with double spigot calibration to facilitate the jointing on existing piping segment.

Fixing Test Plugs:

There are more than one methods to close temporarily the pipe ends for hydrotest purposes:

1. **Using Blind End Caps:**
   Blind end cap is GRP coupling with one end closed through lamination, while the other end is with groove for rubber gasket to work as sealing the end.

   Fix the end cap with the last pipe end to be tested after placing the rubber gasket into end cap groove.

   Joint with the spigot pipe end through pullers/come-along jacks.

   Necessary openings could be provided to the end caps for ventilation/pressure gauge. After segment test, these end caps could be removed through pullers & could be reused for other segments after rubber gasket replacement.

   Adequate concrete block supports shall be provided to the end cap to prevent the pipe movement during hydrotest.

2. **Flanged Blind End:**
   Flanged blind end is a spool consisting of flange with pipe piece & blind through a blind flange with bolts at one end while the other end is a spigot calibrated pipe shall be joined with the existing end by coupling.

Check List Prior To Pipe Ends Blind:

To check each coupling joint is connected correctly and the clearance between the pipe end is uniform all around. (Field joints testing equipment is available for pipe diameters ranging from 700 mm to 4000 mm). This test ensures the rubber gasket's correct positioning inside the double bell coupling groove. The test shall be conducted prior to start backfill. For details, contact Amiantit Fiberglass filed representative.

Internal visual inspection shall be carried out for accessible pipe diameters for any possible damage during installation/backfilling.
In no case, shall a single person be allowed to get inside of the piping for inspection.

Vertical deflection measurements shall be taken to observe the pipe behavior after the backfill. (Refer to underground installation manual for details).
Make sure that the pipes are backfilled to the minimum cover depth requirements of hydrotest.

For 80 mm to 300 mm diameters
(Min. 600 mm cover over the pipe crown)

For 350 mm diameters & above
(Min. 1000 mm cover over the pipe crown)

Double bell coupling joints could be exposed in case of the client requirements.
Make sure that the backfilling slope at the joints location is maintained with minimum pipe exposure.

Preparation Prior To Hydrotest:

Make sure that the test method statement is available with full understanding of implementation to the testing team.

Allowance for each branch / manhole to move freely, within limits, during the hydrotest.

Fixing ventilation at highest points, minimum two pressure gauges and filling points with valves. The values and reading at the pressure shall be calculated taking into account the static head between the lowest pipe invert level along the complete line and the level of the pressure gauge.

All flanges are tightened to the specified torque bolt sequence. Make sure that the valves are anchored in the above ground piping, if any is supported as specified.
In no case, shall a single person be allowed to get inside of the piping for inspection.

Upon verification of the inspection, when the findings are all judged acceptable & recorded, manhole covers shall be closed.
Prior to start water filling, temporary piping & blinds shall be installed checked & verified by the client / consultant / contractor representatives.

Water Filling & Pressurizing the System:

(It shall be confirmed that all vent points are fully opened to atmosphere, prior to start water filling). Introduce water filling through temporary hosing & pump at lowest point. Pump capacity shall be chosen according to the pipe diameter and segment / system linear length. (Pump having 100 m^3 capacity / hour are generally used for large diameter pipes).
The sign of complete water filling is when the water starts coming through higher point ventilation opened valves. Stop water pumps at this stage & check the flanges, valves and connected accessories for any weepage / leakage while keeping the vents open.

Pressurizing:

Start pressurizing the segment / system through pump. Once the water starts coming out through vent opening, close the valves at low elevation. Later, on the high elevation end the vent values shall be closed as well after water starts coming.
The pressure increment shall be maintained approx. as 0.5 bar / 110 minutes at this stage. When the pressure reaches to 2 bar, the pumps shall be stopped.

Keep this stoppage for 15-20 minutes. During this time, following checks shall be made:

- Pressure at each test gauge shall be checked & recorded on inspection sheet.
- Watch the pressure at the water feed point for any decrease in pressure.
- Walk through along with the under ground lines to observe any traces of wet soil. Check the coupling joints if exposed.The inspection sheet shall be maintained for the observations & findings.

Anything unusual shall be immediately reported to the team leader. Unless there is no findings which prevent the test from continuing, the segment / system shall be further pressurized. Connect the hose with the pressure pump and start pressurizing the line. At this stage, slightly open the vent. Valve should be fixed at a higher elevation to ensure that no entrapped air is present. Upon confirmation of water coming out of the vent, valve shall be closed. The system is now totally closed and under pressure.

Continue the pressure pump until it reaches to 5.0 bar. During this operation, the pump shall be constantly attended for pressure control.

Stop the pressure pump once it reaches to 5.0 bar and let it stabilize.

There could be a drop in pressure due to the thermal expansion, which could be resolved by restarting the pump or keep it as it is and record it on the inspection sheet.

Keep this stoppage for about 30 minutes. During this period, repeat the same sequence of inspection as described earlier. The findings & observations shall be recorded on inspection sheets.

Any unusual findings shall be reported immediately to the team leader.

Unless there are no findings which prevent the test from continuing, the segment/system shall be further pressurized to the requirement.

The test pressure should not exceed 1.5 times the maximum rated operating pressure. The test pressure shall be maintained for a minimum period of time.
(It is recommended to maintain the test hold time to a maximum of 15 minutes after pressure stabilization).
A thorough inspection shall be made as FINAL INSPECTION.

Fill up the inspection sheets accordingly. The test shall be considered as “PASS” if no signs of leakage is observed.

The inspection sheet(s) shall be signed by the authorities.

Post Hydrotest:

After completion of the test, drain or flush out the filled water from the pipe segment / system through drain valves and vents shall be opened. This pressure release shall be made slowly with 2 bar / 5 minutes.

1. Remove the end cap from the segment as per procedure.

2. Prepare the pipe end to be ready for next installation.

3. Exposed joints may be backfilled using the specified backfill material.

4. Connect the adjacent segment ends with closure pipe piece.

5. Continue the installation for the other segments and conduct the hydrotest in the similar manner as described earlier, keep connecting the segments through closure spools.

6. Complete system hydrotest /final hydrotest.

The purpose of this hydrotest is to test the pipe closure spools joints. Following arrangements shall be made:

1. All branch connections shall be kept free to move.

2. Separate the line from all connecting equipments.

3. Exposure of joints at closure pipe piece shall be done manually in order to prevent the pipe from any damage.

The procedure described for the segment testing is applicable to the final hydrotest.
For final hydrotest, it is recommended to maintain the test hold pressure for minimum period of time (one is enough to inspect the joint / fittings) and the pressure shall be equal to the maximum rated operating pressure.

Appendix A - Environmental Guide AFIL Pipe

The following guide was compiled from corrosion re-sistance information obtained from resin manufacturers. Individual project specifications and requirements should be considered when selecting the product. Maximum Temperature 50° C unless otherwise noted. For chemicals not listed, please contact your local sales office.

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester Only	Not Recom-mended
Acetic Acid <20%		●	
Adipic Acid		●	
Alum (Aluminum Potassium Sulfate)	●		
Aluminum Chloride, Aqueous	●		
Ammonia, Aqueous <20%		●	
Ammonium Chloride, Aqueous (40°C)	●		
Ammonium Fluoride			●
Ammonium Nitrate, Aqueous (40°C)	●		
Ammonium Phosphate-Monobasic, Aqueous	●		
Ammonium Sulfate, Aqueous	●		
Aniline Hydrochloride		●	
Antimony Trichloride			●
Barium Carbonate		●	
Barium Chloride		●	
Barium Sulfate		●	
Beet Sugar Liquor		●	
Benzene Sulfonic Acid (10%)*		●	
Benzoic Acid*		●	
Black Liquor (Paper)		●	
Bleach			●
Borax		●	
Boric Acid		●	
Bromine, Aqueous 5%*		●	
Butyric Acid, < 25% (40°C)**		●	
Calcium Bisulfide**	●		
Calcium Carbonate	●		
Calcium Chlorate, Aqueous (40°C)	●		
Calcium Chloride (Saturated)	●		
Calcium Hydroxide, 100%		●	
Calcium Hypochlorite*		●	
Calcium Nitrate (40°C)	●		
Calcium Sulfate NL AOC	●		
Cane Sugar Liquors		●	
Carbon Dioxide, Aqueous	●		
Carbon Tetrachloride			●
Casein	●		
Caustic Potash (KOH)			●
Chlorine, Dry Gas*		●	
Chlorine, Water*		●	
Chlorine, Wet Gas**		●	
Chlorocetic Acid			●

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester Only	Not Recom-mended
Citric Acid, Aqueous (40°C)			●
Copper Acetate, Aqueous (40°C)	●		
Copper Chloride, Aqueous	●		
Copper Cyanide (30°C)	●		
Copper Nitrate, Aqueous (40°C)	●		
Copper Sulfate, Aqueous (40°C)	●		
Crude Oil (Sour)*		●	
Crude Oil (Sweet)*		●	
Crude Oil, Salt Water (25°C)*		●	
Cyclohexane			●
Cyclohexanol			●
Dibutyl Sebacate**	●		
Dibutylphthalate**	●		
Diesel Fuel*	●		
Dioctyl Phthalate**	●		
Ethylene Glycol	●		
Ferric Chloride, Aqueous	●		
Ferric Nitrate, Aqueous	●		
Ferric Sulfate, Aqueous	●		
Ferrous Chloride	●		
Ferrous Nitrate, Aqueous**	●		
Ferrous Sulfate, Aqueous	●		
Formaldehyde			●
Fuel Oil*	●		
Gas, Natural, Methane			●
Gasoline, Ethyl*		●	
Glycerine		●	
Green Liquor, Paper			●
Hexane*		●	
Hydrobromic Acid			●
Hydrochloric Acid, Up To 15%	●		
Hydrofluoric Acid			●
Hydrogen Sulfide, Dry		●	
Kerosene*		●	
Lactic Acid, 10%	●		
Lactic Acid, 80% (25°C)	●		
Lauric Acid	●		
Lauryl Chloride		●	
Lauryl Sulfate**	●		
Lead Acetate, Aqueous	●		
Lead Nitrate, Aqueous (30°C)	●		
Lead Sulfate	●		

Note: This guide is intended to serve as a basic guide when considering FLOWTITE pipe. Final determination of the suitability of a particular resin system for a given environment is the responsibility of the customer. This list is based on information supplied by resin manufacturers who provide FLOWTITE producers with their material. Thus, this guide provides only general information and does not imply approval of any application as FLOWTITE Technology has no control of the conditions of usage nor any means of identifying environments to which the pipe may unintentionally have been exposed.

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester Only	Not Recom-mended
Linseed Oil*	●		
Lithium Bromide, Aqueous (40°C)**	●		
Lithium Chloride, Aqueous (40°C)**	●		
Magnesium Bicarbonate, Aqueous (40°C)**	●		
Magnesium Carbonate (40°C)*	●		
Magnesium Chloride, Aqueous (25°C)	●		
Magnesium Nitrate, Aqueous (40°C)	●		
Magnesium Sulfate	●		
Manganese Chloride, Aqueous (40°C)**	●		
Manganese Sulfate, Aqueous (40°C)**	●		
Mercuric Chloride, Aqueous**	●		
Mercurous Chloride, Aqueous	●		
Mineral Oils*	●		
n-Heptane*		●	
Naphthalene*		●	
Naptha*		●	
Nickel Chloride, Aqueous (25°C)	●		
Nickel Nitrate, Aqueous (40°C)	●		
Nickel Sulfate, Aqueous (40°C)	●		
Nitric Acid			●
Oleic Acid	●		
Oxalic Acid, Aqueous	●		
Ozone, Gas			●
Paraffin*	●		
Pentane			●
Perchloric Acid		●	
Petroleum, Refined & Sour*		●	
Phosphoric Acid		●	
Phosphoric Acid (40°C)	●		
Phthalic Acid (25°C)**		●	
Potassium Permanganate, 25%		●	
Potassium Bicarbonate**	●		
Potassium Bromide, Aqueous (40°C)	●		
Potassium Chloride, Aqueous	●		
Potassium Dichromate, Aqueous	●		
Potassium Ferrocyanide (30°C)**	●		
Potassium Ferrocyanide, Aqueous (30°C)**	●		
Potassium Nitrate, Aqueous	●		
Potassium Sulfate (40°C)	●		

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester Only	Not Recom-mended
Propylene Glycol (25°C)			
Sea Water			
Sewage (50°C)			
Silicone Oil			
Silver Nitrate, Aqueous			
Sodium Bromide, Aqueous			
Sodium Chloride, Aqueous			
Sodium Dichromate			
Sodium Dihydrogen Phosphate**			
Sodium Ferrocyanide			
Sodium Hydroxide 10%			
Sodium Mono-Phosphate**			
Sodium Nitrate, Aqueous			
Sodium Nitrite, Aqueous**			
Sodium Silicate			
Sodium Sulfate, Aqueous			
Sodium Sulfide			
Sodium Tetraborate			
Stannic Chloride, Aqueous*			
Stannous Chloride, Aqueous			
Stearic Acid*			
Sulfur			
Sulfuric Acid, <25%(40°C)*			
Tannic Acid, Aqueous			
Tartaric Acid			
Toluene Sulfonic Acid**			
Tributyl Phosphate			
Triethanolamine			
Triethylamine			
Turpentine			
Urea, (Aqueous)**			
Vinegar			
Water, Distilled			
Water, Sea			
Water, Tap			
Zinc Chloride, Aqueous			
Zinc Nitrate, Aqueous**			
Zinc Sulfate, Aqueous			
Zinc Sulfite, Aqueous (40°C)**			

* Current EPDM type gasket can not be used. Use of FPM type gasket is recommended, or consult your local gasket supplier.
** No Flowtite Technology recommendation, consult your local gasket supplier for compatibility.

Appendix B - Joint Lubricant Requirements

Nominal Pipe Diameter (mm)	Nominal Amount of Lubricant (kg) Required per Joint
100 to 250	0.050
300 to 500	0.075
600 to 800	0.10
900 to 1,000	0.15
1,100 to 1,200	0.20
1,500 to 1,600	0.30
1,800	0.35
2,000	0.40
2,200	0.45
2,400	0.50
2,600	0.55
2,800	0.60
3,000	0.65

! **Note:** Lubricants amounts are based on lubricating two gaskets and two spigot ends per joint. Factory pre-assembled coupling joints will only require half the above amounts per joint.

Utmost care has been taken to ensure that all the contents of this brochure are accurate. However, Amiantit and its subsidiaries do not accept responsibility for any problems which may arise as a result of errors in this publication. Therefore customers should make inquiries into the potential product supplier and convince themselves of the suitability of any products supplied or manufactured by Amiantit and/or its subsidiaries before using them.

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