AMIANTIT QATAR PIPES CO. LTD

FLOWTITE™

GRP Pipe systems

for Water, Sewage and Industrial Applications

AMIANTIT PIPE SYSTEMS

Product Guide

Content

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Product Guide

1. Amiantit Group Of Companies

The Amiantit Group is an internationally operating organization with a track record of growth-oriented success. It´s mission is to provide customers throughout the world with pipe solutions for water, sewage, gas, oil
and industrial applications as well as with pipe technologies, water management services and building materials of superior quality and value. The company has a convincing history of long-term growth and profitability and a competitive position thanks to the experience and commitment of our staff and our performance. Therefore they look forward with confidence to achieving their vision of global leadership.

1.1 Amiantit Qatar Pipe Co.

Amiantit Qatar Pipe Company (AQAP) was established in Doha, Qatar as a joint venture among Qatar Industrial manufacturing Co.(QIMC), Saudi Arabian Amiantit Co. (SAAC) and Trading & Agency Services Ltd. (TRAGS). The three partners amass among them 91yrs of experience in the pipes and industrial business.

AQAP Manufactures fiber reinforced Plastic (FRP) pipes & fittings commonly known as GPR, in sizes up to 4000 mm in diameter.

1.2 *Flowtite* Technology Norway

Flowtite fibreglass pipes and fittings are used in many applications. They can be found in the transmission of drinking water, in fire-fighting, sea and desalinated water, in power plants, in chemical and industrial wastes as well as in sewage applications and irrigation. The use of ***Flowtite*** pipe systems is virtually unlimited. You find the products in siphon lines just as much as in sea-water outfalls, bridge dewatering, desalination projects and as protection lines for cables. If you have an interesting application, please do not hesitate to contact us.

The Amiantit Group manufactures ***Flowtite*** GRP pipes in many factories around the world. The facilities supply pipes and fittings

in variousdesigns, lengths and diameters, also specially customized to suit your application. ***Flowtite*** products are available directly from all Amitech manufacturing sites as well as from the APS sales offices worldwide. If you would like to receive further details, please contact us. Address details can be found on the reverse ofthis brochure.

1.3 Our Mission

- **To be the leader in the manufacturing, engineering & after sales services of FRP (GRP) piping.**

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

Fulfill the customers satisfaction and expectation.
Ensure continuous improvement in all aspects.
Enhancing “safety” as our first priority.

1.4 Introduction

The world’s infrastructure is aging. Millions of kilometers of water and saver 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 infrastructure - 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 saver system, which generated through the hydrogen sulfide cycle.

Externally, soil conditions and stray electrical currents will deteriorated underground pipes. Metallic pipes can corrode when placed in poorly aerated, poorly drained soils of low resistivity. The presence of sulfate ñ reducing bacteria will accelerate corrosion.

These problems can be significantly reduced, if not eliminated, by the careful selection of material resistant to corrosion protection, only to learn a few years later of the consequences. And corrosion is not a reversible process. The remedy to this situation is very simple.

Amiantit Qatar Pipes Co ***(FLOWTITE)*** Brand of PipesAQAP Pipe is a glass- reinforced plastic(GRP) pipe produced on the continuously advancing mandrel process, ensuring a consistently uniform product meter to meter. Immune galvanic and electrolytic corrosion, AQAP 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 application too. In fact, AQAP pipe has been the material of choice in many middle east sewers, known to be the most aggressive in the world, for the past 20 years.

Technologies Yield Higher performance at Lower Cost

Light Weight, corrosion resistant and manufactured under strict quality standards, AQAP pipe is 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 optional cost savings and superior corrosion resistance offered by glass-reinforced plastics pipe by AQAP operation has resulted in it's widespread application for the following:

- Water transmission and distribution (portable & raw water)
- Sanitary sewerage collection systems and 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 waste.
- Irrigation
- Fire fighting

In replacing other material AQAP pipe delivers long, effective service life with low operation and maintenance costs. And AQAP pipe is usually the lowest cost option upfront too!

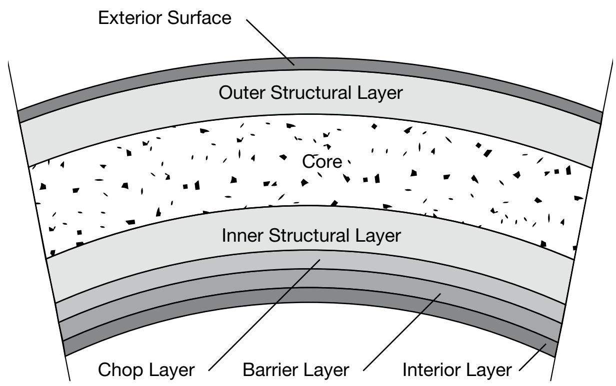
2. Product Benefits and Performance standards

Amiantit Qatar Pipe Company has been able to bring a product to market that can provide 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.

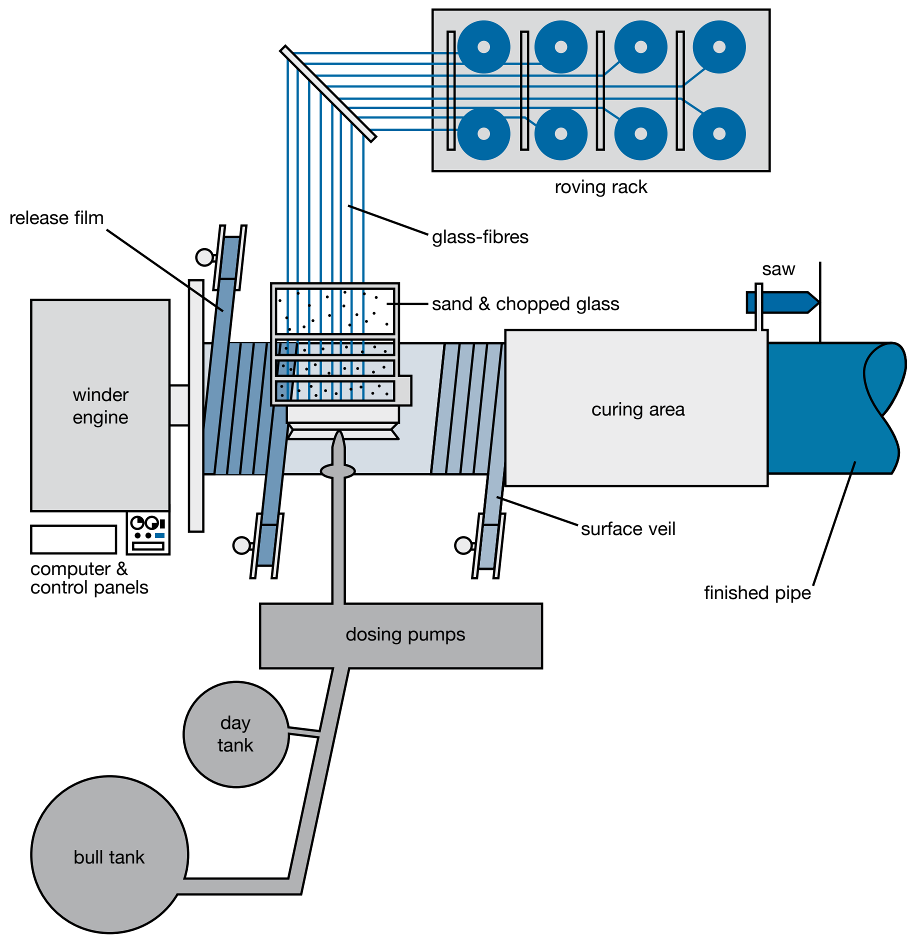
Features	Benefits
Corrosion-resistant material	• Long, effective service life • No need for lining, coatings, cathodic protection, wrap or other forms of corrosion protection. • Low maintenance costs • Hydraulic characteristics essentially constant overtime
Light weight (1/4 weight of ductile iron 1/10 weight of concrete)	• Low transport cost (nestable) • Eliminates needs 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 slim build-up can help lower cleaning costs
Precision FLOWTITE AQAP coupling with elastomeric REKA gaskets	• Tight efficient joint 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 lining projects
High technology pipe design	• Lower wave celerity than other piping material can mean less cost when designing for surge and water hummer pressure
High technology pipe manufacturing system producing pipe that complies to stringent performance standards (AWWA, ASTM, BS,etc…)	• High and consistent product quality world wide which ensure reliable product performance

The basic raw materials used in the ***FLOWTITE*** pipe's manufacturing are resin, fibreglass and silica sand. Usually unsaturated polyester resins are used since they give good performance for pressure sewer applications.

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 in the circumferential direction, thus incorporating continuous reinforcements in this direction yields a higher performing product at a lower cost. Using technology developed by material specialists, a very dense laminate is created that maximizes the contribution from 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 severe corrosive applications while utilising a less costly resin for the structural and outer portion of the laminate. Taking advantage of the winding process, other materials, such as a glass veil or polyester veil can be used to enhance the abrasion resistance and the finishing of the pipe.



The figure above shows a typical cross section of a pipe laminate. This section, as well as the way of applying and placing different raw materials, can differ depending on the pipe application.



Standards developed by ASTM. AWWA, BS, and ISO are applied to a variety of fiber glass pipe application including conveyance of sanitary sewage, water and industrial waste. Other local approvals are also available, dependent on country specific requirements. Amiantit is participating in the development of all these standards with representatives of all the worldwide organisations, thereby ensuring performancerequirements will result in reliable products.

ASTM

Currenly, there are several ASTM product standards in use which apply to a variety of fiber glass pipe with diameter ranges of 200 mm to 4000 mm and require the flexible, joint to withstand hydrostatic testing in configurations (per ASTM D4161) that simulate exaggerated in-use conditions. These standard include many tough qualifications and quality control tests. AQAP pipe is designed to meet all these ASTM standards.

ASTM	D3262	Gravity sewer
ASTM	D3517	Pressure pipe(water)
ASTM	D3754	Pressure sewer

AWWA

C950 is one of the most comprehensive product standard in existence for fiberglass pipe. This standard for pressure water application has extensive requirement for pipe and joints, concentrating on quality control and prototype qualification testing. Like ASTM standards. This is a product performance standard. AQAP pipe is designed to meet the performance requirements of this standard. AWWA has recently 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

3. Control Testing & Qualification Testing

3.1 Raw Materials

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

Raw Materials used in pipe production are:

Glass
Resin
Catalyst
Sand
Additives

3.2 Finished pipe

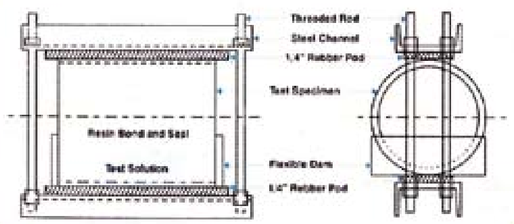
All pipes are subjected to the following control checks:

- Visual inspection
- Barcol hardness
- Wall thickness
- Section length
- Diameter
- Hydrostatic leak tightness test to 2 times rated pressure (only for PNG bar and above)

3.3 Physical Properties

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

Figure 1 Strain Corrosion Test Apparatus



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)

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
failure
- Axial and circumferential tensile load capacity
- Loss of Ignition (LOI)

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 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. AQAP pipe has been rigorously tested to verify conformance to the ASTM, BSEN, ISO and AWWA requirements.

3.4 Strain corrosion Testing

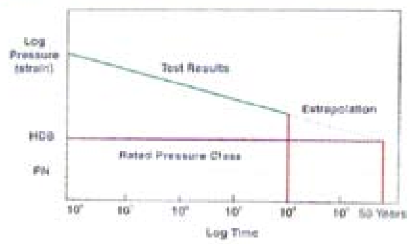
A unique and important performance requirement for GRP gravity pipe used in sewer applications is the chemical testing of the pipe deflected or strained condition. This strain corrosion testing is carried out in accordance with ASTM D 3681, and requires minimum of 18 ring samples of the pipe to be deflected to various level and held constant. These strained rings are then exposed at the invert of the interior surface to 1.0N (5% by weight) sulphuric acid (see figure 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. The time to failure (leakage) for each test sample is measured. The minimum extrapolated failure strain at 50 years, using a least square sregression 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 limitation for GRP pipe used for this type of service. Typically this is 5% in ground long – term deflections.

3.5 Hydrostatic design basis – HDB

Another important qualification test is the establishment of 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 a very high constant, pressure level. 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) for HDB, must be at least 1.8 times the rated pressure class (strain at the rated pressure) (see Figure 2).In other words, 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 2 Test Results Evaluation - ASTM Test Procedure B



3.6 Joint testing

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

3.7 Initial ring deflection:

All pipe 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%

3.8 Long-term ring bending

A GRP pipe's long-term (50 year) ring deflection of 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 pipe design. AQAP pipe is tested using the guidelines of ASTM D5365 "long-term ring bending strain of fiber glass pipe" and meets both requirements.

4. Product scope-Technical Data

4.1 Diameters

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

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

*other pipe ranges are available, consult Amiantit Qatar Pipe Company.

4.2 Lengths

The standard length of AQAP is 12 meters for diameters over 300 mm. Lengths of 6 and 18 meters are also available.

4.3 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.

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, and reducers.

4.5 Stiffness Class

Flowtite pipe can be supplied to the following specific initial stiffilesses (EI/D³)(STIS).

Stiffness Class	N/m²
SN 2500	2500
SN 5000	5000
SN 10000	10000

Hoop Tensile Load Capacity								
DN/PN	gravity	6	10	12	16	20	25	32
80	N/B	96	160	192	256	320	400	512
100	N/A	120	200	240	320	400	500	640
150	N/A	180	300	360	480	600	750	960
200	N/A	240	400	480	640	800	1000	1280
250	N/A	300	500	600	800	100	1250	1600
300	N/A	360	600	720	960	1200	1500	1920
350	N/A	420	700	840	1120	1400	1750	2240
400	N/A	480	800	960	1280	1600	2000	2560
450	N/A	540	900	1080	1440	1800	2250	2880
500	N/A	600	1000	1200	1600	2000	2500	3200
600	N/A	720	1200	1440	1920	2400	3000	3840
700	N/A	840	1400	1680	2240	2800	3500	4480
800	N/A	960	1600	1920	2560	3200	4000	5120
900	N/A	1080	1800	2160	2880	3600	4500	5760
1000	N/A	1200	2000	2400	3200	4000	5000	6400
1100	N/A	1320	2200	2640	3520	4400	5500	7040
1200	N/A	1440	2400	2880	3840	4800	6000	7680
1300	N/A	1560	2600	3120	4160	5200	6500	8320
1400	N/A	1680	2800	3360	4480	5600	7000	8960
1500	N/A	1800	3000	3600	4800	6000	7500	9600
1600	N/A	1920	3200	3840	5120	6400	8000	10240
1700	N/A	2040	3400	4080	5440	6800	8500	10880
1800	N/A	2160	3600	4320	5760	7200	9000	11520
2000	N/A	2400	4000	4800	6400	8000	10000	12800
2200	N/A	2640	4400	5280	7040	8800	11000	14080
2300	N/A	2760	4600	5520	7360	9200	11500	14720
2400	N/A	2880	4800	5760	7680	9600	12000	15360
2600	N/A	3120	5200	6240	8320	10400	13000	16640
2800	N/A	3360	5600	6720	8960	11200	14000	17920
2900	N/A	3480	5800	6960	9280	11600	14500	18560
3000	N/A	3600	6000	7200	9600	12000	15000	19200
3200	N/A	3840	6400	7680	10240	12800	16000	20480
3400	N/A	4080	6800	8160	10880	13600	17000	21760
3600	N/A	4320	7200	8640	11520	14400	18000	23040
3800	N/A	4560	7600	9120	12160	15200	19000	24320
4000	N/A	4800	8000	9600	12800	16000	20000	25600

Axial Tensile Load Capacity								
DN/PN	gravity	6	10	12	16	20	25	32
80	63	63	63	63	63	63	63	63
100	70	75	80	85	90	99	110	125
150	80	85	100	105	100	119	130	145
200	102	102	110	115	120	120	140	155
250	102	105	125	130	135	150	169	197
300	102	115	140	145	150	169	192	236
350	105	123	150	155	168	193	224	276
400	105	130	160	165	185	216	255	315
450	110	140	175	183	207	242	287	355
500	115	150	190	200	228	268	319	394
600	125	165	220	235	273	322	383	473
700	135	180	250	265	296	356	431	532
800	150	200	280	300	325	380	450	545
900	165	215	310	330	394	474	574	709
1000	185	230	340	360	410	493	597	738
1100	195	245	360	388	457	549	666	823
1200	205	260	380	415	504	605	735	908
1300	215	275	400	440	486	629	764	944
1400	225	290	420	465	567	652	792	979
1500	238	305	440	493	607	707	855	1047
1600	250	320	460	520	646	761	917	1114
1700	263	342	486	550	686	816	980	1181
1800	275	366	511	580	725	870	1042	1248
2000	300	380	553	601	751	902	1094	1352
2200	325	410	596	675	810	927	1125	1390
2300	338	432	638	708	868	993	1196	1452
2400	350	454	681	740	925	1059	1267	1513
2600	375	482	723	786	982	1125	1346	1608
2800	400	511	766	832	1040	1192	1425	1702
2900	415	539	809	879	1098	1258	1506	1797
3000	430	567	851	925	1156	1324	1584	1891
3200	460	596	894	971	1214	1390	1663	1986
3400	490	624	936	1017	1271	1456	1741	2080
3600	520	681	1021	1110	1387	1589	1899	2270
3800	550	710	1064	1156	1445	1655	1979	2365
4000	580	738	1106	1202	1503	1721	2058	2459

4.6 Pressure

Pressure classes of AQAP pipe shall be selected from the series listed below. Not all pressure classes are available in all Diameters and stiffness.

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 AQAP designed, the following capabilities should be noted and observed in service.

Diameter and Pressure

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

*other pressure ratings are available, please consult Amiantit Qatar Pipes Co. Ltd

Hydrotesting	
Standard Factory Test Pressure	2X PN
Mlxilnum Field	1.5 X PN(Pressure Class)
Surge	
Maximum Pressure	1.4 X PN(Pressure Class)

4.7 Flow Velocity

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

4.8 UV Resistance

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

4.9 Poisson's Ratio

Poisson's ratio is influenced by the pipe construction. For AQAP, 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.

4.10 Thermal Coefficient

The thermal coefficient of axial expansion and contraction for AQAP is 24 to 30 $x10^{-}$ cm/cmjC.

5. Hydraulic Characteristics Of AQAP's FRP Pipe

Amiantit Qatar Pipes Ltd. (AQAP) produces FRP 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 surfaces 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 FRP 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 are in good agreement even with the international standards.

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

AQAP is capable of carrying out Hydraulic Calculations using state of the art commercially available software PIPENET. As guide line to designer figure 1.1 and 1.2 will provide typical head losses for long diameter pipes and small diameter pipes.

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

5.1 Abrasion Resistance

Abrasion resistance can be related to the effects that send or other similar material may have on the interior surface of the pipe. While there is no widely standardized testing procedure or rating method, FLOWTITE AQAP has been evaluated by using the Dramastadt 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 the used at Dramastadt University, the average abrasion loss of AQAP is 0.84 mm at 100.000 cycles.

Roughness Parameters (Men Values)			
Flow Rate	Cole Brooke- White	Manning	Hazen - Williams
(m^3/hr)	E or K (mm)	M($m^{1/3}$/s)	C(10^{-13} m /s)
410-2860	0.029	104	146

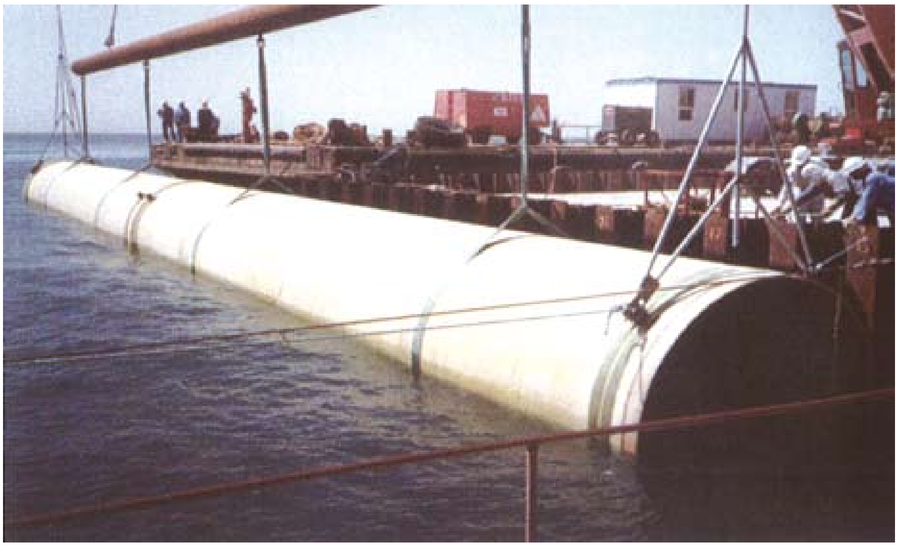
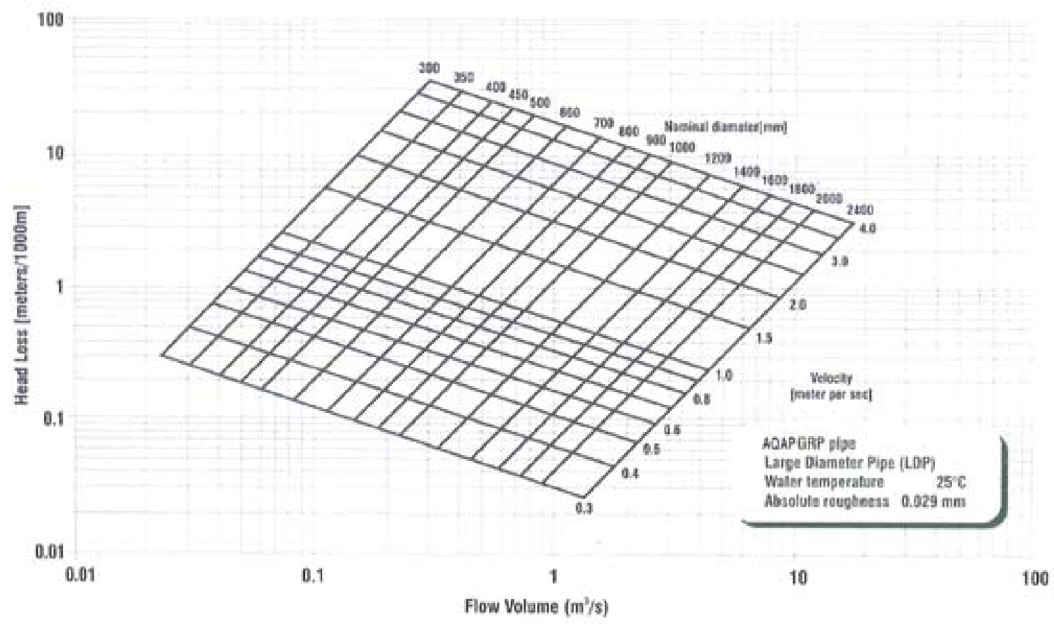
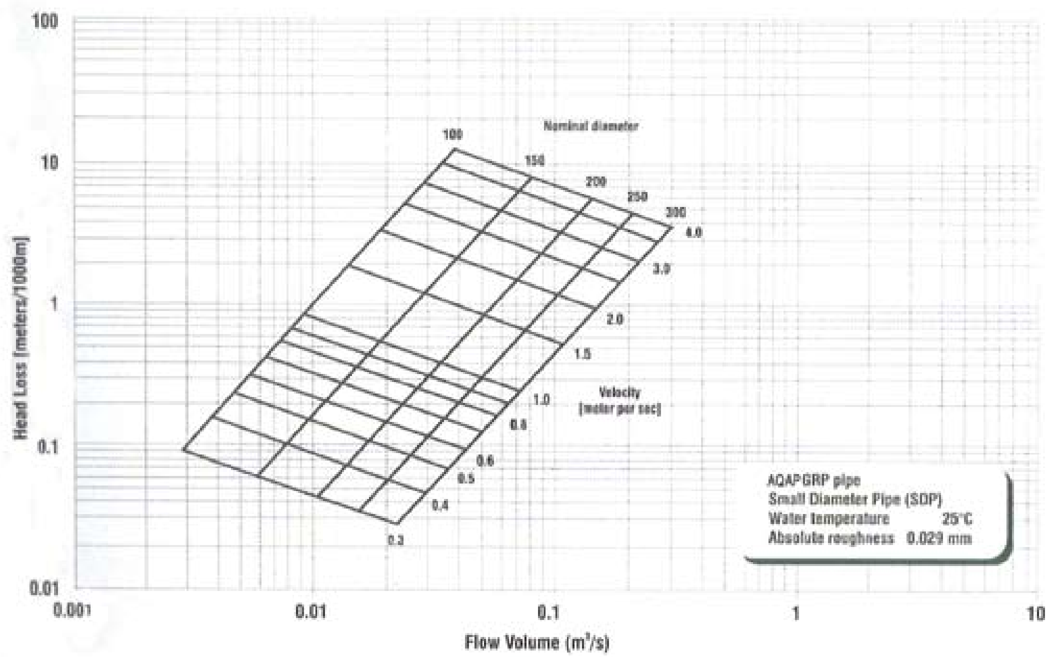


Fig. 1.1



Head Loss (meters/1000m)
Flow Volume (m³/s)
Nominal diameter(mm)
300
350
400
450
500
600
700
800
900
1000
1200
1400
1600
1800
2000
2400
Velocity
(meter per sec)
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
AQAPGRP pipe
Large Diameter Pipe (LDP)
Water temperature 25°C
Absolute roughness 0.029 mm

Fig. 1.2



Head Loss (meters/1000m)
Flow Volume (m³/s)
Nominal diameter
100
150
200
250
300
Velocity
(meter per sec)
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
AQAPGRP pipe
Small Diameter Pipe (SDP)
Water temperature 25°C
Absolute roughness 0.029 mm

5.2 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, hoop tensile modulus and physical layout of the pipe system

The water hammer pressure expected for AQAP is approximately 50% of that for steel and ductile, iron pipe, for similar conditions. AQAP 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 from 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 (m²/s)

Surge Wave Celerity for AQAP Fiberglass Pipes

DN	350-400	450-800	900-2500
SN2500	Meters/Sec		
PN6	365	350	340
PN10	435	420	405
PN16	500	490	480
SN5000	Meters/Sec		
PN6	405	380	370
PN10	435	420	410
PN16	505	495	480
PN25	575	570	560
SN10000	Meters/Sec		
PN6	420	415	410
PN10	435	425	415
PN16	500	495	485
PN25	580	570	560
PN32	620	615	615

DN	80	100	150	200	250
SN 10000	Meters/Sec				
PN6	580	560	540	520	500
PN10	590	570	560	540	520
PN16	640	620	610	600	590

6. Pipe Classification Selection

6.1 Stiffness

The stiffness of AQAP 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 is selected according to two parameters.

Stiffness Class	N/m^2
SN 2500	2500
SN 5000	5000
SN 10000	10000

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 D 1586 Standard Penetration Test. Some typical soil blow count values relative to soil types and density are given in Table 4.1.

A wide range of backfill soil types are offered in Table 4.2 (Page 30) 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 large, 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 4.3 (page31).

The second parameter for pipe stiffness class selection is negative pressure, if it exists. Table 4.6(Page32) of this brochure 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.

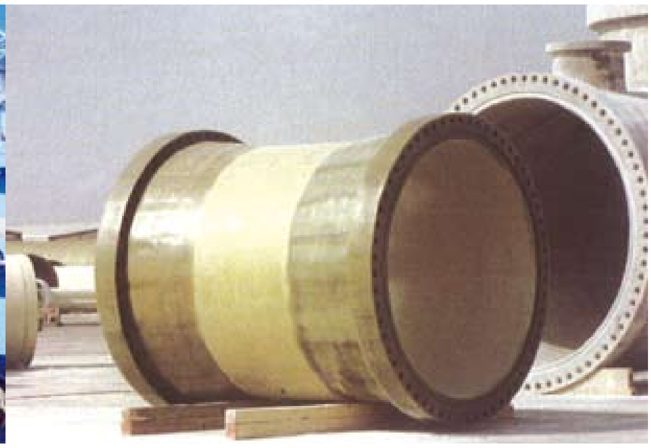
6.2 Installation Types

The illustrations on Page 32 show the standard installation types commonly used with AQAP. 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.

AQAP can be installed in a number of different situation including above ground, sub-aqueous, trenchless and sloped applications. These application can require more initial planning and more care than the standard buried pipe installation and therefore AQAP has developed specific instructions for these methods. Please contact Amiantit Qatar Pipe Co. for these detailed instructions.

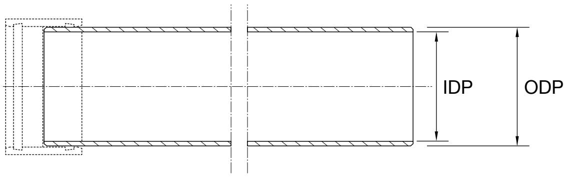
Table 4.1

Native Soil Group Classification			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

7. Standard Pipe and Coupling Data Sheet

Our ***Flowtite*** pipe systems for pressure sewer applications are supplied in the standard diameter range, pressure and stiffness classes as listed below. Other diameters and pressure classes are available on request.



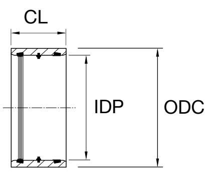
Small Dia Pipes

"B2"-OD Series	SN	1000			
	PN	10/16			
		DN	ODP	IDP	kg/m*
		mm	mm	mm	
		100	116.4	109.2	2.0
		150	168.4	158.8	4.2
		200	220.9	208.9	7.3
		250	272.5	258.3	11.0
		300	325.1	308.5	15.4

* Approx. Weights

Table7.1 Small Diameters – Pipe Thickness & Weight

SN = Pipe stiffness, PN = Nominal Pressure, ODP = Outside diameter of pipe, IDP = Inside diameter of pipe.



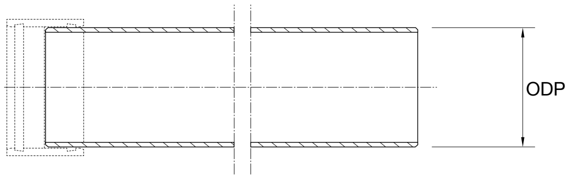
Double Bell Coupling FPC for SDP

	SN	1000			
	PN	10/16			
		DN	ODP	IDP	kg/m*
		mm	mm	mm	
		100	116.5	150	1.3
		150	168.5	150	2.1
		200	222.0	175	4.2
		250	273.6	175	5.1
		300	326.0	175	6.0

* Approx. Weights

Table 7.2 Small Diameters – Pipe Thickness & Weight

SN = Pipe stiffness, PN = Nominal Pressure, ODC = outside diameter of coupling, IDC = Inside diameter of coupling, CL = Coupling length

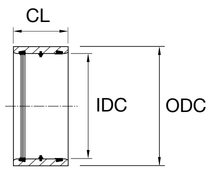


Large Dia Pipes (LDP)

	SN		5000		10000	
	PN		6	10	6	10
		ODP+/-0.5				
	DN	mm	kg/m²	kg/m²	kg/m²	kg/m²
"B2"-OD Series	300	324.0	11.1	11.1	13.4	13.5
	350	375.9	14.8	14.8	18.3	18.3
	400	426.8	18.9	18.6	23.6	23.6
	450	477.7	23.2	23.2	29.4	29.4
	500	529.6	29.0	29.0	36.6	36.6
"B1"-OD Series	600	616.5	39.2	38.5	48.6	48.6
	700	718.5	52.9	48.9	65.5	64.4
	800	820.5	69.3	62.2	84.8	82.6
	900	922.5	86.8	77.4	106.6	102.7
	1000	1024.5	105.0	94.6	129.7	125.5
	1100	1126.5	125.5	113.2	154.6	150.9
	1200	1228.5	148.1	134.3	183.5	178.7
	1300	1330.0	172.6	157.0	212.8	208.4
	1400	1432.5	198.3	181.1	246.9	241.3
	1500	1534.5	227.4	207.3	281.0	276.1
	1600	1636.5	256.8	235.5	319.0	313.0
	1700	1738.5	290.1	264.8	359.2	353.0
	1800	1840.5	323.4	296.6	402.3	394.4
	1900	1962.0	362.2	332.8	451.3	443.1
	2000	2044.5	397.3	364.3	494.1	485.5
	2100	2146.5	437.1	401.1	543.8	534.7
	2200	2248.5	478.9	439.7	595.5	585.7
	2300	2350.5	522.1	479.3	648.9	640.5
	2400	2452.5	566.9	521.7	706.4	696.9
	2500	2554.5	614.8	564.9	764.9	754.6
	2600	2656.5	663.9	610.3	826.4	815.9
	2700	2758.5	715.6	658.1	891.4	879.4
	2800	2860.5	768.9	707.2	957.3	944.6
	2900	2962.5	822.6	757.2	1025.9	1013.0
	3000	3064.5	881.4	809.6	1096.6	1083.1
	3200	3263.5	991.6	924.5	12389	-
	3400	3472.5	1120.2	1042.1	1396.1	-
	3600	3676.5	1252.7	1168.6	1565.8	-
	3800	3880.5	1397.3	1302.0	1397.3	-
	4000	4100.5	1552.6	1447.6	1938.7	-

* Approx. Weights

Table 7.3 Large Diameters – Data & Weight



Double Bell Coupling for LDP

Series	PN			6		10	
		Length CL	IDC +/-0.5	ODC		ODC	
	DN	mm	mm	mm	kg/pc*	mm	kg/pc*
"B2"-OD Series	300	270	326.0	367.8	10.9	368.6	11.1
"B2"-OD Series	350	270	377.9	419.5	12.4	420.7	12.8
"B2"-OD Series	400	270	428.8	470.4	14.0	471.6	14.5
"B2"-OD Series	450	270	479.7	520.9	15.6	522.5	16.3
"B2"-OD Series	500	270	531.6	572.6	17.2	574.2	17.9
"B1"-OD Series	600	330	619	666.1	28.6	667.7	29.6
"B1"-OD Series	700	330	721	767.7	32.8	770.1	34.5
"B1"-OD Series	800	330	823	869.5	37.1	873.7	40.6
"B1"-OD Series	900	330	925	972.5	42.5	977.1	46.8
"B1"-OD Series	1000	330	1027	1075.5	48.1	1080.3	53.1
"B1"-OD Series	1100	330	1129	1178.1	53.5	1183.5	59.5
"B1"-OD Series	1200	330	1231	1280.7	58.9	1286.5	65.9
"B1"-OD Series	1300	330	1333	1380.8	64.4	1388.8	72.4
"B1"-OD Series	1400	330	1435	1485.7	69.9	1491.9	78.7
"B1"-OD Series	1500	330	1537	1587.6	75.4	1594.2	85.4
"B1"-OD Series	1600	330	1639	1690.7	81.2	1697.5	92.3
"B1"-OD Series	1700	330	1741	1790.1	86.9	1797.1	99.3
"B1"-OD Series	1800	330	1843	1895.5	92.6	1902.9	106.2
"B1"-OD Series	1900	330	1945	1995.3	98.5	2002.3	115.1
"B1"-OD Series	2000	330	2047	2100.3	104.4	2110.1	124.4
"B1"-OD Series	2100	330	2149	2199.9	110.4	2209.9	133.8
"B1"-OD Series	2200	330	2251	2305.1	116.4	2316.9	142.7
"B1"-OD Series	2300	330	2353	2404.5	122.6	2415.5	151.8
"B1"-OD Series	2400	330	2455	2509.9	128.8	2523.3	161.1
"B1"-OD Series	2500	330	2557	2628.0	187.7	2646.4	224.7
"B1"-OD Series	2600	360	2659	2733.5	208.8	2742.6	237.9
"B1"-OD Series	2700	360	2761	2730.4	218.4	2845.2	248.6
"B1"-OD Series	2800	360	2863	2938.7	228.2	2947.8	259.5
"B1"-OD Series	2900	360	2965	3035.7	238.1	3050.4	270.6
"B1"-OD Series	3000	360	3067	3143.9	248.2	3153.0	281.7
"B1"-OD Series	3200	360	3271	3343	251.6	3353.6	289.8
"B1"-OD Series	3400	360	3475	3548	270.9	3558.6	311.4
"B1"-OD Series	3600	360	2679	3753	290.5	3763.5	333.3
"B1"-OD Series	3800	360	3883	3957.8	309.9	3968.4	355.0
"B1"-OD Series	4000	360	4103	4178.6	330.9	4189.2	378.5

* Approx. Weights

Table 7.4 Large Diameters – Data & Weight – Double Bell Coupling (FPC) data

Alternatively AQAP has B1 Series for DN 300-500

B1 Series for Pipes and Couplings

Series		Pipe	Coupling	
		ODP+/-0.5	Length CL	IDC +/-0.5
	DN	mm	mm	mm
"B1"-OD Series	300	310.5	270	313
"B1"-OD Series	350	361.5	270	364
"B1"-OD Series	400	412.5	270	415
"B1"-OD Series	450	463.5	270	466
"B1"-OD Series	500	514.5	270	517

8. Pipe Joining

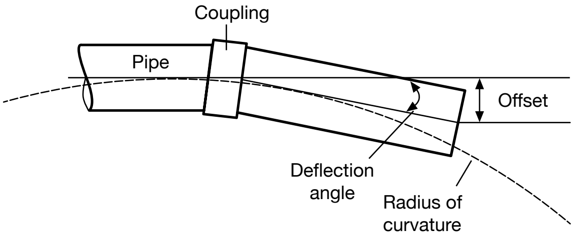
8.1 Double Bell Coupling (FPC)

FLOWTITE pipe sections are typically joined using
FLOWTITE pressure couplings (FPC). Pipe and couplings may be supplied separately, or the pipe may be supplied with a coupling installed on one end. The FLOWTITE coupling utilises an elastomeric gasket for sealing. The gasket sits in a precision-machined groove in each end of the coupling and seats and seals against a spigot surface

*Note: Detailed installation instructions can be found in our separate publications for pipe installation.

8.2 Joint Angular Deflection

The joint is extensively tested and qualified in accordance with ASTM D4161, ISO DIS8639 and EN 1119. Maximum angular deflection (turn) at each coupling joint, measured as the change in adjacent pipe centre lines, must not exceed the amounts given in table below.



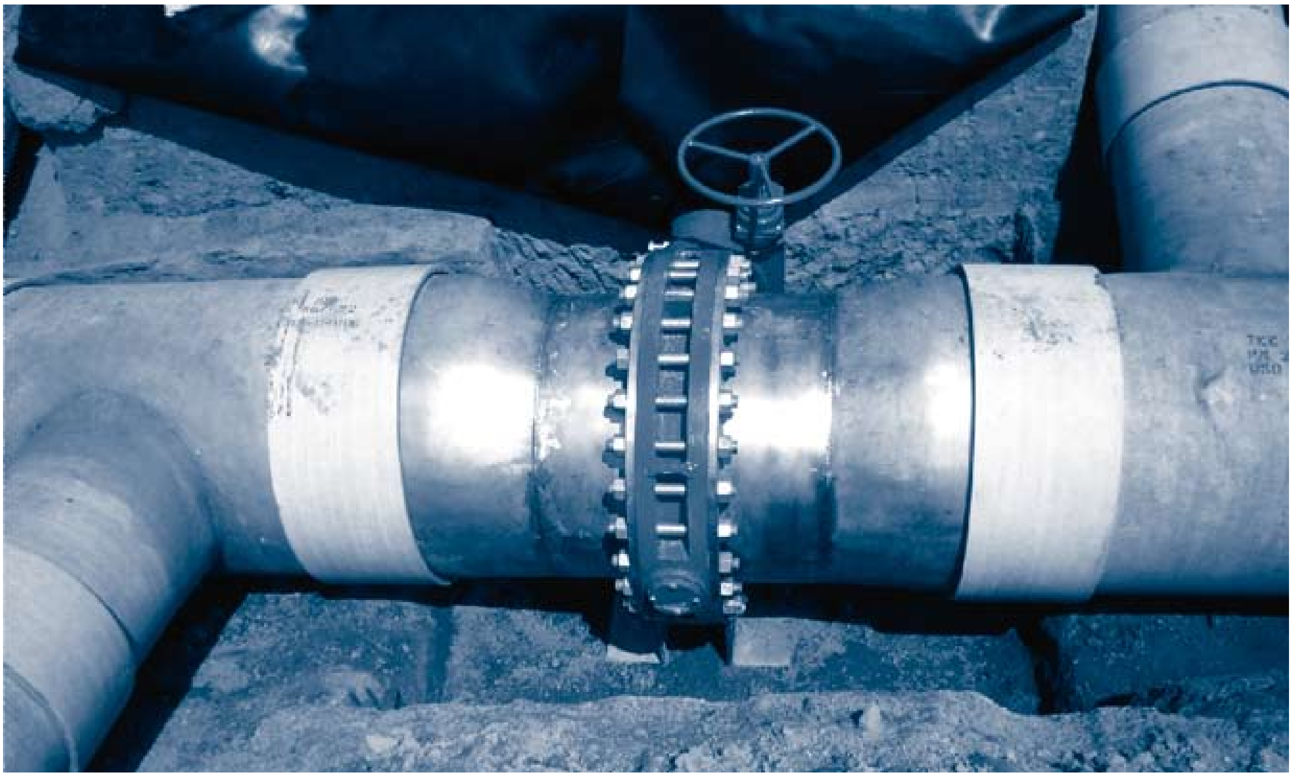
The pipes must be joined in a straight alignment, but not all the way to the home line, and thereafter deflected angularly as required.

Nom Pipe Diameter (mm)	Angular deflection (degrees)
DN< 500	3.0
15<DN< 1800	2.0
900< DN< 1800	1.0
DN> 1800	0.5

Table 8.1 Angular Deflection at Double coupling Joint

Angle of Deflection (deg)	Maximum Offset (mm) Pipe length			Radius of Cuvature (m) Pipe length		
	3 m	6 m	12 m	3 m	6 m	12 m
3.0	157	314	628	57	115	229
2.5	136	261	523	69	137	275
2.0	105	209	419	86	172	344
1.5	78	157	313	114	228	456
1.3	65	120	240	132	265	529
1.0	52	105	209	172	344	688
0.8	39	78	156	215	430	860
1.5	25	52	104	344	688	1376

Table 8.2 Offset and Radius of Curvature



8.3 Locked Joints

The ***FLOWTITE*** locked joint is a double bell with rubber gaskets and locking rods to transfer axial thrust from one pipe section to another. On each side, the coupling bell has a standard rubber gasket and a rod-groove system, through which the load is transferred via compressive and shear action. The pipe spigot for locked joints has a matching groove.

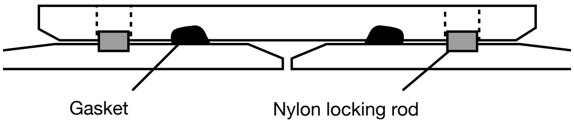


Figure 8.3 Locked Joint

The joint is assembled by using a similar procedure as the standard FLOWTITE coupling, except that there is no centre register.

8.4 GRP Flanges

The standard bolt pattern to which our flanges are manufactured is in accordance with ISO2084. Other bolting dimension systems such as AWWA, ANSI, DIN and JIS can also be supplied. Available are flange connections with fibreglass adhesives, as well as zinc steel loose-type flanges. Fibreglass tight flanges and loose-type flanges made of fibreglass can be delivered to order. Loose and fixed flanges are available for all pressure classes.

Contact moulded Flanged joints:

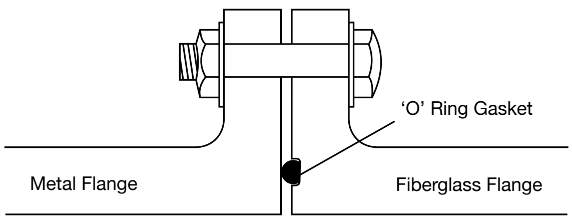


Figure 8.4 Flanged joint

Fixed Flange joints:

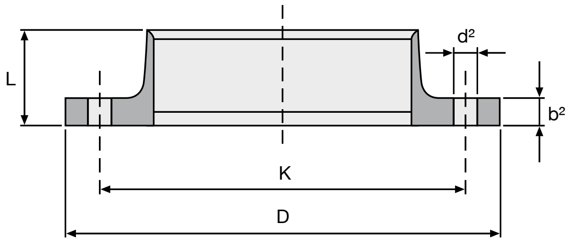


Figure 8.5 Flanged joint

Loose Ring Flanges

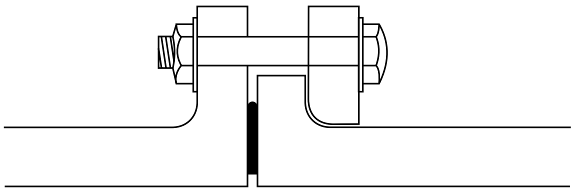


Figure 8.6 Loose Ring with flat gasket incl. steel support

8.5 Mechanical Steel Couplings

When connecting FLOWTITE pipe to other materials with different outside diameters, flexible steel couplings are one of the preferred jointing methods. These couplings consist of a steel mantle with an interior rubber sealing sleeve. They may also be used to join FLOWTITE pipe sections together, for example in a repair or for closure. Three grades are commonly available:

Coated steel mantle
Stainless steel mantle
Hot dip galvanized steel mantle

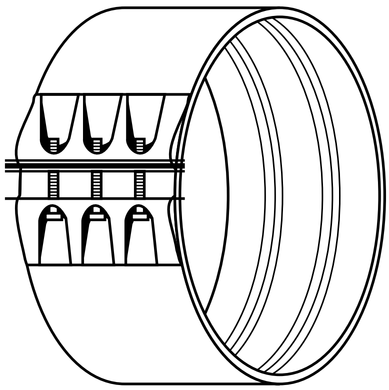


Figure 8.7 Flexible steel coupling

Mechanical couplings have been used to join pipes of different materials and diameters, and to adapt to flange outlets. FLOWTITE Technology has found a wide manufacturing variance in these couplings, including bolt size, number of bolts and gasket design which makes standardized recommendations impossible. If a mechanical joint is used to join FLOWTITE to another pipe material then a dual independent bolting system allows for the independent tightening of the FLOWTITEside which typically requires less torque than recommen-ded by the coupling manufacturer.

Consequently, we cannot recommend the general use of mechanical couplings with FLOWTITE pipe. If the installer intends to use a specific design (brand and model) of mechanical coupling, he is advised to consult with the local FLOWTITE pipe supplier prior to its purchase. The pipe supplier can then advise under what specific conditions, if any, this design might be suitable for use with FLOWTITE.

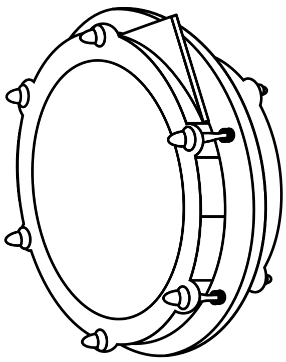


Figure 8.8 Dual bolt mechanical coupling

8.6 Laminated Joints (Butt strap)

Laminated Joints are typically where the transmission of axial forces from internal pressure is required, or as a repair method. The length and thickness of the lay-up depends on diameter and pressure.

Detailed information about the local availability of joints and joining systems can be requested from your local supplier, or is attached to this brochure.

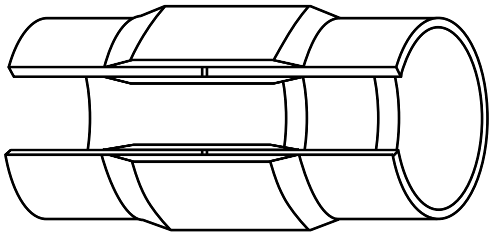
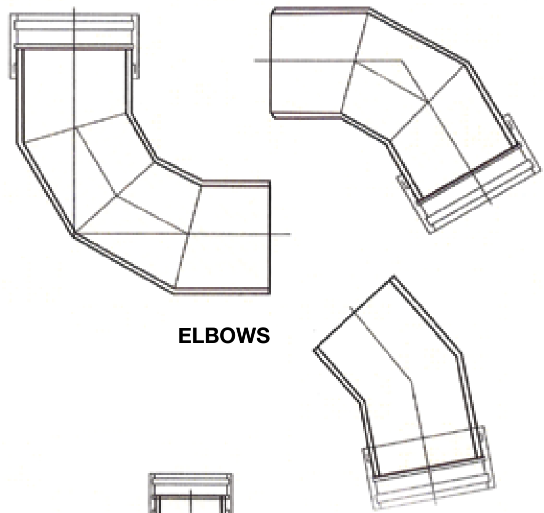


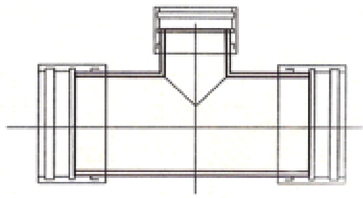
Figure 8.9 Laminated joint

9. Fittings

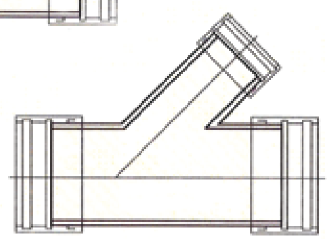
Amiantit Qatar Pipe Company has created a standardized line of GRP fitting that are moulded or fabricated using the same material that are used to produce AQAP pipe. One of the benefit of ***Flowtite*** AQAP pipe is the ability to fabricate as wide assortment of fittings, standard as well as non standard. The following table shows the standard dimensions of standard fittings with different ends configuration.



ELBOWS

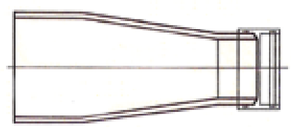


TEES

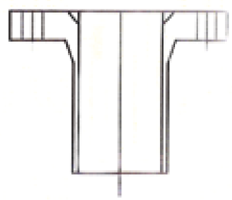


WYES

ECCENTRIC REDUCERS

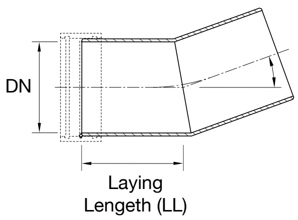


CONCENTRIC REDUCERS

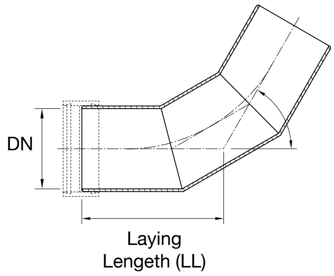


WYES

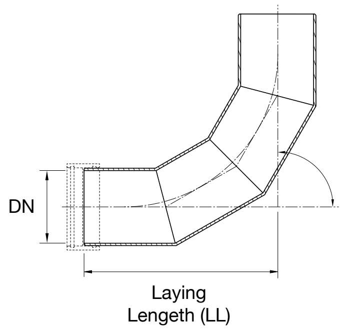
9.1 Segmented Bends



One Segmented Bend



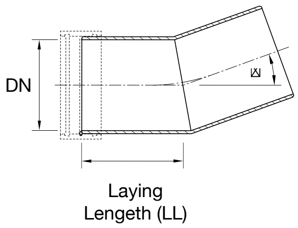
Two Segmented Bend



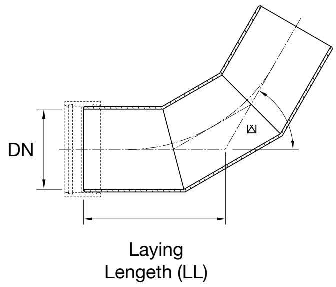
Three Segmented Bend

	Angle						
"B2" OD Series	11.25°	15°	22.5°	30°	45°	60°	90°
DN	No. of Mitres with Laying Length (LL)						
mm	1	1	1	1	2	2	3
100	250	250	250	250	250	300	350
150	250	250	250	250	300	300	400
200	250	250	250	300	350	400	500
250	300	300	300	300	400	450	600
300	400	350	400	400	500	550	750
350	400	400	400	450	550	600	800
400	450	450	450	450	600	650	900
450	450	450	500	500	600	700	1000
500	450	450	500	500	650	750	1050

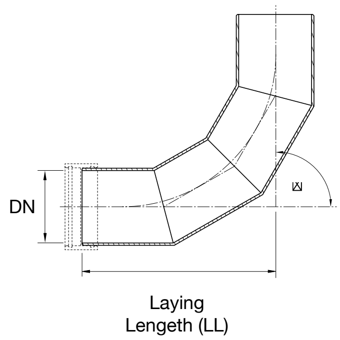
Table 9.1 Small Diameters – Laying Length LL in mm – Stiffness and Pressure Classes acc. to Table 4.5 and 5-2



One Segmented Bend



Two Segmented Bend

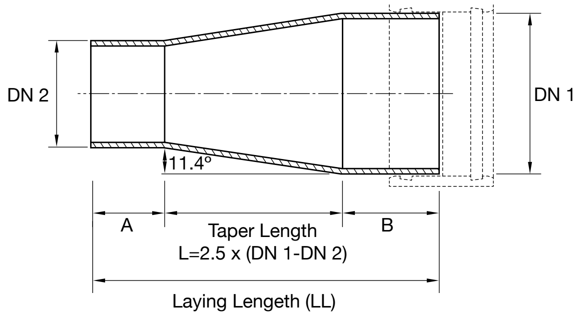


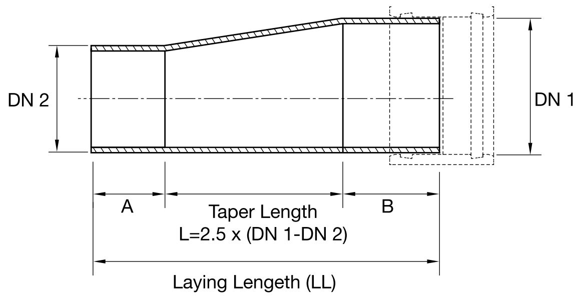
Three Segmented Bend

	Angle						
”B1“ OD Series	11.25°	15°	22.5°	30°	45°	60°	90°
DN	No. of Mitres with Laying Length (LL)						
mm	1	1	1	1	2	2	3
600	400	400	400	450	600	700	1100
700	400	400	450	450	650	800	1200
800	450	450	450	500	700	850	1350
900	450	450	500	550	800	950	1500
1000	450	500	500	550	850	1000	1650
1100	500	500	550	600	900	1100	1800
1200	500	550	600	600	950	1200	1950
1300	600	600	650	700	1050	1300	2100
1400	600	600	650	700	1100	1350	2250
1500	650	650	700	750	1200	1450	2400
1600	650	700	750	800	1250	1550	2550
1700	650	700	750	800	1300	1600	2700
1800	700	750	800	850	1350	1700	2850
1900	700	750	800	850	1400	1750	2950
2000	700	750	800	900	1450	1800	3100
2100	700	750	800	900	1500	1850	3200
2200	700	750	800	900	1550	1950	3350
2300	700	750	800	950	1550	2000	3450
2400	700	750	800	1000	1550	2100	3600
2500	700	750	800	1000	1600	2200	3750
2600	700	800	900	1000	1700	2200	3800
2700	800	800	900	1000	1800	2200	4000
2800	800	800	900	1000	1800	2300	4100
2900	800	800	900	1000	1900	2400	4200
3000	800	800	900	1100	1900	2400	4300

Table 9.2 Large Diameters – Laying Length LL in mm – Stiffness and Pressure Classes acc. to Table 4.5 and 4.6

9.2 Segmented Reducers – Concentric –Excentric





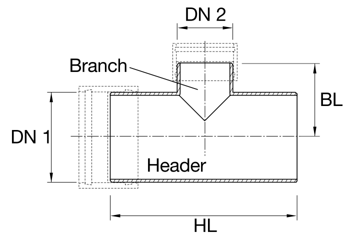
DN 1 [mm]	DN 2 [mm]	Taper Length L [mm]	Pipe Length A=B [mm]	Laying Length LL [mm]
150	100	125	300	725
200	100	250	300	850
200	150	125	300	725
250	150	250	300	850
250	200	125	300	725
300	200	250	400	1050
300	250	125	400	925
350	250	250	400	1050
350	300	125	400	925
400	300	250	400	1050
400	350	125	400	925
450	350	250	400	1050
450	400	125	400	925
500	400	250	400	1050
500	450	125	400	925
600	400	500	500	1300
600	450	375	400	1175
600	500	250	400	1050
700	500	500	400	1300
700	600	250	400	1050
800	600	500	400	1300
800	700	250	400	1050
900	700	500	400	1300
900	800	250	400	1050
1000	800	500	400	1300
1000	900	250	400	1050
1100	900	500	500	1500
1100	1000	250	500	1250
1200	800	1000	500	2000
1200	1000	500	500	1500
1200	1100	250	500	1250
1300	1100	500	500	1500
1300	1200	250	500	1250
1400	1200	500	500	1500
1400	1300	250	500	1250

Table 9.3Concentric Reducers – Stiffness and Pressure Classes acc. to Table 4.5 and 4.6

DN 1 [mm]	DN 2 [mm]	Taper Length L [mm]	Pipe Length A=B [mm]	Laying Length LL [mm]
1500	1300	500	600	1700
1500	1400	250	600	1450
1600	1200	1000	600	2200
1600	1400	500	600	1700
1600	1500	250	600	1450
1700	1500	500	600	1700
1700	1600	250	600	1450
1800	1600	500	600	1700
1800	1700	250	600	1450
1900	1700	500	600	1700
1900	1800	250	600	1450
2000	1800	500	600	1700
2000	1900	250	600	1450
2100	1900	500	600	1700
2100	2000	250	600	1450
2200	2000	500	600	1700
2200	2100	250	600	1450
2300	2100	500	600	1700
2300	2200	250	600	1450
2400	2200	500	600	1700
2400	2300	250	600	1450
2500	2300	500	600	1700
2500	2400	250	600	1450
2600	2200	1000	600	2200
2600	2400	500	600	1700
2700	2500	500	600	1700
2700	2600	250	600	1450
2800	2400	1000	600	2200
2800	2600	500	600	1700
2900	2700	500	600	1700
2900	2800	250	600	1450
3000	2600	1000	600	2200
3000	2800	500	600	1700

Table 9.4 Concentric Reducers – Stiffness and Pressure Classes acc. to Table 4.5 and 4.6

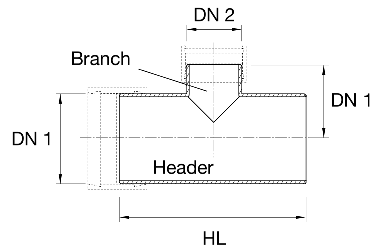
9.3 Segmented Tees
Pressure Class PN 6
DN 2 = 100 – 1100 mm



DN 2 / DN 1	100		150		200		250		300		350		400		450		500		600		700		800		900		1000		1100	
	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	720	380	780	380	820	400	900	420	1000	500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	720	400	780	400	820	420	900	460	1020	540	1100	560	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	720	440	780	440	820	440	920	480	1020	560	1100	580	1180	600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	720	460	780	460	840	480	920	500	1020	580	1100	600	1180	620	1260	640	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	720	480	780	480	840	500	920	520	1020	620	1100	640	1180	640	1280	680	1360	680	–	–	–	–	–	–	–	–	–	–	–	–
600	780	520	840	520	900	540	980	560	1080	660	1160	680	1260	700	1340	720	1420	720	1560	800	–	–	–	–	–	–	–	–	–	–
700	800	580	860	580	920	600	980	620	1080	700	1160	720	1260	740	1340	760	4440	780	1600	860	1760	880	–	–	–	–	–	–	–	–
800	800	620	860	640	920	660	1000	680	1080	760	1160	780	1260	800	1360	820	1440	840	1600	900	1780	940	1940	980	–	–	–	–	–	–
900	820	680	880	680	940	700	1000	720	1100	800	1180	820	1260	840	1360	880	1440	880	1600	960	1800	1000	1960	1040	2120	1060	–	–	–	–
1000	850	750	900	750	950	750	1000	800	1100	850	1200	900	1300	900	1400	950	1450	950	1600	1000	1800	1050	2000	1100	2150	1150	2300	1150	–	–
1100	850	800	900	800	950	800	1050	850	1100	900	1200	950	1300	950	1400	1000	1450	1000	1600	1050	1800	1100	2000	1150	2150	1200	2350	1250	2500	1250
1200	850	850	900	850	950	900	1050	900	1150	1000	1200	1000	1300	1000	1400	1050	1450	1050	1650	1100	1800	1150	2000	1200	2150	1250	2350	1300	2500	1300
1300	850	900	950	900	1000	950	1050	950	1150	1050	1250	1050	1300	1050	1400	1100	1500	1100	1650	1200	1800	1200	2000	1250	2150	1300	2350	1350	2550	1400
1400	900	950	950	950	1000	1000	1050	1000	1150	1100	1250	1100	1300	1100	1400	1150	1500	1150	1650	1250	1800	1250	2000	1300	2150	1350	2350	1400	2550	1450
1500	900	1000	950	1000	1000	1050	1050	1050	1150	1150	1250	1150	1300	1150	1400	1200	1500	1200	1650	1300	1800	1300	2000	1350	2200	1400	2350	1450	2550	1500
1600	950	1050	1000	1100	1050	1100	1100	1100	1150	1200	1250	1200	1300	1200	1400	1250	1500	1250	1650	1350	1850	1350	2000	1400	2200	1450	2350	1500	2550	1550
1700	950	1150	1000	1150	1050	1150	1100	1150	1150	1250	1250	1250	1350	1300	1400	1300	1500	1300	1650	1400	1850	1400	2000	1450	2200	1500	2350	1550	2550	1600
1800	1000	1200	1050	1200	1100	1200	1150	1200	1200	1300	1250	1300	1350	1350	1450	1350	1500	1350	1650	1450	1850	1450	2000	1500	2200	1550	2350	1600	2550	1650
1900	1000	1250	1050	1250	1100	1250	1150	1250	1200	1350	1250	1350	1350	1400	1450	1400	1500	1400	1650	1500	1850	1550	2000	1550	2200	1600	2400	1650	2550	1700
2000	1000	1300	1100	1300	1100	1300	1200	1300	1300	1400	1300	1500	1400	1500	1500	1500	1500	1500	1700	1600	1900	1600	2100	1600	2200	1700	2400	1700	2600	1800
2100	1100	1400	1100	1400	1200	1400	1200	1400	1300	1500	1300	1500	1400	1500	1500	1500	1600	1600	1700	1600	1900	1700	2100	1700	2200	1700	2400	1800	2600	1800
2200	1100	1400	1100	1400	1200	1400	1200	1500	1300	1500	1300	1600	1400	1600	1500	1600	1600	1600	1700	1700	1900	1700	2100	1700	2200	1800	2400	1800	2600	1900
2300	1100	1500	1200	1500	1200	1500	1300	1500	1300	1600	1400	1600	1400	1600	1500	1600	1600	1700	1700	1700	1900	1800	2100	1800	2200	1800	2400	1900	2600	1900
2400	1100	1500	1200	1500	1200	1500	1300	1600	1300	1600	1400	1700	1400	1700	1500	1700	1600	1700	1700	1800	1900	1800	2100	1800	2200	1900	2400	1900	2600	2000
2500	1100	1600	1200	1600	1200	1600	1300	1600	1400	1700	1400	1700	1500	1700	1500	1800	1600	1800	1700	1800	1900	1900	2100	1900	2300	1900	2400	2000	2600	2000
2600	1200	1600	1200	1600	1300	1600	1300	1700	1400	1700	1400	1800	1500	1800	1600	1800	1600	1800	1800	1900	2000	1900	2100	2000	2300	2000	2500	2000	2600	2100
2700	1200	1700	1300	1700	1300	1700	1400	1700	1400	1800	1500	1800	1500	1800	1600	1900	1600	1900	1800	1900	2000	2000	2100	2000	2300	2000	2500	2100	2600	2100
2800	1200	1700	1300	1700	1300	1800	1400	1800	1400	1900	1500	1900	1500	1900	1600	1900	1700	1900	1800	2000	2000	2000	2100	2100	2300	2100	2500	2100	2700	2200
2900	1300	1800	1300	1800	1400	1800	1400	1800	1500	1900	1500	1900	1600	1900	1600	2000	1700	2000	1800	2000	2000	2100	2100	2100	2300	2100	2500	2200	2700	2200
3000	1300	1800	1300	1800	1400	1900	1400	1900	1500	2000	1500	2000	1600	2000	1600	2000	1700	2000	1800	2100	2000	2100	2100	2200	2300	2200	2500	2200	2700	2300

Table 9.5 Header- and Branch Lengths Segmented Tee Pipe Series in mm – PN 6 – Stiffness Classes acc. to Table 4.5

Segmented Tees
Pressure Class PN 6
DN 2 = 1200 – 2600 mm



DN 2	1200		1300		1400		1500		1600		1700		1800		1900		2000		2100		2200		2300		2400		2500		2600	
DN 1	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
800	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
900	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1200	2700	1350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1300	2700	1400	2850	1450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1400	2700	1450	2850	1500	3050	1550	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1500	2700	1500	2900	1550	3050	1600	3200	1650	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1600	2700	1550	2900	1600	3050	1650	3250	1700	3400	1700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1700	2700	1600	2900	1650	3100	1700	3250	1750	3400	1800	3600	1800	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1800	2750	1650	2900	1700	3100	1750	3250	1800	3450	1850	3600	1850	3750	1900	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1900	2750	1700	2900	1750	3100	1800	3300	1850	3450	1900	3600	1950	3800	1950	3950	2000	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2000	2800	1800	2900	1800	3100	1900	3300	1900	3500	2000	3700	2000	3800	2000	4000	2100	4200	2100	–	–	–	–	–	–	–	–	–	–	–	–
2100	2800	1800	2900	1900	3100	1900	3300	2000	3500	2000	3700	2100	3800	2100	4000	2100	4200	2200	4300	2200	–	–	–	–	–	–	–	–	–	–
2200	2800	1900	3000	1900	3100	2000	3300	2000	3500	2100	3700	2100	3900	2200	4000	2200	4200	2200	4400	2300	4500	2300	–	–	–	–	–	–	–	–
2300	2800	2000	3000	2000	3100	2000	3300	2100	3500	2100	3700	2200	3900	2200	4000	2200	4200	2300	4400	2300	4500	2300	4700	2400	–	–	–	–	–	–
2400	2800	2000	3000	2000	3100	2100	3300	2100	3500	2200	3700	2200	3900	2300	4000	2300	4200	2300	4400	2400	4600	2400	4700	2400	4900	2500	–	–	–	–
2500	2800	2100	3000	2100	3100	2100	3300	2200	3500	2200	3700	2300	3900	2300	4000	2300	4200	2400	4400	2400	4600	2500	4700	2500	4900	2500	5100	2600	–	–
2600	2800	2100	3000	2100	3200	2200	3400	2200	3500	2300	3700	2300	3900	2400	4100	2400	4300	2400	4400	2500	4600	2500	4800	2600	5000	2600	5100	2600	5300	2700
2700	2800	2200	3000	2200	3200	2200	3400	2300	3500	2300	3700	2400	3900	2400	4100	2400	4300	2500	4500	2500	4600	2600	4800	2600	5000	2600	5100	2700	5300	2700
2800	2800	2200	3000	2200	3200	2300	3400	2300	3500	2400	3700	2400	3900	2500	4100	2500	4300	2500	4500	2600	4600	2600	4800	2700	5000	2700	5100	2700	5300	2800
2900	2800	2300	3000	2300	3200	2300	3400	2400	3500	2400	3700	2500	3900	2500	4100	2600	4300	2600	4500	2600	4600	2700	4800	2700	5000	2800	5200	2800	5300	2800
3000	2800	2300	3000	2400	3200	2400	3400	2400	3500	2400	3700	2500	3900	2600	4100	2600	4300	2600	4500	2700	4600	2700	4800	2800	5000	2800	5200	2800	5400	2900

Table 9.6 Header- and Branch Lengths Segmented Tee Pipe Series in mm – PN 6 – Stiffness Classes acc. to Table 4.5

Segmented Tees
Pressure Class PN 6
DN 2 = 2700 – 3000 mm

DN 2	2700		2800		2900		3000	
DN 1	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	—	–	–
350	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–
700	–	–	–	–	–	–	–	–
800	–	–	–	–	–	–	–	–
900	–	–	–	–	–	–	–	–
1000	–	–	–	–	–	–	–	–
1100	–	–	–	–	–	–	–	–
1200	–	–	–	–	–	–	–	–
1300	–	–	–	–	–	–	–	–
1400	–	–	–	–	–	–	–	–
1500	–	–	–	–	–	–	–	–
1600	–	–	–	–	–	–	–	–
1700	–	–	–	–	–	–	–	–
1800	–	–	–	–	–	–	–	–
1900	–	–	–	–	–	–	–	–
2000	–	–	–	–	–	–	–	–
2100	–	–	–	–	–	–	–	–
2200	–	–	–	–	–	–	–	–
2300	–	–	–	–	–	–	–	–
2400	–	–	–	–	–	–	–	–
2500	–	–	–	–	–	–	–	–
2600	–	–	–	–	–	–	–	–
2700	5400	2700	–	–	–	–	–	–
2800	5500	2800	5600	2800	–	–	–	–
2900	5500	2900	5700	2900	5800	2900	–	–
3000	5500	2900	5700	3000	5900	3000	6000	3000

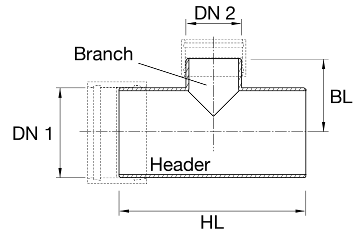
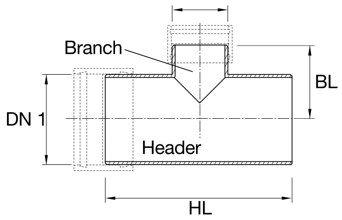


Table 9.7 Header- and Branch Lengths Segmented Tee Pipe Series in mm – PN 6 – Stiffness Classes acc. to Table 4.5

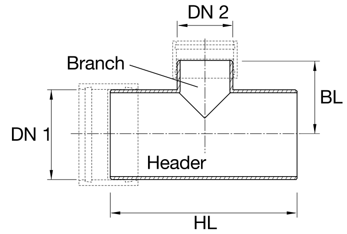
Segmented Tees
Pressure Class PN 10
DN 2 = 100 – 1100 mm



DN 2	100		150		200		250		300		350		400		450		500		600		700		800		900		1000		1100	
DN 1	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	720	380	800	400	860	420	940	440	1040	520	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	720	400	800	420	860	440	940	460	1040	560	1120	580	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	740	440	800	440	860	460	940	500	1040	580	1140	600	1220	620	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	740	460	800	480	860	500	940	520	1060	600	1140	620	1240	640	1320	660	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	740	500	800	500	860	520	960	540	1060	640	1140	660	1240	680	1320	700	1400	720	–	–	–	–	–	–	–	–	–	–	–	–
600	820	540	880	540	940	560	1020	580	1120	680	1220	700	1320	720	1400	740	1500	760	1640	820	–	–	–	–	–	–	–	–	–	–
700	820	600	880	600	940	620	1020	640	1140	720	1220	760	1320	780	1400	800	1500	820	1660	900	1840	920	–	–	–	–	–	–	–	–
800	820	640	900	640	960	660	1040	700	1140	780	1220	800	1320	820	1420	860	1500	860	1660	940	1860	980	2020	1020	–	–	–	–	–	–
900	840	700	900	700	960	720	1040	740	1140	840	1240	860	1320	880	1420	900	1500	920	1680	1000	1860	1040	2060	1080	2220	1120	–	–	–	–
1000	850	750	950	750	1000	800	1050	800	1150	900	1250	950	1350	950	1450	950	1550	1000	1700	1050	1900	1100	2050	1150	2250	1200	2450	1250	–	–
1100	850	800	950	800	1000	850	1050	850	1200	950	1250	1000	1350	1000	1450	1000	1550	1050	1700	1100	1900	1150	2100	1200	2250	1250	2450	1300	2600	1300
1200	900	850	950	900	1000	900	1100	900	1200	1000	1250	1050	1350	1050	1450	1100	1550	1100	1700	1150	1900	1200	2100	1250	2300	1300	2450	1350	2650	1400
1300	900	950	950	950	1000	950	1100	950	1200	1050	1300	1100	1350	1100	1450	1150	1550	1150	1700	1200	1900	1250	2100	1300	2300	1350	2450	1400	2650	1450
1400	900	1000	950	1000	1050	1000	1100	1050	1200	1100	1300	1150	1400	1150	1450	1200	1550	1200	1700	1250	1950	1300	2100	1350	2300	1400	2500	1450	2650	1500
1500	950	1050	1000	1050	1050	1050	1100	1100	1200	1150	1300	1200	1400	1200	1500	1250	1550	1250	1750	1350	1950	1350	2100	1400	2300	1450	2500	1500	2700	1550
1600	950	1100	1000	1100	1050	1100	1150	1150	1200	1200	1300	1250	1400	1250	1500	1300	1600	1300	1750	1400	1950	1400	2100	1450	2300	1500	2500	1550	2700	1600
1700	1000	1150	1050	1150	1100	1150	1150	1200	1200	1250	1300	1300	1400	1300	1500	1350	1600	1350	1750	1450	1950	1450	2100	1500	2300	1550	2500	1600	2700	1650
1800	1000	1200	1050	1200	1100	1200	1150	1250	1250	1350	1300	1350	1400	1350	1500	1400	1600	1400	1750	1500	1950	1500	2150	1550	2300	1600	2500	1650	2700	1700
1900	1050	1250	1100	1250	1150	1250	1200	1300	1250	1400	1300	1400	1400	1400	1500	1450	1600	1450	1750	1550	1950	1550	2150	1600	2350	1650	2500	1700	2700	1750
2000	1100	1300	1100	1300	1200	1400	1200	1400	1300	1500	1400	1500	1500	1500	1500	1500	1600	1500	1800	1600	2000	1700	2200	1700	2400	1700	2500	1800	2700	1800
2100	1100	1400	1200	1400	1200	1400	1300	1400	1300	1500	1400	1500	1500	1600	1600	1600	1600	1600	1800	1700	2000	1700	2200	1800	2400	1800	2600	1800	2700	1900
2200	1100	1400	1200	1400	1200	1500	1300	1500	1300	1600	1400	1600	1500	1600	1600	1600	1600	1600	1800	1700	2000	1800	2200	1800	2400	1900	2600	1900	2800	1900
2300	1100	1500	1200	1500	1300	1500	1300	1500	1400	1600	1400	1600	1500	1700	1600	1700	1700	1700	1800	1800	2000	1800	2200	1900	2400	1900	2600	1900	2800	2000
2400	1200	1600	1200	1600	1300	1600	1300	1500	1400	1700	1400	1700	1500	1700	1600	1700	1700	1800	1800	1800	2000	1900	2200	1900	2400	2000	2600	2000	2800	2000

Table 9.8 Header- and Branch Lengths Segmented Tee Pipe Series in mm – PN 10 – Stiffness Classes acc. to Table 4.5

Segmented Tees
Pressure Class PN 10
DN 2 = 1200 – 2400 mm



DN 2	1200		1300		1400		1500		1600		1700		1800		1900		2000		2100		2200		2300		2400	
DN 1	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL	HL	BL
300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
350	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
800	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
900	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1200	2800	1400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1300	2850	1500	3000	1500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1400	2850	1550	3000	1550	3200	1600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1500	2850	1600	3050	1650	3250	1650	3400	1700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1600	2900	1650	3050	1700	3250	1750	3400	1800	3600	1800	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1700	2900	1700	3050	1750	3250	1800	3450	1850	3600	1850	3800	1900	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1800	2900	1750	3100	1800	3250	1850	3450	1900	3600	1950	3800	1950	3950	2000	–	–	–	–	–	–	–	–	–	–	–	–
1900	2900	1800	3100	1850	3300	1900	3450	1950	3650	2000	3800	2000	4000	2050	4150	2100	–	–	–	–	–	–	–	–	–	–
2000	2900	1900	3100	1900	3300	2000	3500	2000	3700	2100	3900	2100	4000	2100	4200	2200	4400	2200	–	–	–	–	–	–	–	–
2100	2900	1900	3100	2000	3300	2000	3500	2100	3700	2100	3900	2200	4100	2200	4200	2200	4400	2300	4600	2300	–	–	–	–	–	–
2200	2900	2000	3100	2000	3300	2100	3500	2100	3700	2200	3900	2200	4100	2300	4200	2300	4400	2300	4600	2400	4800	2400	–	–	–	–
2300	2900	2000	3100	2100	3300	2100	3500	2200	3700	2200	3900	2300	4100	2300	4200	2400	4400	2400	4600	2400	4800	2500	5000	2500	–	–
2400	2900	2100	3100	2100	3300	2200	3500	2200	3700	2300	3900	2300	4100	2400	4300	2400	4500	2500	4600	2500	4800	2500	5000	2600	5100	2600

Table 9.9 Header and Branch Lengths Segmented Tee Pipe Series in mm – PN 10 – Stiffness Classes acc. to Table 4.5

Other Diameters on Request

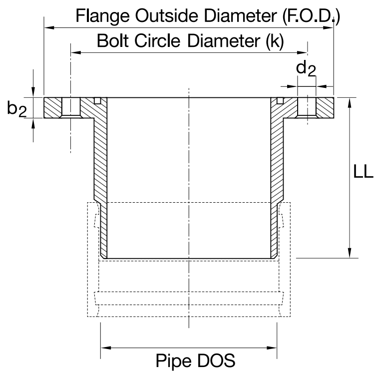
9.4 Why Branch 45 degrees, for Garvity only

	100			150			200			250			300			350			400			450			500			600			700			800		
	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E
100	600	350	420																																	
150	600	375	420	700	420	420																														
200	600	400	420	700	450	500	800	500	500																											
250	600	425	500	700	475	500	800	525	570	900	570	570																								
300	700	500	500	800	550	570	900	600	570	1000	650	650	1100	710	710																					
350	700	550	570	800	575	570	900	625	640	1000	675	640	1100	725	710	1200	775	780																		
400	700	550	570	800	600	640	900	650	640	1000	700	710	1100	750	780	1200	800	850	1300	850	850															
450	700	570	640	800	620	670	900	670	710	1000	720	740	1100	770	820	1200	820	880	1300	880	880	1400	920	920												
500	700	600	710	800	650	710	900	700	780	1000	750	780	1100	800	850	1200	850	920	1300	900	920	1400	950	960	1500	1000	1000									
600													1100	850	920	1200	900	960	1300	950	990	1400	1000	1030	1500	1050	1060	1600	1100	1130						
700													1100	900	990	1200	950	1030	1300	1000	1060	1400	1050	1100	1500	1100	1130	1700	1200	1200	1900	1300	1270			
800													1100	950	1060	1200	1000	1100	1300	1050	1130	1400	1100	1160	1500	1150	1200	1700	1250	1270	1900	1350	1340	2100	1450	1410
900													1100	1000	1130	1200	1050	1170	1300	1100	1200	1400	1150	1230	1500	1200	1270	1700	1300	1410	1900	1400	1490	2100	1500	1560
1000													1100	1050	1200	1200	1100	1240	1300	1150	1270	1400	1200	1300	1500	1250	1340	1700	1400	1490	1900	1450	1560	2100	1550	1630
1100													1100	1170	1270	1200	1200	1310	1300	1230	1340	1400	1260	1380	1500	1300	1410	1700	1430	1530	1900	1530	1630	2200	1630	1700
1200													1200	1200	1340	1300	1250	1380	1400	1300	1410	1500	1330	1450	1500	1350	1490	1700	1450	1560	2000	1600	1700	2200	1700	1770
1300													1200	1250	1460	1300	1300	1490	1400	1350	1510	1500	1390	1560	1600	1430	1590	1800	1530	1660	2000	1650	1770	2200	1750	1880
1400													1200	1300	1560	1300	1350	1600	1400	1400	1630	1500	1450	1670	1600	1500	1700	1800	1600	1770	2000	1700	1840	2200	1800	1980
1500													1200	1350	1630	1300	1400	1670	1400	1450	1700	1500	1500	1730	1600	1550	1770	1800	1650	1840	2000	1750	1910	2200	1850	2020
1600													1200	1400	1700	1300	1450	1740	1400	1500	1770	1500	1550	1800	1600	1600	1840	1800	1700	1910	2000	1800	1980	2200	1900	2050

	900			1000			1100			1200			1300			1400			1500			1600		
	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E	B	F	E
100																								
150																								
200																								
250																								
300																								
350																								
400																								
450																								
500																								
600																								
700																								
800																								
900	2300	1600	1630																					
1000	2300	1650	1700	2500	1750	1770																		
1100	2300	1730	1770	2500	1800	1840	2700	1870	1910															
1200	2400	1800	1840	2500	1850	1910	2700	1950	1980	2900	2050	2050												
1300	2400	1850	1910	2500	1920	1980	2700	2010	2050	2900	2100	2120	3100	2170	2190									
1400	2400	1900	1980	2600	2000	2050	2700	2070	2120	2900	2150	2190	3100	2250	2260	3300	2350	2330						
1500	2400	1950	2080	2600	2050	2150	2800	2130	2220	2900	2230	2290	3200	2320	2360	3300	2420	2440	3400	2500	2540			
1600	2400	2000	2190	2600	2100	2260	2800	2200	2330	3000	2300	2400	3200	2400	2470	3400	2500	2550	3500	2570	2650	3700	2650	2750

9.5 Fix Flanges – Type A

The standard bolting pattern to which our flanges are manufactured is ISO 2084. Other bolting dimension systems such as AWWA, ANSI, DIN, JIS can be supplied. The table refers to fixflanges up to pressure class PN 10.



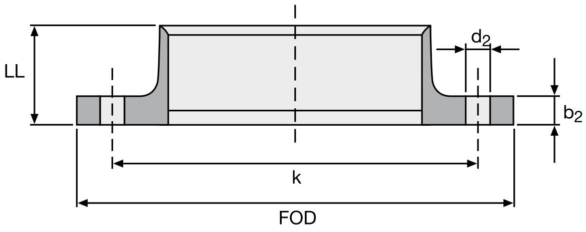
Pressure Classes PN 6 & PN 10

DN	Pipe DOS	b_2	F.O.D.	LL	k			d_2		
Nominal Diameter	O.D. [mm]	Flange Thickness [mm]	Flange Outside Diameter [mm]	Laying Length [mm]	Bolt Circle Diameter [mm]	Number of Bolts	Bolt Diameter [mm]	Bolt Hole Diameter [mm]	Washer Diameter [mm]	O-Ring Gasket Diameter [mm]
300	324.5	40	450	1000	400	12	20	26	36	12
350	376.4	45	525	1000	460	16	20	26	36	12
400	427.3	47	575	1000	515	16	24	30	44	12
450	478.2	52	625	1000	565	20	24	30	44	12
500	530.1	53	675	1000	620	20	24	30	44	12
600	617	55	800	1000	725	20	27	33	50	12
700	719	64	900	1000	840	24	27	33	50	19
800	821	69	1025	1000	950	24	30	36	56	19
900	923	74	1125	1000	1050	28	30	36	56	19
1000	1025	79	1250	1000	1160	28	33	39	60	19
1100	1127	88	1350	1000	1270	32	33	39	60	22
1200	1229	94	1475	1000	1380	32	36	42	68	22
1300	1331	97	1575	1000	1490	32	39	45	72	22
1400	1433	104	1700	1000	1590	36	39	45	72	22
1500	1535	107	1800	1000	1700	36	39	45	72	22
1600	1637	114	1925	1000	1820	40	45	51	85	22
The following flanges list the maximum pipe O.D. on which the flange can be fabricated without interference of bolt hole and spot facing with the flange hub.										
1800	1815	128	2125	1000	2020	44	45	51	85	25
2000	2015	139	2350	1000	2230	48	45	51	85	25
2200	2200	153	2575	1000	2440	52	52	58	98	28
2400	2400	164	2775	1000	2650	56	52	58	98	28
2600	2588	176	2975	1000	2850	60	52	58	98	28
2800	2796	186	3200	1000	3070	64	52	58	98	28
3000	2999	197	3425	1000	3290	68	56	62	105	28

Table 9.10 Fix Flanges – Type A – PN 6 & PN 10 – for all Stiffness Classes

Bigger Dimensions on Request

9.6 Fix Flanges – Type B



Pressure Class PN 6

DN	FOD [mm]		d_2[mm]	k [mm]		b_2[mm]		LL [mm]		No. of bolts	Weight* [kg/pc]
100	220		20	170		26		45		4	1.68
150	285	±2	20	225		32		65		8	2.72
200	340		20	280		34		125		8	3.72
250	405		20	335		38	±2	100	+5 -0	12	5.07
300	460		24	395	±1.6	40		125		12	6.87
350	520	±3	24	445		45		145		12	8.72
400	580		24	495		49		165		16	10.43
500	715		24	600		30		75		20	17.47
600	840		28	705		33		90		20	24.32
700	910	±5	28	810	+1.9 -0	37	+8 -2	105	+10 -0	24	29.33
800	1025		31	920		40		120		24	37.37

* Approx. Weights

Table 9.11 Fix Flanges Type – B – PN 6

Pressure Class PN 6

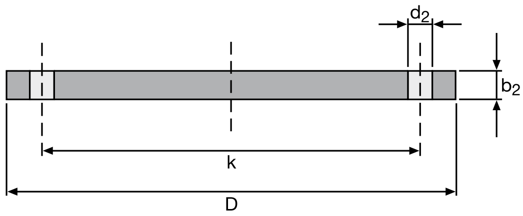
DN	FOD [mm]		d_2[mm]	k [mm]		b_2[mm]		LL [mm]		No. of bolts	Weight* [kg/pc]
100	220		20	180		26		45		8	1.88
150	285	±2	24	240		32		65		8	3.28
200	340		24	295		34		125		8	4.45
250	405		24	350		38	±2	100	+5 -0	12	6.02
300	460		24	400	±1.6	40		125		12	7.33
350	520	±3	24	460		45		145		16	14.84
400	580		28	515		49		165		16	13.38
500	715		28	620		48		125		20	29.80
600	840		31	725		52		150		20	43.40
700	910	±5	31	840	+1.9 -0	56	+8 -2	175	+10 -0	24	49.75
800	1025		34	950		60		200		24	66.57

* Approx. Weights

Table 9.12 Fix Flanges Type B – PN 10

9.7 Blind Flanges

The standard bolting pattern to which our flanges are manufactured is ISO 2084. Other bolting dimension systems such as AWWA, ANSI, DIN, JIS can be supplied. The table refers to fixflanges up to pressure class PN 10.



Pressure Class PN 6

DN	D [mm]		d_2[mm]	k [mm]		b_2[mm]		No. of bolts	Weight* [kg/pc]
100	220		20	170		26		4	1.39
150	285	±2	20	225		32		8	2.58
200	340		20	280		34		8	3.84
250	405		20	335		38		12	5.69
300	460		24	395	±1,6	40		12	7.30
350	520	±3	24	445		45	±2	12	10.25
400	580		24	495		49		16	13.30
500	715		24	600		54		20	21.88
600	840		28	705		60		20	32.55
700	910	±5	28	810	±1,9 -0	70		24	42.49
800	1025		31	920		72		24	57.45

* Approx. Weights

Table 9.13 Blind Flanges PN 6

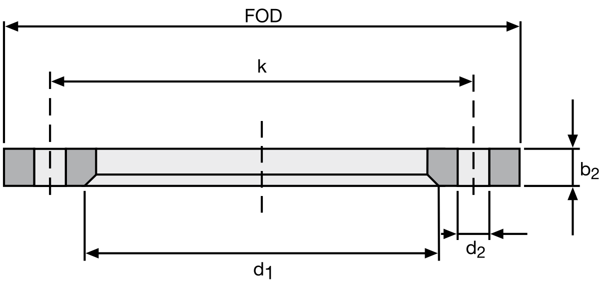
Pressure Class PN 10

DN	D [mm]		d_2[mm]	k [mm]		b_2[mm]		No. of bolts	Weight* [kg/pc]
100	220		20	180		26		8	1.75
150	285	±2	24	240		32		8	3.62
200	340		24	295		34		8	5.52
250	405		24	350		38		12	8.35
300	460		24	400	±1,6	40		12	11.47
350	520	±3	24	460		45	±2	16	15.55
400	580		28	515		49		16	20.46
500	715		28	620		54		20	36.30
600	840		31	725		60		20	49.89
700	910	±5	31	840	±1,9 -0	70		24	62.80
800	1025		34	950		72		24	84.99

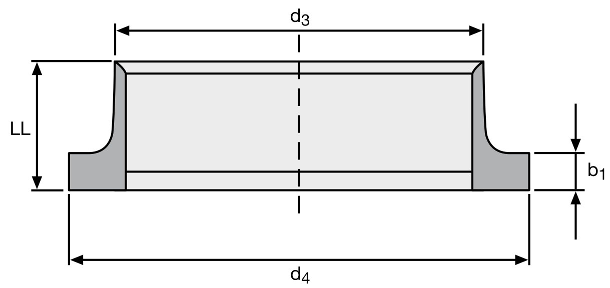
* Approx. Weights

Table 9.14 Blind Flanges PN 10

9.8 Loose Flanges and Collars



Loose Flange



Moulded Collar

Pressure Class PN 6

DN	FOD [mm]		d_1 [mm]	d_2 [mm]	d_3 [mm]		d_4 [mm]		k [mm]		b_1 [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight* [kg/pc] Collar	Flange	Total
100	220		134	20	133		148	+0.5 -0	170		26		26		45		4	1.68	0.84	2.52
150	285	±2	189	20	188		201		225		32		32		65		8	2.72	1.41	4.12
200	340		238	20	237	±1	257		280		34		34		125		8	3.72	1.91	5.63
250	405		294	20	292		309		335	±1.6	38	±2	38	±2	100	+5 -0	12	5.07	2.64	7.70
300	460		344	24	342		365	+1 -0	395		40		40		125		12	6.87	3.16	10.03
350	520	±3	388	24	386	±2	415		445		45		45		145		12	8.63	4.47	13.10
400	580		442	24	440		466		495		49		49		165		16	10.43	5.49	15.92

* Approx. Weights

Table 9.15 Loose Ring Flanges incl. Collar – PN 6

Other Diameters on Request

Pressure Class PN 10

DN	FOD [mm]		d_1 [mm]	d_2 [mm]	d_3 [mm]		d_4 [mm]		k [mm]		b_1 [mm]		b_2 [mm]		LL [mm]		No. of bolts	Weight* [kg/pc] Collar	Flange	Total
100	220		134	20	133		158	+0.5 -0	180		26		26		45		8	1.88	1.06	2.94
150	285	±2	189	24	188		212		240		32		32		65		8	3.28	1.97	5.26
200	340		238	24	237	±1	268		295		34		34		125		8	4.45	2.75	7.20
250	405		294	20	292		320		350	±1.6	38	±2	38	±2	100	+5 -0	12	6.02	3.87	9.89
300	460		344	24	342		370	+1 -0	400		40		40		125		12	7.33	4.96	12.29
350	520	±3	388	24	386	±2	430		460		45		45		145		16	10.48	6.78	17.26
400	580		442	28	440		482		515		49		49		165		16	13.38	8.45	21.83

* Approx. Weights

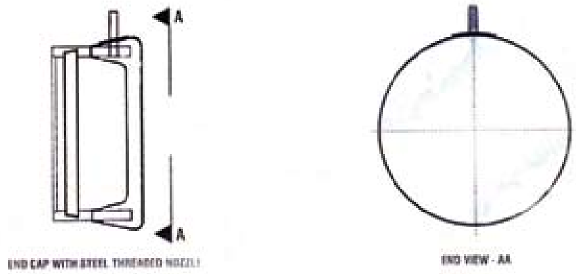
Table 9.16 Loose Ring Flanges incl. Collar – PN 10

Other Diameters on Request

10. Special Fittings

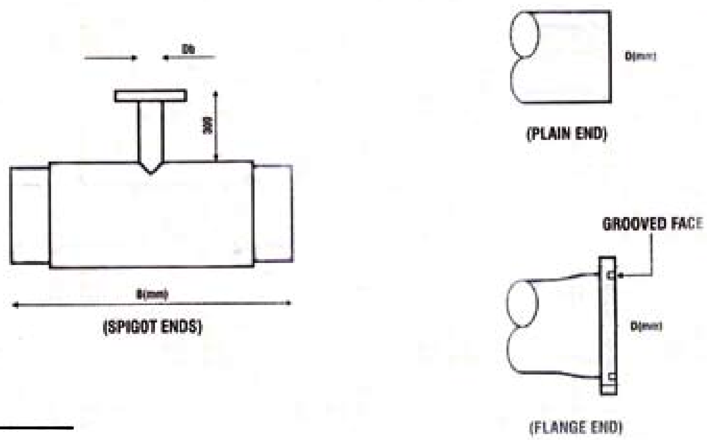
End Cap

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



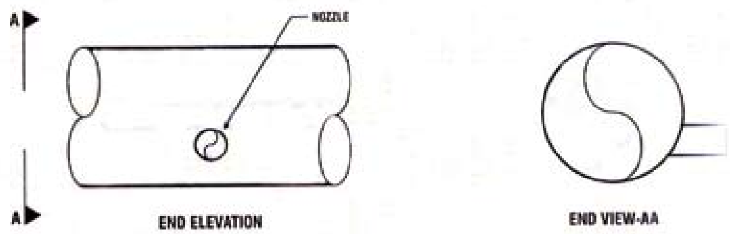
Flanged Nozzles

- Flanged nozzles are available in Diameters range 4”,6”,8” & 10”.
- Flanged nozzles are drilled to ANSI B 16.5.150lb. OR as required.
- Pipe Header diameter could vary from 300 mm. to 3000 mm.

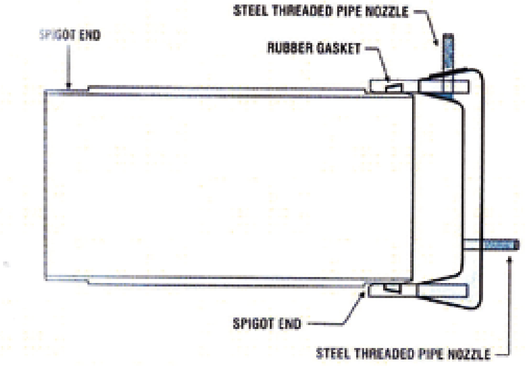


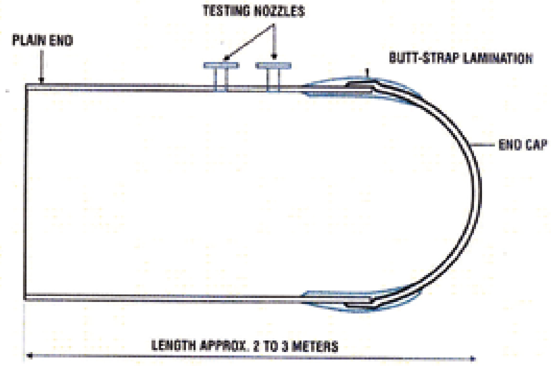
Eccentric Tees

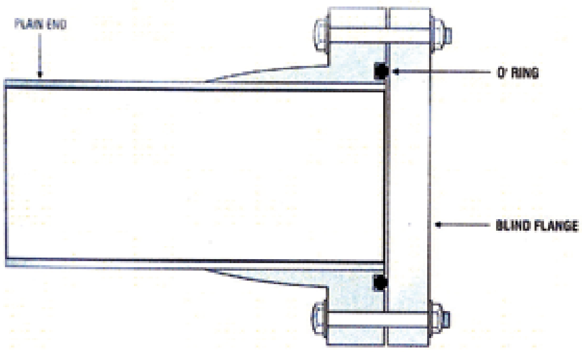
- Eccentric Tees can be manufactured upon request. The overall dimensions should be as per customer requirement but not less than of wyes dimensions table. It can be, Plan end, Spigot end, or Flanged end.
- Flanged Eccentric tees can be fabricated as per required drilling.

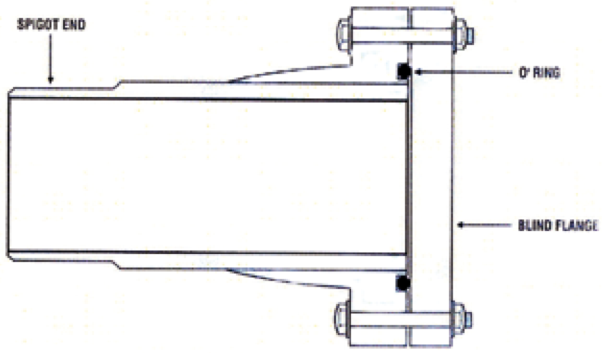


11. Hydrotest Spool









12. Environmental Guide AQAP Pipe

All materials listed in “Black” can be used with our current standard pipe resin system as well as vinyl ester lined pipes. All trials listed in “blue” are in addition to the “Black” materials that can be used In pipes that use a vinyl ester resin liner. All trials listed in “red” are not recommended and may not work in any type of AQAP pipe system.

	Standard Pipe Resin Or Vinyl Ester	Vinyl Ester only	NR
Acetic Acid		X	
Adipic Acid		X	
Alum (Aluminum Potassium Sulfate)	X		
Aluminum Chloride, Aqueous	X		
Ammonia, Aqueous, 20%		X	
Ammonium Chloride, Aquesous (40jC)	X		
Ammonium Fluoride			X
Ammonium Nitrate, Aquesous (40jC)	X		
Ammonium Phosphate Monobasic, Aquesous	X		
Ammonim Sulfate, Aqueous	X		
Anilline Hydrochioride		X	
Antimony Trichioride			X
Barium Carbonate		X	
Barium Chloride		X	
Barium Sulfate		X	
Beet Sugar Liqour		X	
Benzene Sulfonic Acid (100%)		X	
Benzoic Acid		X	
Black Liquor (Paper)		X	
Bleach			X
Borax		X	
Boric Acid		X	
Bromine, Aqueous 5%		X	
Butyric Acid, <25% (40jC)		X	
Calcium Bisulfide	X		
Calcium Carbonate	X		
Calcium Chloride (Saturated)	X		
Calcium Hydroxide, 100%	X		
Calcium Hypochlorite		X	
Calcium Nitrate (40jC)		X	
Calcium Sulfate NL AOC	X		
Cane Sugar Liquours	X		
Carbon Dioxide, Aqueous	X		
Carbon Tetrachloride			X
Casein	X		
Caustic Potash KOH)			X
Chlorine, Dry Gas	X		

	Standard Pipe Resin Or Vinyl Ester	Vinyl Ester only	NR
Chlorine, Water		X	
Chlorine Wet Gas		X	
Chlorocetic Acid			X
Citric Acid, Aqueous(40jC)			X
Copper Acetate, Aqueous (40jC)	X		
Copper Chloride, Aqueous	X		
Copper Cyanide (30jC)	X		
Copper Nitrate, Aquesous (40jC)	X		
Copper Sulfate, Aqueous (40jC)	X		
Crude Oil (Sour)		X	
Crude Oil (Sweet)	X		
Crude Oil, Salt Water (25jC)		X	
Cyclohexane			X
Cyclohexanol			X
Dibuty Sebacate	X		
Dibutyl phthalate	X		
Diesel Fuel	X		
Dioctyl Phthalate	X		
Ethyience Glycol	X		
Ferric Chloride, Aqueous	X		
Ferric Nitrate, Aqueous	X		
Ferric Sulfate, Aqueous	X		
Ferrous Sulfate, Aqueous	X		
Formaldehyde			X
Fuel Oil	X		
Gas, Natural, Methane			X
Gasoline, Ethyl		X	
Glycerine		X	
Green Liquor, Pape		X	
Hexane		X	
Hydrobromic Acid			X
Hydrochloric Acid, up to 15%	X		
Hydroflouric Acid			X
Hydrogen Sulfide, Dry		X	
Kerosene		X	
Lactic Acid, 10%	X		
Lactic Acid, 80% (25jC)	X		

Cont...

	Standard Pipe Resin Or Vinyl Ester	Vinyl Ester only	NR
Lauric Acid	X		
Lauryl Chloride		X	
Lauric Sulfate			
Lead Acetate, Aqueous	X		
Lead Nitrate	X		
Lead Sulfate	X		
Linseed Oil	X		
Lithium Bromide, Aqueous (40jC)	X		
Lithium Chloride, Aqueous (40jC)	X		
Magnesium Bicarbonate, Aqueous (40jC)	X		
Magnesium Carbonate (40jC)	X		
Magnesium Cloride, Aqueous (25jC)	X		
Magnesium Nitrate, Aqueous (40jC)	X		
Magnesium Sulfate	X		
Maganese Cloride, Aqueous (40jC)	X		
Maganese Sulfate, Aqueous (40jC)	X		
Mercuric Chloride, Aqueous	X		
Mercurous Chloride, Aqueous	X		
Mineral Oils	X		
n-Heptane		X	
Naphthalene		X	
Naptha		X	
Nickel Chloride, Aqueous (25jC)	X		
Nickel Nitrate, Aqueous (40jC)	X		
Nickel Sulfate, Aqueous (40jC)	X		
Nitric Acid			X
Oleic Acid	X		
Oxalic Acid, Aqueous	X		
Ozone, Gas			X
Paraffin	X		
Pentane			X
Perchloric Acid		X	
Petroleum, Refined & Sour		X	
Phosphoric Acid		X	
Phosphoric Acid (40jC)	X		
Phthalic Acid (25jC)		X	
Potassium Permanganate, 25%		X	
Potassium Bicarbonate	X		
Potassium Bromide, Aqueous (40jC)	X		
Potassium Chloride, Aqueous	X		
Potassium Dichromate, Aqueous	X		
Potassium Ferrocyanide (30jC)	X		
Potassium Ferrocyanide, Aqueous (30jC)	X		
Potassium Nitrate, Aqueous	X		
Potassium Sulfate (40jC)	X		

	Standard Pipe Resin Or Vinyl Ester	Vinyl Ester only	NR
Propylene Glycol (25%)	X		
Zinc Sulfite, Aqueous (40jC)	X		
Sea Water	X		
Sewage (50jC)	X		
Silicone Oil	X		
Silver Nitrate, Aqueous	X		
Sodium Bromoide, Aqueous	X		
Sodium Cloride, Aqueous	X		
Sodium Dichromate		X	
Sodium Dihydrogen Phosphate	X		
Sodium Ferrocyanide	X		
Sodium Hydroxide 10%		X	
Sodium Mono- Phosphate	X		
Sodium Nitrate- Aqueous	X		
Sodium Nitrite, Aqueous	X		
Sodium Silicate		X	
Sodium Sulfhate, Aqueous	X		
Sodium Sulfide		X	
Sodium Tetraborate		X	
Stannic Cloride, Aqueous	X		
Stannous Cloride, Aqueous	X		
Stearic Acid	X		
Sulfur			X
Sulfuric Acid, 25% (40jC)		X	
Tannic Acid, Aqueous	X		
Tartaric Acid	X		
Toluene Sulfonic Acid	X		
Tributyl Phosphate			X
Triethanolamine			X
Triethylamine			X
Turpentine			X
Urea, (Aqueous)		X	
Vinegar		X	
Water, Distilled		X	
Water, Sea	X		
Water, Tap	X		
Zinc Cloride, Aqueous	X		
Zinc Nitrate, Aqueous	X		
Zinc Sulfate, Aqueous	X		

NOTE : This guide is intended to serve as a basic guide when considering AQAP 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 AQAP producers with their materials. Thus, this guide provides only general information and does not imply approval of any application as AQAP has no control of the conditions of usage nor any means of identifying environments to which the pipe may unintentionally have been exposed.

AQAP makes the difference

- We fulfil the customer needs
- We are experts in GRP
- We keep the environment

Utmost care has been taken to ensure that all contents of this brochure are accurate. However AQAP Co Ltd do not accept responsibilities for any problems, which may errors in this publication. Therefore, customers should make inquiries in to the potential product supplier and convince themselves of the suitability of any products supplied or manufactured by AQAP Co Ltd before using them.

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