



the corrosion expert

PTFE and PFA Lined Piping Systems

CRP is a world leader in the manufacture of PTFE and PFA lined equipment including pipe, fittings, valves, bellows, sight glasses and other ancillary equipment. CRP supplies to the chemical, agro-chemical, pharmaceutical, petrochemical, biotechnology, pulp & paper, metals refining, food and beverage manufacturing sectors.

The core of CRP's product offering is PTFE and PFA lined piping. CRP manufacture the most comprehensive range of equipment to provide a cost effective and versatile piping system.

This manual covers the ASME Class 150 product range. The range is also manufactured to DIN dimensional standards and to other international piping standards.

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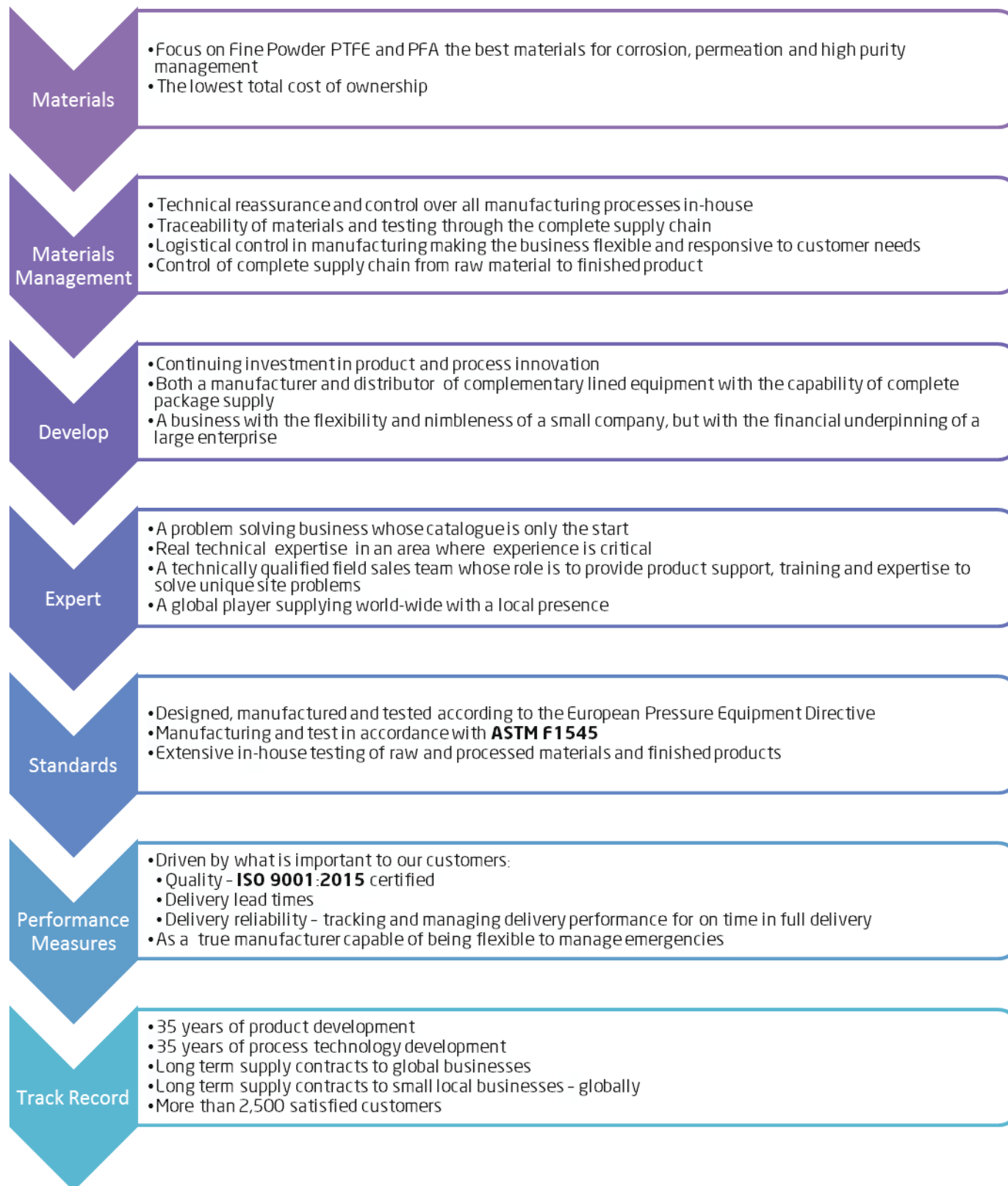
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ASME B16.5 Class 150

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Our Plan

“To be a World Class supplier of fluoropolymer lined equipment through delivering technically superior products and by creating close relationships with customers that require high levels of service, quality, innovation and technical support to provide the lowest cost of ownership.”

Key Product Families		Piping Options	
Materials Introduction		Venting Systems	
Design Philosophy		Venting Types	
Summary Dimensional Table		Non-Permenat Duty Uninsulated Line	
Joint Data		Non-Permenat Duty Insulated Line	
Popular Lined Piping Product		Permeant Duty Uninsulated Line	
Pipe Spools		Permeant Duty Insulated Line	
Van Stone Pipe Spool		Directional Venting	
Welded Pipe Spool		Earthing	
Spacer Type 1		Spikies	
Spacer Type 1 Tapered		Fluorogask	
Spacer Type 2		Toughgask	
Spacer Type 3		Safety Shields	
Fittings		Flange Shields	
90° Elbow		Bellows, Valve & High Temperature Shields	
90° Elbow Rotating Flanges		Construction	
45 ° Elbow		Flange Protection Tape	
Equal Tee		Dip Pipes	
Equal Tee Rotating Flanges		Continuously Lined Dip Pipe (CLDP)	
Reducing Tee		Curved CLDP	
Instrument Tee		Dip Leg	
Concentric Reducer		Entry Pipe	
Eccentric Reducer		Lined Equipment Basics	
Reducing Flange Taper Bore		Specification Details	
Blank Flange		Pressure & Temperature	
Less Frequent Lined Piping Product		Vacuum & Temperature	
Pipe Spools		Product Materials of Construction	
Puddle Flange Pipe Spool		PTFE & PFA Materials Properties	
Drain Leg		PTFE Liner Dimensions	
Jacketed Pipe Spools & Fittings		PFA Lining Dimensions	
Closing Pipe Spool		Spool & Fitting Bores	
Field Flare Pipe Spools		Materials Contact Compliance	
Field Flare Pipe Spool Slide Fit No Flanges		Static-Dissipating PTFE Performance	
Field Flare Pipe Spool Slide Fit Van Stone		Material Standards	
Field Flare Pipe Spool Slide Fit Welded		PTFE & PFA Materials Standards	
Field Flare Pipe Spool Tight Fit Van Stone		Steelwork Materials Standards	
Field Flare Threaded Companion Flange		Steelwork Materials Dimensions	
Field Flare Equipment		Flange Dimensions	
Spacer Type 1 Variable Angle		Stub End Dimensions	
Fittings		Cast Fittings Dimensions	
90° Elbow 5D		Key Product Tolerances	
Short Stack Tee		Design Standards	
Equal Lateral Tee		Quality Standards	
Reducing Lateral Tee		Other Activities	
Double Branch Instrument Tee		Welding	
Equal Cross		Product Finishing	
Reducing Cross		Product Testing	
Short Stack Cross		Permanent Product Marking	
Reducing Flange Parallel Bore		Shipment Product Marking	
Lined Piping Specials		Product Traceability	
Blanking Spade		Installation	
Orifice Plate		Non-Destructive Testing	
Sliding Blind		Training	
Spectacle Blind		Template Lined Piping Specification	
Full Face Flange Adapter			
Camlock Hose Adapter			
Strainer Cross			

CRP complement the lined piping with associated products that follow the PTFE or PFA lined theme. These include:

- **PFA lined Ball, Plug and Butterfly Valves for the UK market**
- **PFA lined Swing Check and Poppet Check Valves**
- **PFA lined Control Valves**
- **PFA lined Strainers**
- **PFA lined and unlined Tubular Sight Glasses and Level Gauges**
- **PTFE Bellows or Expansion Joints**

The business also produces a comprehensive range of standard and customised sampling systems for those that require safe and representative sampling, typically for sampling hazardous or expensive materials. These can be in-line, mounted directly to pipe work or reactor vessels or mounted to the top of

reactors. CRP distribute a range of Graphite and Silicon Carbide Heat Exchangers plus many pipeline complementary items including special earthing washers “Spikies” for lined systems, PTFE gaskets designed specifically for lined systems and a comprehensive range of safety shields. Most importantly CRP positions itself as

a problem solving business and although we produce catalogues we spend much time developing specific products or product combinations to solve customer processing problems. Again, this is facilitated by having our own design and manufacturing capability.

Materials Introduction

Lining Materials

CRP manufactures product in both virgin and static-dissipating (also known as anti-static) fluoropolymer resins; principally in PTFE and PFA. These are supplied under the HiPerFlon label representing a combination of raw materials and processing choices. In addition we manufacture products in a modified PTFE that provides enhanced performance against permeation. This is termed Ultra HiPerFlon or abbreviated to UHP.

More background to lining materials is provided in the following section on Design Philosophy, but here is a very simple guide to our key fluoropolymer resins and where they are used.

Virgin PTFE HiPerFlon

CRP's Virgin PTFE is called HiPerFlon in order to recognise the unique combination of material - a fine powder PTFE and process - paste extrusion. It is used principally on pipe spools in straight lengths and some simple fittings without branches.

PTFE UHP (Ultra HiPerFlon)

This material is used for high performance requirements specifically for the management of permeation.

Static-Dissipating PTFE (Anti-static)

Here a small percentage of carbon black is used within the virgin PTFE which reduces the electrical resistance of the material to a level at which any electrical charge generated by static charging within a pipeline can flow through the PTFE to the adjoining

Lining Material Range							
Nominal Bore		Pipe Spools				Fittings	
		Virgin PTFE HiPerFlon	Static-Dissipating PTFE	UHP PTFE		Virgin PFA/PTFE	Static-Dissipating PFA/PTFE
Inches	mm	Heavy Duty	Heavy Duty	Heavy Duty	Superweight	Heavy Duty	Heavy Duty
½	15	✓	✓		✓	✓	✓
¾	20	✓	✓		✓	✓	✓
1	25	✓	✓		✓	✓	✓
1½	40	✓	✓		✓	✓	✓
2	50	✓	✓		✓	✓	✓
3	80	✓	✓		✓	✓	✓
4	100	✓	✓		✓	✓	✓
6	150	✓	✓		✓	✓	✓
8	200	✓	✓	✓		✓	✓
10	250	✓	✓	✓		✓	✓
12	300	✓	✓	✓		✓	✓
14	350	✓	✓	✓		✓	✓

Key Lining Choices	
Application	Product Choice
Most applications requiring lined pipe and fittings	HiPerFlon Virgin PTFE and PFA
Applications with known permeant chemicals	UltraHiPerFlon PTFE and PFA
Applications for high purity	HiPerFlon Virgin PTFE and PFA
Applications requiring management of static discharge; typically non-conducting solvents	HiPerFlon Static-Dissipating PTFE and PFA

steelwork and to earth.

Virgin PFA

PFA as a melt processable material with all of the performance characteristics of PTFE and some more is used as the material of choice for lined fittings, being capable of dealing with more complex geometries and having superior performance in the most challenging applications.

Static-Dissipating (Anti-static) PFA

This fulfills the same requirement for fittings as static-dissipating PTFE does for pipe spools.

Outer Housings

Pipe Spools and Fabricated Fittings

Pipe spools are manufactured using carbon steel rated for pressure containing purposes. These are either provided with integral stub ends behind which we mount a flange - referred to as Van Stone spools, or a welded flange or stub end combined with a loose or rotating flange. Fabricated

fittings are made from a combination of carbon steel pipe, forgings, flanges and stub ends. All welding activities are undertaken using “coded” welders.

Cast Fittings

Where CRP differs significantly from the competition is that the majority of pipe fittings are manufactured as steel lost wax investment castings. A number of product quality reasons have driven this choice, notably:

1. No fabrication welds, therefore no concerns about weld integrity
2. Greater strength
3. Precise close tolerance parts for installation fit
4. Dimensional accuracy for lining geometry
5. No flash or parting lines
6. Clear written casting detail for identification and traceability

Cast steel fittings are significantly - almost 50% - stronger than fabrications of a similar nominal bore and importantly do

not contain construction welds. The grade of steel used by CRP is ASTM A216 WCB with a minimum cast wall of 5.5mm at 25NB which is some 2.12 mm thicker than schedule 40 steel tube of the equivalent nominal bore

The dimensional accuracy gives improved lining control with lined faces which are square to the line axis of the fittings bores and bores that are concentric to the flange periphery and the body outside diameter. The extensive machining of the steel casting provides flat rear faces to flanges allows accurate torqueing of bolts and assists in flanges being pulled up square. The fine ceramic powder used in creating the steel casting mould allows much greater detail to be cast and moreover be much more readable than that provided by sand cast ductile iron and such markings are not even possible with fabricated fittings - generally leaving them anonymous and untraceable.



Manufacturing

It is important to understand that CRP manufacture their own products in their manufacturing facility based just north of Manchester in the UK. CRP is unusual in the UK as the only direct manufacturer of the product from raw fluoropolymer through to the finished product. This gives the business great advantages of logistical control of delivery lead-times and due date adherence. It also means that we are fully in control of our own manufacturing processes and quality and can provide complete product traceability.

Process Expertise

CRP has been around for much of the time that PTFE and all of the time that PFA have existed on the planet. The company has had the benefit of growing up with these materials and has played a key role in their development for processing through working with the raw material manufacturers and developing their own processing equipment. All of the key machines and associated equipment at CRP for both PTFE and PFA production have been developed - and continue to be developed in-house. This enables us to continue to expand the product range, but as importantly gives us the certain knowledge of how products have been manufactured. This is critical when not all attributes of such products can be tested through routine production tests. CRP is the only manufacturer producing PFA moulded elbows and tees in sizes up to 14in diameter.

Our Materials and Processes

CRP are proud of their association with key materials manufacturers and have selected the top international suppliers of fluoropolymers for their materials providing both quality and technical support. Concerning PTFE there are two key material forms used in our industry, granular powders and fine powders

(technically known as coagulated dispersions.)

Paste Extrusion

CRP chooses to use fine powders combined with a pipe liner production process called paste extrusion. The powder has a base particle size of 0.18 - 0.25µm making them one hundred times smaller than the granular powders. Moreover, the particle size distribution is extremely narrow versus that of the granular powders. A combination of the two characteristics provides a packing density for the material of 55%, which is close to the theoretical maximum for spheres of equal size. However, the fine powder material has another attribute that really moves its processing on and this is the agglomeration of these base or primary particles into larger secondary particles of 400-600 µm in size.

These features come into their own in the paste extrusion process. In this process the PTFE is extruded through a die with a pin inside providing the internal diameter and wall thickness of the soon to become pipe liner. The die has a smaller cross-sectional area than the PTFE billet being extruded and its form is gradual causing the flow velocity to increase as the material enters the die. This generates a shear gradient in the direction of the flow and forces the paste material into irreversible plastic deformation. The extruded material gains strength from the deformation, a process called fibrillation and the void content is further reduced. This is because the secondary particles are deformed into fibrils - a string like alignment of the primary particles, and have irreversibly deformed, but the primary particles are preserved intact although kneaded, bouncing back into their round form after extrusion. Once through the extrusion process the primary particles relax and return to their original spherical shape, leaving a more compact

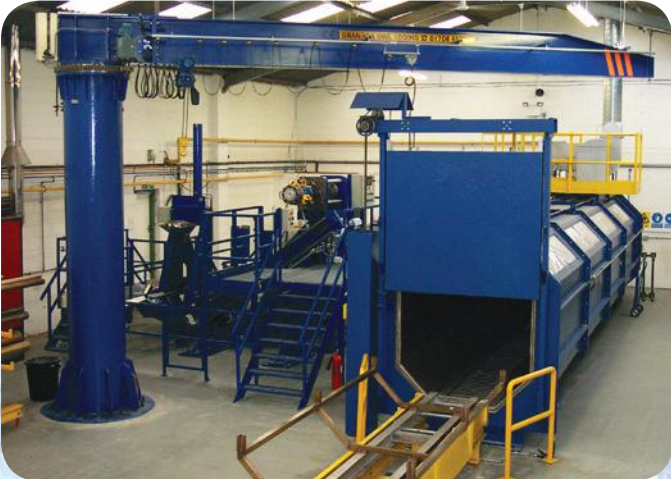
structure.

In terms of what this means for the user is that paste extruded fine powders, combined with the homogeneous nature of the liner and it's uniform wall thickness provide the highest levels of permeation resistance and the smoothest material finish - aiding both service life and the cleanability of the product.

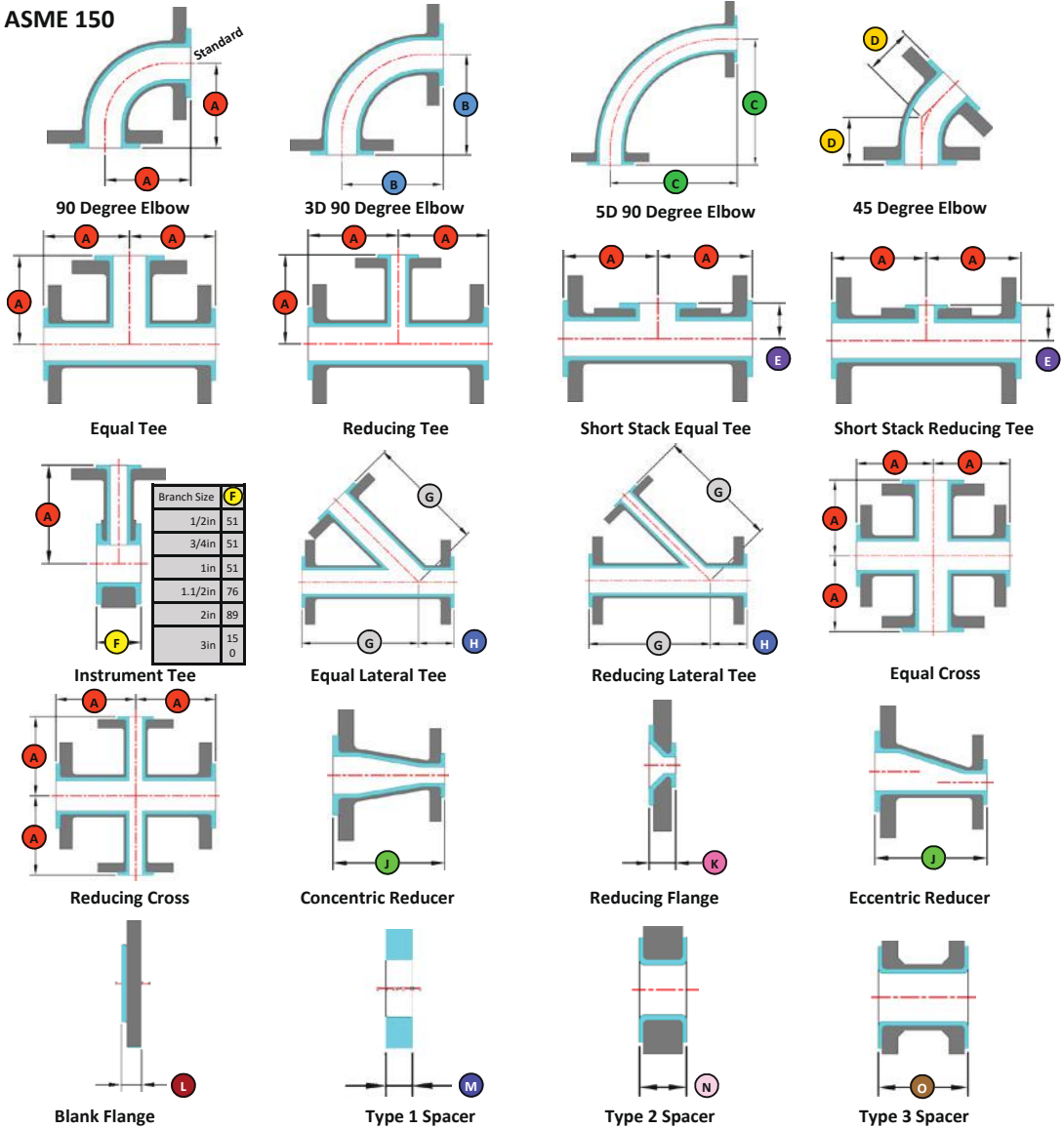
PFA Transfer Moulding

PFA was the outcome of years of research into creating a fluoropolymer that is a true thermoplastic and therefore melt processable. In production PTFE has the challenge of requiring very specialist techniques to create the shapes required for products. PFA does not have this disadvantage as it is capable of being melted and moulded into shape. Again CRP chooses PFA's that have the highest performance in corrosive applications - manifest by a low melt flow rate (MFR). Also high purity PFA's are also available for specific applications. The process for lining components in PFA is challenging, as the PFA has to be injected at high pressure and temperature into a void created inside the component in a stress free manner. The process is isothermal in that the component, it's tooling and the PFA all have to be at the melt temperature of the PFA through the moulding process - called transfer moulding. A further challenge is that the PFA reduces in volume as it cools and this reduction has to be catered for through the introduction of futher raw material.

The equipment for transfer moulding has been developed in-house and significant equipment development has been initiated recently with the use of the expertise of the Polymer Science department at a local university.



Dimensions are generally to ASME B16.5 and expressed in millimetres.



Nominal Bore	DN	A	B	C	D	E	G	H	J	K	L	M Max.	N Max.	O Max.	Van Stone Spool Min.	Fixed/Rotating Spool Min.	Spool Max.
1/2 in	DN 15	65*									14	25	60	100	250	90	6000
3/4 in	DN 20	75								30	15	25	60	100	250	90	6000
1 in	DN 25	89	n/a	127	44	30	146	44		30	16	25	60	100	250	90	6000
1 1/2 in	DN 40	102	114	191	57	37	178	51	114	30	19	25	60	100	250	95	6000
2 in	DN 50	114	152	254	63	43	203	64	127	30	21	25	70	150	250	110	6000
3 in	DN 80	140	229	381	76	56	254	76	152	35	26	25	70	150	250	120	6000
4 in	DN 100	165	305	508	102	67	305	76	178	35	26	25	70	150	250	125	6000
6 in	DN 150	203	457	762	127	105	368	89	229	40	27	25	80	150	500	140	6000
8 in	DN 200	229	610	1016	140	125	444	114	279	40	31	25	80	200	500	150	3000
10 in	DN 250	279	762	1270	165	165	521	127	305	35	32	25	80	200	n/a	165	3000
12 in	DN 300	305	914	1524	190	190	622	140	356	40	34	25	80	200	n/a	170	3000
14 in	DN 350	356	1067	1778	190	210			406	40	37	25	80	200	n/a	190	3000

*Please note that 1/2in 90 Degree Elbow is 100mm. The Face to face Dimension of reducing fittings is normally defined by the nominal bore of the larger size. Special dimensions are available on request. For further information go to our website at www.crp.co.uk or call us on +44(0)1706 756400. Please note, no warranties are given on the accuracy of the data, which may be subject to revision, for confirmation please refer to the appropriate standards documents. CRP's dimensions may vary from those of other manufacturers and not all components

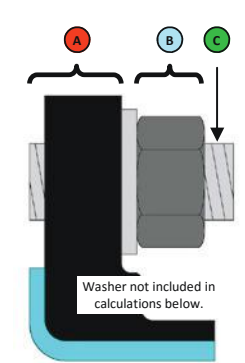
Half Joint Calculator for ASME B16.5 Class 150 Joints for CRP Lined Equipment

Dimensions in millimetres

Bolting and Torque Details

Nominal Bore	DN	Flange Ø	Pitch Circle Ø	No. of Bolt Holes	Hole Ø	Bolts/ Studs	Bolts/Studs Metric	Torque Nm
1/2 in	DN 15	90	60.3	4	15.9	1/2"	M12	7
3/4 in	DN 20	98	69.9	4	15.9	1/2"	M12	15
1 in	DN 25	108	79.4	4	15.9	1/2"	M12	19
1 1/2 in	DN 40	127	98.4	4	15.9	1/2"	M12	27
2 in	DN 50	152	120.7	4	19.0	5/8"	M16	47
3 in	DN 80	190	152.4	4	19.0	5/8"	M16	73
4 in	DN 100	229	190.5	8	19.0	5/8"	M16	54
6 in	DN 150	279	241.3	8	22.2	3/4"	M20	108
8 in	DN 200	343	298.5	8	22.2	3/4"	M20	136
10 in	DN 250	406	362.0	12	25.4	7/8"	M24	127
12 in	DN 300	483	431.8	12	25.4	7/8"	M24	145
14 in	DN 350	533	476.3	12	28.6	1"	M27	182

Please refer to CRP User Guide for more information relating to making joints in PTFE/PFA lined equipment. Remember re-torquing is required after 24 hours or one process cycle.



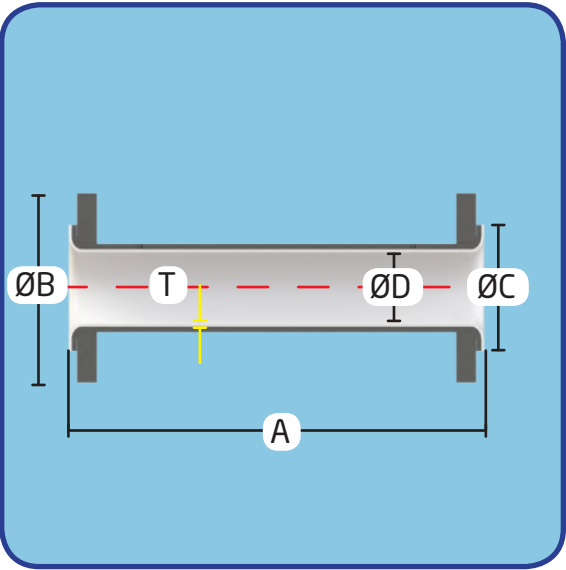
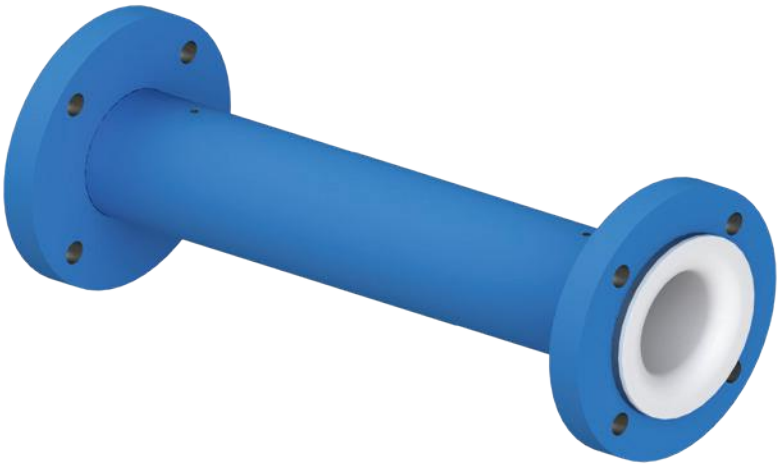
Nominal Bore	DN	Component	Half Joint Total Thickness A
1 in	DN 25	Heavy Duty Van Stone Spool	20.5
1 1/2 in	DN 40	Heavy Duty Van Stone Spool	23.5
2 in	DN 50	Heavy Duty Van Stone Spool	25.5
3 in	DN 80	Heavy Duty Van Stone Spool	29.5
4 in	DN 100	Heavy Duty Van Stone Spool	33.0
6 in	DN 150	Heavy Duty Van Stone Spool	36.5
8 in	DN 200	Heavy Duty Van Stone Spool	42.0
1/2 in	DN 15	Heavy Duty Spool Fixed Flange	13.5
3/4 in	DN 20	Heavy Duty Spool Fixed Flange	14.5
1 in	DN 25	Heavy Duty Spool Fixed Flange	17.5
1 1/2 in	DN 40	Heavy Duty Spool Fixed Flange	20.5
2 in	DN 50	Heavy Duty Spool Fixed Flange	21.5
3 in	DN 80	Heavy Duty Spool Fixed Flange	26.5
4 in	DN 100	Heavy Duty Spool Fixed Flange	28.0
6 in	DN 150	Heavy Duty Spool Fixed Flange	31.0
8 in	DN 200	Heavy Duty Spool Fixed Flange	35.0
10 in	DN 250	Heavy Duty Spool Fixed Flange	38.0
12 in	DN 300	Heavy Duty Spool Fixed Flange	40.0
1/2 in	DN 15	Heavy Duty Spool Rotating Flange	23.5
3/4 in	DN 20	Heavy Duty Spool Rotating Flange	26.5
1 in	DN 25	Heavy Duty Spool Rotating Flange	29.5
1 1/2 in	DN 40	Heavy Duty Spool Rotating Flange	32.5
2 in	DN 50	Heavy Duty Spool Rotating Flange	35.5
3 in	DN 80	Heavy Duty Spool Rotating Flange	42.5
4 in	DN 100	Heavy Duty Spool Rotating Flange	44.0
6 in	DN 150	Heavy Duty Spool Rotating Flange	49.0
8 in	DN 200	Heavy Duty Spool Rotating Flange	55.0
10 in	DN 250	Heavy Duty Spool Rotating Flange	60.0
12 in	DN 300	Heavy Duty Spool Rotating Flange	62.0
14 in	DN 350	Heavy Duty Spool Rotating Flange	65.5

Please note that for certain sizes of product - particularly small 45 degree elbows, threaded holes and stud bolts are used, changing these calculations. For more information please see our website

*Assuming nuts are faced one side

Nominal Bore	DN	Component	Half Joint Total Thickness A
1/2 in	DN 15	Fitting Fixed Flange	12.5
3/4 in	DN 20	Fitting Fixed Flange	15.0
1 in	DN 25	Fitting Fixed Flange	17.0
1 1/2 in	DN 40	Fitting Fixed Flange	21.0
2 in	DN 50	Fitting Fixed Flange	23.0
3 in	DN 80	Fitting Fixed Flange	28.5
4 in	DN 100	Fitting Fixed Flange	29.5
6 in	DN 150	Fitting Fixed Flange	31.5
8 in	DN 200	Fitting Fixed Flange	36.5
10 in	DN 250	Fitting Fixed Flange	39.5
12 in	DN 300	Fitting Fixed Flange	41.0
14 in	DN 350	Fitting Fixed Flange	43.5
1/2 in	DN 15	Fitting Rotating Flange	22.5
3/4 in	DN 20	Fitting Rotating Flange	27.0
1 in	DN 25	Fitting Rotating Flange	29.0
1 1/2 in	DN 40	Fitting Rotating Flange	33.0
2 in	DN 50	Fitting Rotating Flange	37.0
3 in	DN 80	Fitting Rotating Flange	44.5
4 in	DN 100	Fitting Rotating Flange	45.5
6 in	DN 150	Fitting Rotating Flange	49.5
8 in	DN 200	Fitting Rotating Flange	56.5
10 in	DN 250	Fitting Rotating Flange	61.5
12 in	DN 300	Fitting Rotating Flange	63.0
14 in	DN 350	Fitting Rotating Flange	67.5

UNC Thread	Thread Pitch C	Nut Thickness * [mm]	
		Ordinary	Heavy B
1/2"	2.0	11	12
5/8"	2.3	14	16
3/4"	2.5	17	19
7/8"	2.8	19	22
1"	3.0	22	25
Metric Thread	Thread Pitch C	Nut Thickness [mm] B	
		M12	1.75
		M16	2.0
		M20	2.5
		M24	3.0
		M27	3.0



The process of manufacturing a pipe spool with both flanges rotating without the use of conventionally welded or screw threaded stub ends is known as the "Van Stone" system. The process essentially forms a lap collar by spinning over the

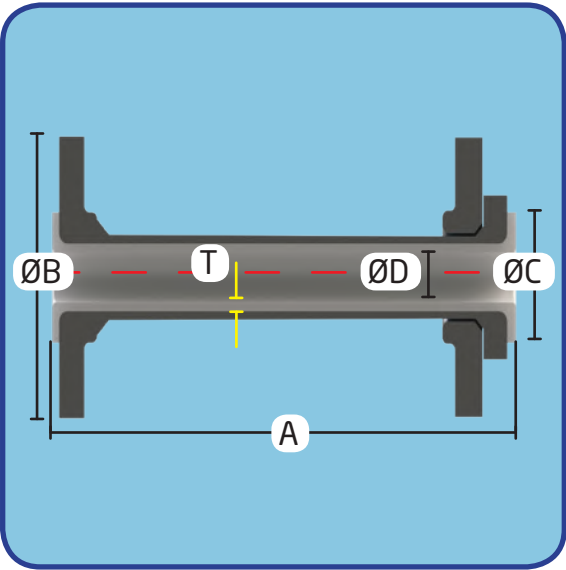
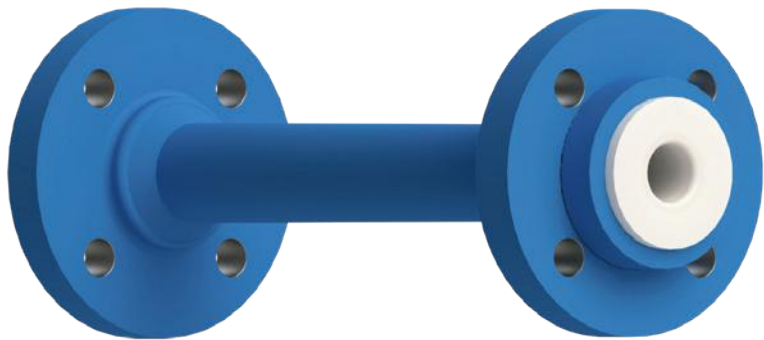
parent tube at right angles to the original tube axis.

The technical advantages are that flanges are absolutely square, flange to flange bolting is short so giving less

shank to gather dirt or become corroded and it provides a cost effective means of providing two rotating flanges for ease of installation. Van Stone pipe spools are available in sizes up to 8 inch nominal bore.

Van Stone Pipe Spool Rotating Flanges							UltraHiPerFlon®			
Nominal Bore		Length		Flange Outside Diameter	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Superweight/ Heavy Duty UHP PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight	
		Minimum	Maximum						Flange Pack	Per metre
Inches	mm	mm	mm	Ø B	Ø C	T	T	Ø D	kg	kg
½	15	250	6000	90	35	2.3	2.3	16	1.0	2.0
¾	20	250	6000	100	43	2.3	2.3	16	1.3	2.0
1	25	250	6000	110	51	3.2	4.5	20	3.0	2.8
1½	40	250	6000	125	73	3.2	4.5	34	4.0	5.0
2	50	250	6000	150	92	3.2	4.5	46	6.0	6.5
3	80	250	6000	190	127	3.2	4.8	70	10	12.3
4	100	250	6000	230	157	4.5	5.0	93	12	16.0
6	150	500	6000	280	216	5.5	6.0	143	22	32.0
8	200	500	3000	345	270	8.5	8.5	188	27	54.0

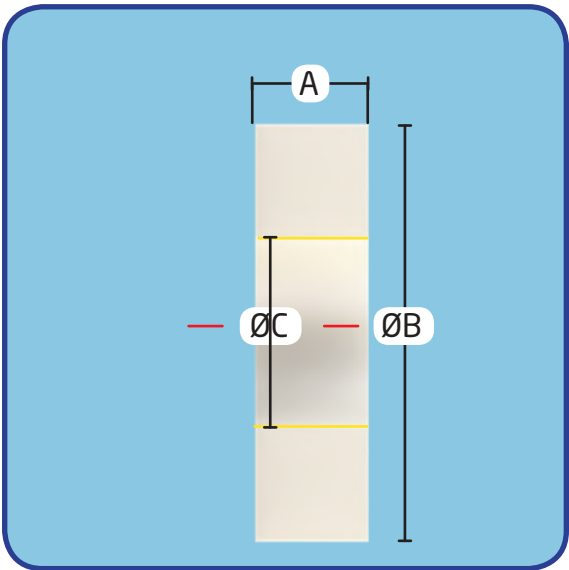
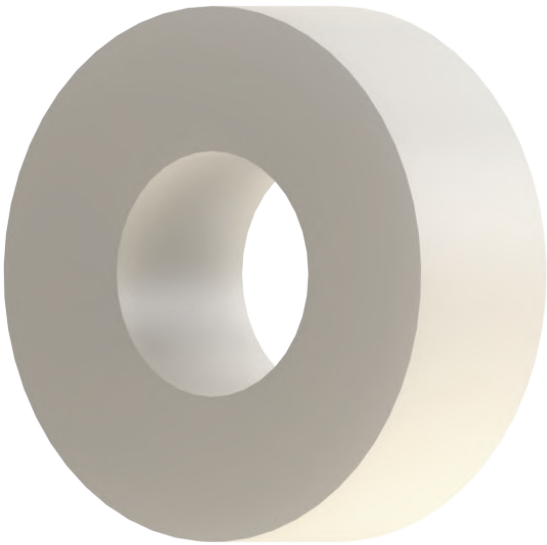
1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Based on HiPerFlon and because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.



This spool construction has a welded slip on flange at one end and a welded stub end and loose backing flange at the other to provide a rotating flange. This is the most common pipe spool standard world-wide.

Welded Pipe Spool F/R							UltraHiPerFlon®			
Nominal Bore		Length		Flange Outside Diameter	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Superweight/ Heavy Duty UHP PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight	
		Minimum	Maximum						Flange Pack	
		A		Ø B	Ø C	T	T	Ø D		
Inches	mm	mm	mm	mm	mm	mm		mm	kg	kg
½	15	90	6000	90	35	2.3	2.3	16	2	2.0
¾	20	90	6000	100	43	2.3	2.3	16	2	2.0
1	25	90	6000	110	51	3.2	4.5	20	3	2.8
1½	40	95	6000	125	73	3.2	4.5	34	4	5.0
2	50	110	6000	150	92	3.2	4.5	46	6	6.5
3	80	120	6000	190	127	3.2	4.8	70	10	12.3
4	100	125	6000	230	157	4.5	5.0	93	12	16.0
6	150	140	6000	280	216	5.5	6.0	143	22	32.0
8	200	150	3000	345	270	8.5	8.5	188	27	54.0
10	250	165	3000	405	324	9.1	9.1	247	38	70.0
12	300	170	3000	485	381	10.4	10.4	286	59	86.0
14	350	190	3000	535	413	8.3	8.3	319	80	109.0

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Based on HiPerFlon and because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.



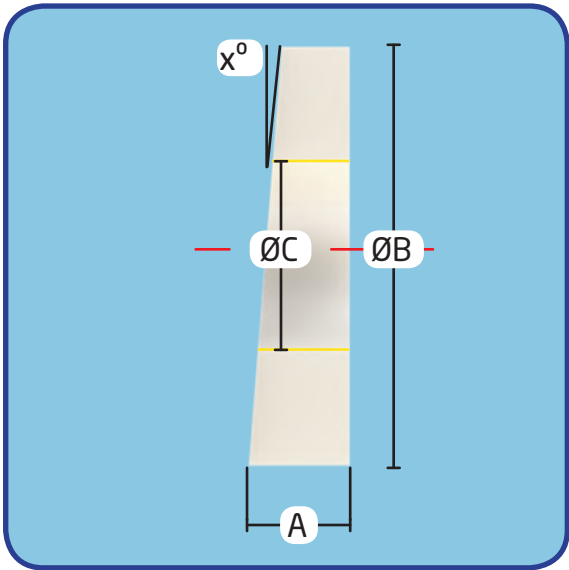
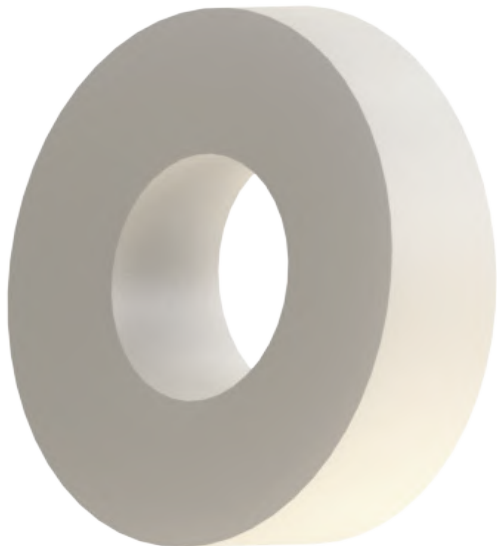
Spacers are used as small gap fillers in a piping system, where the space is too small for a conventional pipe spool or the opportunity does not arise to make a spool to the precise length required. Type 1 spacers have the smallest size range going up to 25mm in length. CRP would not recommend Type 1 spacers above this length as there is no pressure retaining element beyond the PTFE itself. They are a wafer fitting, with an outside diameter sized to fit snugly inside the bolt circle of the adjacent parts.

Spacer Type 1						
Nominal Bore		Length		Outside	Bore	Weight
		Minimum	Maximum		Nominal	
		A		Ø B	Ø C	
Inches	mm	mm	mm	mm	mm	kg/mm
½	15	3	25	44	20	0.003
¾	20	3	25	54	20	0.004
1	25	3	25	64	25	0.006
1½	40	3	25	83	38	0.009
2	50	3	25	102	51	0.013
3	80	3	25	133	76	0.020
4	100	3	25	171	102	0.032
6	150	3	25	219	152	0.042
8	200	3	25	275	203	0.058
10	250	3	25	336	254	0.082
12	300	3	25	405	304	0.119
14	350	3	25	446	367	0.144

Spacer Type 1 Tapered

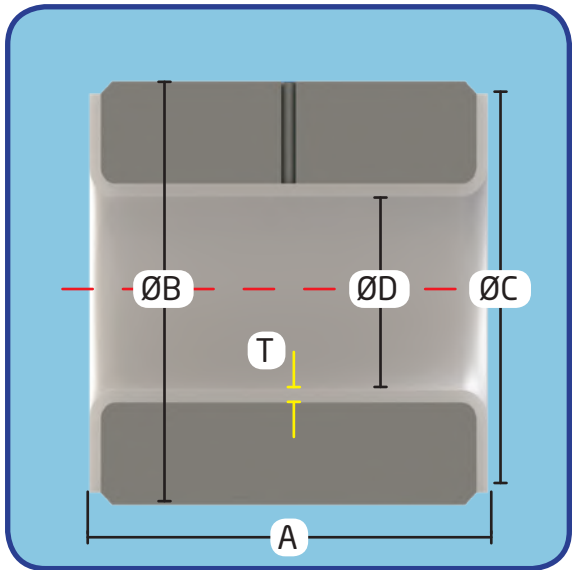


Spacer Type 2



Type 1 spacers can also be provided tapered to a set angle or dimension on opposite sides of a flange face. This can provide a change in the angle of the pipework, useful for starting or ending falls.

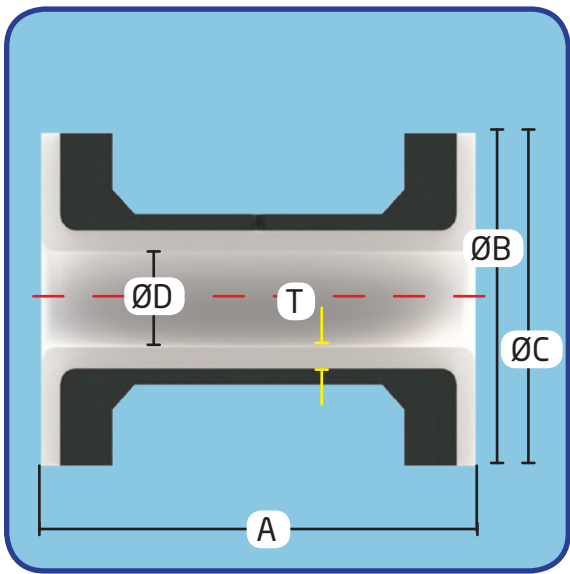
Spacer Type 1 Tapered											
Nominal Bore		Length		Outside	Bore Nominal	Weight	Viable Angles				
		Minimum	Maximum								
		A		Ø B	Ø C						
Inches	mm	mm	mm	mm	mm	kg/mm	1°	2°	3°	4°	5°
½	15	3	25	44	20	0.003	Yes	Yes	Yes	Yes	Yes
¾	20	3	25	54	20	0.004	Yes	Yes	Yes	Yes	Yes
1	25	3	25	64	25	0.006	Yes	Yes	Yes	Yes	Yes
1½	40	3	25	83	38	0.009	Yes	Yes	Yes	Yes	Yes
2	50	3	25	102	51	0.013	Yes	Yes	Yes	Yes	Yes
3	80	3	25	133	76	0.020	Yes	Yes	Yes	Yes	Yes
4	100	3	25	171	102	0.032	Yes	Yes	Yes	Yes	Yes
6	150	3	25	219	152	0.042	Yes	Yes	Yes	Yes	No
8	200	3	25	275	203	0.058	Yes	Yes	Yes	Yes	No
10	250	3	25	336	254	0.082	Yes	Yes	Yes	No	No
12	300	3	25	405	304	0.119	Yes	Yes	Yes	No	No
14	350	3	25	446	367	0.144	Yes	Yes	No	No	No



Spacers are used as small gap fillers in a piping system, where the space is too small for a conventional pipe spool or the opportunity does not arise to make a spool to the precise length required. The type 2 spacer is a wafer fitting and should be specified for gap filling from the shortest size available for the relevant nominal bore - being a more robust fitting than the type 1 spacer. It comprises a hollow steel bar with an outside diameter sized to fit snugly inside the bolt circle of the adjacent parts. Tapered type 2 spacers are also available on request.

Spacer Type 2									
Nominal Bore		Length		Steel Housing	Raised Face	PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Minimum Length Weight	Maximum Length Weight
		Minimum	Maximum						
		A		Ø B	Ø C	T	Ø D		
Inches	mm	mm	mm	mm	mm	mm	mm	kg	kg
½	15	26	60	44	35	2.3	16	0.9	0.9
¾	20	26	60	54	43	2.3	16	1.3	1.4
1	25	26	60	64	51	3.2	20	1.7	1.9
1½	40	26	60	83	73	3.2	34	2.2	2.4
2	50	26	70	102	92	3.2	46	2.9	3.5
3	80	26	70	133	127	3.2	70	5	6
4	100	26	70	171	157	4.5	93	9	11
6	150	26	80	219	216	5.5	143	13	16
8	200	26	80	276	270	8.5	188	15	21
10	250	26	80	336	324	9.1	247	19	27
12	300	26	80	406	381	10.4	286	30	40
14	350	26	80	447	413	8.3	319	40	52

1 - Please note liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Bore is based on virgin PTFE heavy duty liner, because of method of manufacture and steel tolerances this is a guide only, for other materials and thicknesses please consult the liner tables in the manual.



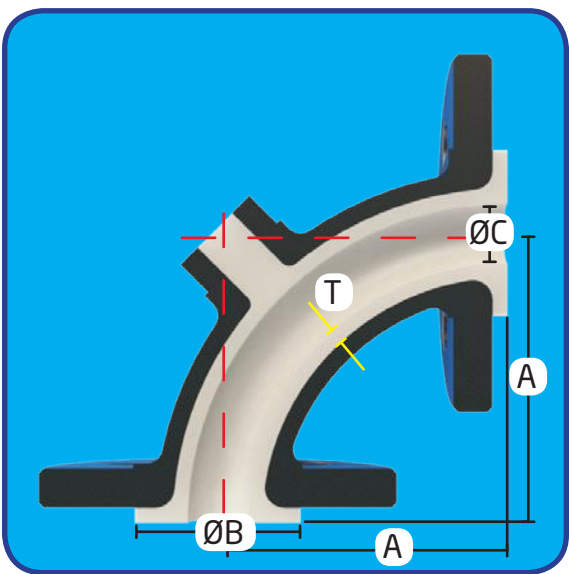
Spacers are used as small gap fillers in a piping system, where the space is too small for a conventional pipe spool or the opportunity does not arise to make a spool to the precise length required. Type

3 spacers are manufactured from pipe spool piping, but have stub ends in place of flanges as conventional bolting would not fit in the distance. They should be specified in preference to Type 2 spacers

as soon as the gap meets the minimum length. They have an outside diameter sized to fit snugly inside the bolt circle of the adjacent parts.

Spacer Type 3									
Nominal Bore		Length		Stub End	Raised Face	PTFE Liner Thickness ¹	Lined Bore Nominal ²	Minimum Length Weight	Maximum Length Weight
		Minimum	Maximum						
		A							
Inches	mm	mm	mm	mm	mm	mm	mm	kg	kg
½	15	61	100	44	35	2.3	20	0.2	0.2
¾	20	61	100	54	43	2.3	20	0.4	0.4
1	25	61	100	64	51	3.2	23	0.5	0.6
1½	40	61	100	83	73	3.2	37	0.9	0.9
2	50	61	150	102	92	3.2	48	1.4	1.6
3	80	71	150	133	127	3.2	75	3	3
4	100	71	150	171	157	4.5	98	3	3
6	150	71	150	216	216	5.5	148	4	5
8	200	81	200	270	270	8.5	191	9	10
10	250	81	200	324	324	9.1	241	6	8
12	300	81	200	381	381	10.4	298	9	11
14	350	81	200	413	413	8.3	326	12	14

1 - Please note liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Bore is based on virgin PTFE heavy duty liner, because of method of manufacture and steel tolerances this is a guide only, for other materials and thicknesses please consult the liner tables in the manual.



The 90° elbow is the most popular of all pipe fittings after the spool, providing a 90° change of direction.

The standard range are dimensioned according to ASME B16.5 and have no specific radius across the size range, from around 3.5 times diameter radius with a 1 inch elbow through to a 1 times diameter radius with a 14 inch elbow. Elbows are wherever possible lined in PFA to provide the permeation and wettability benefits that PFA brings and geometrical accuracy that can be critical in some applications. PFA also brings increased vacuum performance which can be useful in larger line sizes. Non-standard elbows are lined in PTFE as are static-dissipating elbows.

Static-dissipating PFA lining is available on request.

By dint of their versatility they are used throughout piping systems although one common application is to use an elbow to create a fall in pipework utilising a rotating flange. (See next page).

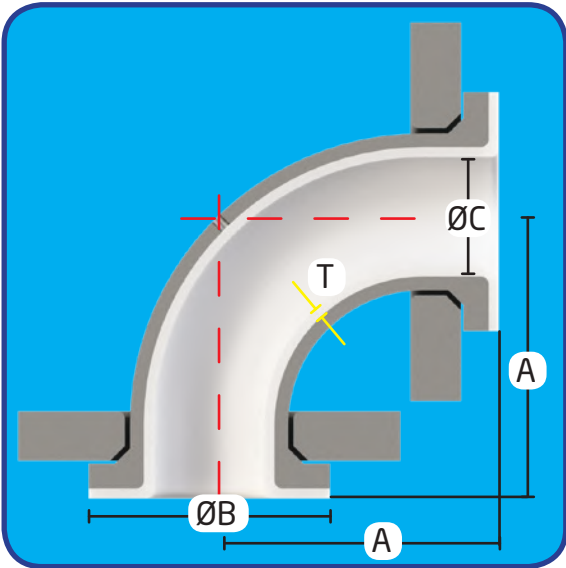
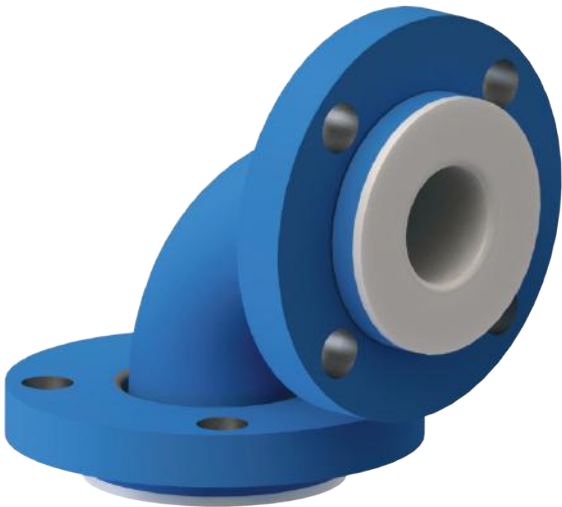
For handling more viscous fluids larger radius elbows are available - typically manufactured at 5D (see the appropriate page), but elbows can be manufactured with various radii and angles up to 180° with 45° being the second most common type and 30° and 60° elbows being relatively popular. Also non-standard centreline to face dimensions and dissimilar centreline to face dimensions

on each leg can be achieved. When centreline to face dimensions are not provided for special angle elbows, those less than 45° have standard 45° centreline to face dimensions. Those greater than 45° have standard 90° centreline to face dimensions.

The most popular elbow sizes are supplied with a high integrity investment cast steel body and wetted parts are lined with a heavy wall PFA (construction code CP), providing superior permeation resistance and very square flanges. Less popular configurations are lined with paste extruded PTFE, flared over the flange faces in a similar manner to pipe spools.

90° Elbow								Construction Codes		
Nominal Bore		Centre Line to Face	Raised Face	Wall Thickness		Bore		Code	Steelwork	Lining
				PFA Heavy Duty Liner Thickness Nominal ¹	HiPerFlon PTFE Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	PTFE Liner Bore Nominal ²	CP	Cast Steel	PFA
				T	T	Ø C	Ø C	CT	Cast Steel	PTFE
Inches	mm	mm	mm	mm	mm	mm	mm	FT	Fabricated Steel	PFA
								Construction		Weight
								Standard	To Order	kg
½	15	100	35	-	2.3	-	16	FT	-	1.5
¾	20	75	43	-	2.3	-	20	FT	-	1.5
1	25	89	51	4.0	3.2	20	20	CP	CT/FT	2.6
1½	40	102	73	4.5	3.2	33	34	CP	CT/FT	4.0
2	50	114	92	4.8	3.2	44	46	CP	CT/FT	6.5
3	80	140	127	6.5	3.2	66	70	CP	CT/FT	12
4	100	165	157	9.0	4.5	86	93	CP	CT/FT	17
6	150	203	216	11.0	5.5	137	43	CP	CT/FT	27
8	200	229	270	10.0	8.5	186	188	CP	CT/FT	56
10	250	279	324	10.0	9.1	237	39	CP	CT/FT	65
12	300	305	381	10.0	10.4	287	286	CP	CT/FT	115
14	350	356	413	10.5	8.3	317	319	CP	CT/FT	140

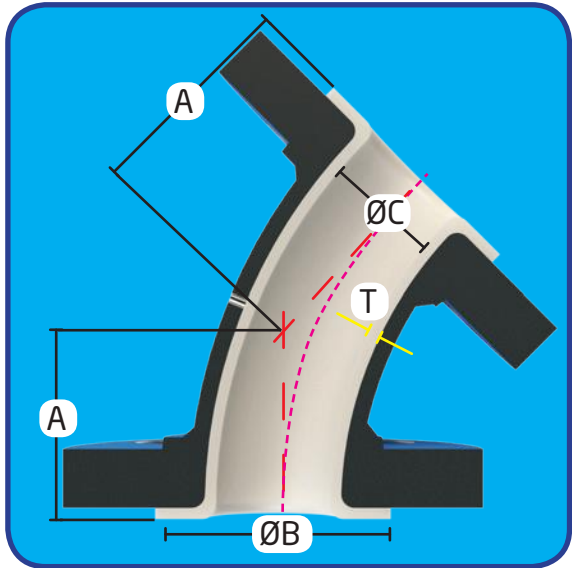
¹ 1 - Liner thicknesses are based on Virgin PTFE heavy duty liner and PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
² 2 - Nominal bores are based on Virgin PTFE heavy duty liner and schedule 40 or 30 steel pipe and PFA heavy duty liner in castings. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a calibrated volume in the product please consult us.



This design of elbow has two rotating flanges captured behind stub ends. This design makes installation easy and provides versatility. The elbow design is ideal as a stock item for maintenance requirements.

90° Elbow Rotating Flanges						Construction Codes			
Nominal Bore		Centre Line to Face	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Construction	Weight	Code	Steelwork	Lining
							CP	Cast Steel	PFA
							CT	Cast Steel	PTFE
							FP	Fabricated Steel	PFA
							FT	Fabricated Steel	PTFE
Inches	mm	mm	mm	mm	Standard	kg			
½	15	100	35	16	FT	2.5			
¾	20	75	43	20	FT	2.5			
1	25	89	51	20	FT	2.6			
1½	40	102	73	34	FT	4.0			
2	50	114	92	46	FT	6.5			
3	80	140	127	70	FT	12			
4	100	165	157	93	FT	17			
6	150	203	216	143	FT	27			
8	200	229	270	188	FT	56			
10	250	279	324	239	FT	65			
12	300	305	381	286	FT	115			
14	350	356	413	319	FT	140			

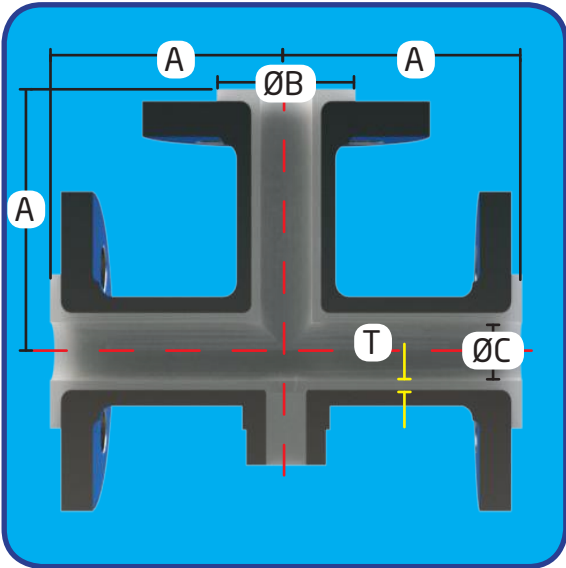
1 - Liner thicknesses are based on Virgin PTFE heavy duty liner.
2 - Nominal bores are based on Virgin PTFE heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a calibrated volume in the product please consult us.



The 45° elbow of course provides a 45° change of direction. These are generally lined in PTFE. Note that a 1 inch 45° elbow does not have through holes in the flanges, they are tapped 1/2 inch UNC because of the clash of nuts that would occur otherwise. A metric version is available with M12 or M14 tapped holes. Similar options to those for 90° elbows are available.

45° Elbow								Construction Codes		
Nominal Bore		Centre Line to Face A	Raised Face Ø B	HiPerFlon PTFE Liner Thickness Nominal ¹ T	PTFE Liner Bore Nominal ² Ø C	Construction		Code	Steelwork	Lining
								CP	Cast Steel	PFA
Inches	mm	mm	mm	mm	mm	Standard	To Order	CT	Cast Steel	PTFE
1/2	15	44	35	2.3	16	FT	-	FP	Fabricated Steel	PFA
3/4	20	44	43	2.3	20	FT	-	FT	Fabricated Steel	PTFE
1	25	44	51	3.2	20	CT	FT			
1 1/2	40	57	73	3.2	34	CT	FT			
2	50	64	92	3.2	46	CT	FT			
3	80	76	127	3.2	70	CT	FT			
4	100	102	157	4.5	93	FT	-			
6	150	127	216	5.5	143	FT	-			
8	200	140	270	8.5	188	FT	-			
10	250	165	324	9.1	239	FT	-			
12	300	190	381	10.4	286	FT	-			
14	350	190	413	8.3	319	FT	-			

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PTFE heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a calibrated volume in the product please consult us.



Equal tees provide a robust pipeline branch of the same nominal bore as the main pipeline itself. They are used for making additions or merging separate flows. Tees are manufactured to ASME B16.5 class 150 dimensions, but variations on standard dimensions are available on request. They

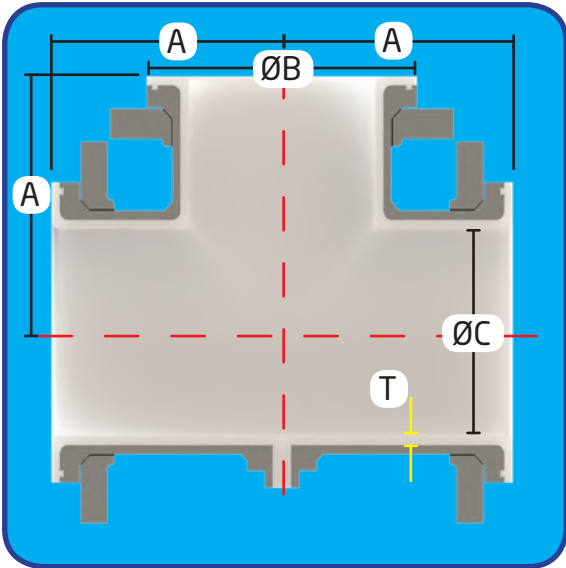
can be manufactured with either fixed flanges, rotating flanges or a mix. Fixed flange products are the most economical solution. The most popular tee sizes are supplied with a high integrity investment cast steel body and wetted parts lined with a heavy wall PFA, providing superior

permeation resistance.

Committed to PFA as a superior lining material for the highest level of performance, CRP is the only global manufacturer producing PFA moulded fittings in up to 14 inch size.

Equal Tee								Construction Codes		
Nominal Bore		Centre Line to Face	Raised Face	PFA Heavy Duty Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	Construction		Code	Steelwork	Lining
								CP	Cast Steel	PFA
Inches	mm	mm	mm	mm	mm	Standard	To Order	CT	Cast Steel	PTFE
1/2	15	65	35	4.5	12	FP	-	FP	Fabricated Steel	PFA
3/4	20	75	43	4.5	12	FP	-	FT	Fabricated Steel	PTFE
1	25	89	51	4.0	19.6	CP	FP			
1 1/2	40	102	73	4.5	33	CP	FP			
2	50	114	92	4.8	44	CP	FP			
3	80	140	127	6.5	66	CP	FP			
4	100	165	157	9.0	86	CP	FP			
6	150	203	216	11.0	137	CP	FP			
8	200	229	270	10.0	186	FP	-			
10	250	279	324	10.0	237	FP	-			
12	300	305	381	10.0	287	FP	-			
14	350	356	413	10.5	317	FP	-			

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner and PFA heavy duty liner in castings. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.

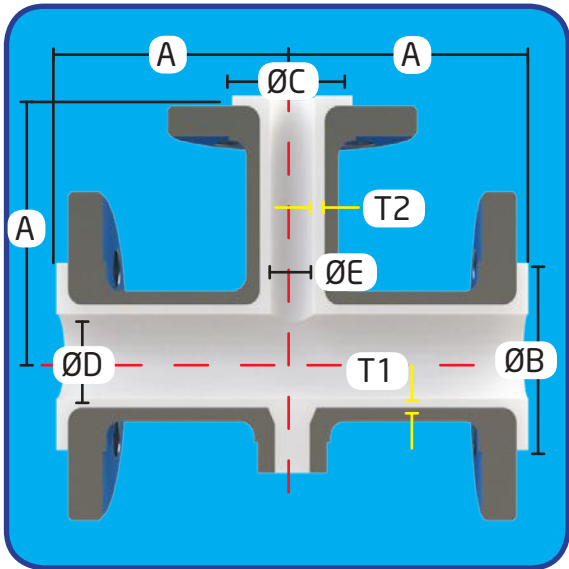


This design of tee has three rotating flanges captured behind stub ends. This design makes installation easy and

provides versatility. The tee design is ideal as a stock item for maintenance requirements.

Equal Tee Rotating Flanges								Construction Codes		
Nominal Bore		Centre Line to Face	Raised Face	PFA Heavy Duty Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	Construction		Code	Steelwork	Lining
								CP	Cast Steel	PFA
Inches	mm	mm	mm	mm	mm	Standard	Weight	CT	Cast Steel	PTFE
1/2	15	65	35	4.5	12	FP	2.0	FP	Fabricated Steel	PFA
3/4	20	75	43	4.5	12	FP	3.0	FT	Fabricated Steel	PTFE
1	25	89	51	4.0	19.6	FP	4.0			
1 1/2	40	102	73	4.5	33	FP	6.5			
2	50	114	92	4.8	44	FP	10			
3	80	140	127	6.5	66	FP	19			
4	100	165	157	9.0	86	FP	27			
6	150	203	216	11.0	137	FP	45			
8	200	229	270	10.0	186	FP	68			
10	250	279	324	10.0	237	FP	90			
12	300	305	381	10.0	287	FP	185			
14	350	356	413	10.5	317	FP	200			

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner and schedule 40 or 30 steel pipe and PFA heavy duty liner in castings. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



Reducing tees have a smaller branch diameter than the main pipeline and are generally available in every nominal bore size down from the main branch. They are used for making additions or merging separate flows. Tees are manufactured to ASME B16.5 class 150 dimensions, with the branch centre-line to face dimension the same as that of the main

bore irrespective of the nominal bore size of the branch. Variations on standard dimensions are available on request. For sizes at ½ inch and ¾ inch a larger pipe is used to achieve a reasonable bore and the PFA may have a machined bore rather than moulded in situ. They can be manufactured with either fixed flanges, rotating flanges or a mix. Please advise

us if you require a specific branch bore for holding or mounting instruments or other devices. Fixed flange products are the most economical solution. The most popular tee sizes are supplied with a high integrity investment cast steel body and wetted parts lined with a heavy wall PFA, providing superior permeation resistance.

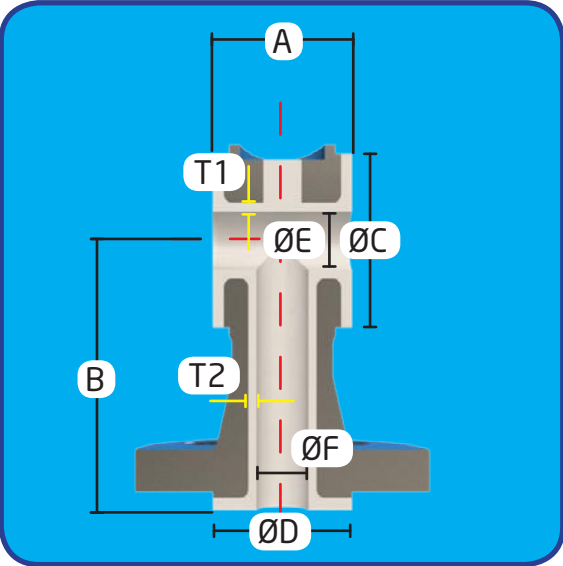
Reducing Tee

Reducing Tee												Construction Codes			
Nominal Bore				Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²		Code	Steelwork	Lining	
												CP	Cast Steel	PFA	
												CT	Cast Steel	PTFE	
												FP	Fabricated Steel	PFA	
												FT	Fabricated Steel	PTFE	
Inches		mm		A	B	Ø C	T1	T2	Ø D	Ø E	Construction		Weight		
				mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg		
¾	x	½	20	x	15	75	43	35	4.5	4.5	12	12	FP	-	2.0
1	x	½	25	x	15	89	51	35	4.0	4.5	20	12	FP	-	2.6
1	x	¾	25	x	20	89	51	43	4.0	4.5	20	12	FP	-	2.9
1½	x	½	40	x	15	102	73	35	4.5	4.5	33	12	FP	-	4.2
1½	x	¾	40	x	20	102	73	43	4.5	4.5	33	12	FP	-	4.4
1½	x	1	40	x	25	102	73	51	4.5	4.0	33	20	CP	FP	4.7
2	x	½	50	x	15	114	92	35	4.8	4.5	44	12	FP	-	6.3
2	x	¾	50	x	20	114	92	43	4.8	4.5	44	12	FP	-	6.6
2	x	1	50	x	25	114	92	51	4.8	4.0	44	20	CP	FP	6.9
2	x	1½	50	x	40	114	92	73	4.8	4.5	44	33	CP	FP	7.6
3	x	½	80	x	15	140	127	35	6.5	4.5	66	12	FP	-	12
3	x	¾	80	x	20	140	127	43	6.5	4.5	66	12	FP	-	13
3	x	1	80	x	25	140	127	51	6.5	4.0	66	20	CP	FP	13
3	x	1½	80	x	40	140	127	73	6.5	4.5	66	33	FP	-	14
3	x	2	80	x	50	140	127	92	6.5	4.8	66	44	CP	FP	15
4	x	½	100	x	15	165	157	35	9.0	4.5	86	12	FP	-	18
4	x	¾	100	x	20	165	157	43	9.0	4.5	86	12	FP	-	19
4	x	1	100	x	25	165	157	51	9.0	4.0	86	20	CP	FP	19
4	x	1½	100	x	40	165	157	73	9.0	4.5	86	33	FP	-	20
4	x	2	100	x	50	165	157	92	9.0	4.8	86	44	FP	-	21

Reducing Tee

Reducing Tee									Construction Codes		
									Code	Steelwork	Lining
Nominal Bore		Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²			
Inches	mm	A	B	Ø C	T1	T2	Ø D	Ø E	Construction		Weight
4 x 3	100 x 80	165	157	127	9.0	6.5	86	66	FP	-	24
6 x ½	150 x 15	203	216	35	11.0	4.5	137	12	FP	-	31
6 x ¾	150 x 20	203	216	43	11.0	4.5	137	12	FP	-	31
6 x 1	150 x 25	203	216	51	11.0	4.0	137	20	FP	-	32
6 x 1½	150 x 40	203	216	73	11.0	4.5	137	33	FP	-	33
6 x 2	150 x 50	203	216	92	11.0	4.8	137	44	FP	-	34
6 x 3	150 x 80	203	216	127	11.0	6.5	137	66	FP	-	37
6 x 4	150 x 100	203	216	157	11.0	9.0	137	86	FP	-	40
8 x 1	200 x 25	229	270	51	10.0	4.0	186	20	FP	-	48
8 x 1½	200 x 40	229	270	73	10.0	4.5	186	33	FP	-	49
8 x 2	200 x 50	229	270	92	10.0	4.8	186	44	FP	-	50
8 x 3	200 x 80	229	270	127	10.0	6.5	186	66	FP	-	54
8 x 4	200 x 100	229	270	157	10.0	9.0	186	86	FP	-	58
8 x 6	200 x 150	229	270	216	10.0	11.0	186	137	FP	-	64
10 x 1	250 x 25	279	324	51	10.0	4.0	237	20	FP	-	72
10 x 1½	250 x 40	279	324	73	10.0	4.5	237	33	FP	-	73
10 x 2	250 x 50	279	324	92	10.0	4.8	237	44	FP	-	75
10 x 3	250 x 80	279	324	127	10.0	6.5	237	66	FP	-	79
10 x 4	250 x 100	279	324	157	10.0	9.0	237	86	FP	-	83
10 x 6	250 x 150	279	324	216	10.0	11.0	237	137	FP	-	90
10 x 8	250 x 200	279	324	270	10.0	10.0	237	186	FP	-	98
12 x 1	300 x 25	305	381	51	10.0	4.0	287	20	FP	-	105
12 x 1½	300 x 40	305	381	73	10.0	4.5	287	33	FP	-	107
12 x 2	300 x 50	305	381	92	10.0	4.8	287	44	FP	-	108
12 x 3	300 x 80	305	381	127	10.0	6.5	287	66	FP	-	113
12 x 4	300 x 100	305	381	157	10.0	9.0	287	86	FP	-	117
12 x 6	300 x 150	305	381	216	10.0	11.0	287	137	FP	-	125
12 x 8	300 x 200	305	381	270	10.0	10.0	287	186	FP	-	134
12 x 10	300 x 250	305	381	324	10.0	10.0	287	237	FP	-	145
14 x 1	350 x 25	356	413	51	10.5	4.0	317	20	FP	-	143
14 x 1½	350 x 40	356	413	73	10.5	4.5	317	33	FP	-	145
14 x 2	350 x 50	356	413	92	10.5	4.8	317	44	FP	-	146
14 x 3	350 x 80	356	413	127	10.5	6.5	317	66	FP	-	151
14 x 4	350 x 100	356	413	157	10.5	9.0	317	86	FP	-	156
14 x 6	350 x 150	356	413	216	10.5	11.0	317	137	FP	-	164
14 x 8	350 x 200	356	413	270	10.5	10.0	317	186	FP	-	173
14 x 10	350 x 250	356	413	324	10.5	10.0	317	237	FP	-	185
14 x 12	350 x 300	356	413	381	10.5	10.0	317	287	FP	-	202

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner in castings. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



Instrument tees are one of the few wafer fittings in a pipeline system, providing the functionality of a flanged equal or reducing tee without the bulk. Their primary use is for the insertion of instrumentation into the flow stream without introducing a dead leg. It is important to know that instrument tees are not included in ASME B16.5, so the dimensions below

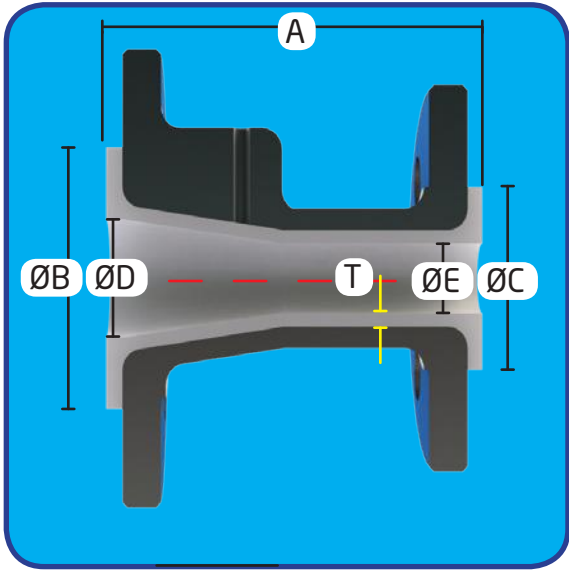
are specific to CRP. The centreline to face dimension of the branch is as ASME B16.5 for the nominal bore of the body, but the body face to face is sized to suit the diameter of the branch nominal bore. Smaller branch sizes are most popular with instrumentation because of their use with instrumentation. If a specific bore is required for an instrument please

discuss this at the time of ordering as sizes are nominal. 3 inch branches are not all possible because of the potential clash with body bolts. Branches of 4 inch and above are not possible because of a clash with the bolts spanning the wafer fitting. The body diameter is sized to fit neatly inside the inner bolt circle of the mating flanges.

Instrument Tee													Construction Codes		
Nominal Bore													Code	Steelwork	Lining
													CP	Cast Steel	PFA
													CT	Cast Steel	PTFE
													FP	Fabricated Steel	PFA
													FT	Fabricated Steel	PTFE
													Construction		Weight
													Standard	To Order	kg
Inches			mm			mm	mm	mm	mm	mm	mm	mm			
½	x	½ ³	15	x	15	51	65	35	35	4.5	4.5	12	FP	-	1.0
¾	x	½ ³	20	x	15	51	75	43	35	4.5	4.5	12	FP	-	1.3
¾	x	¾ ⁴	20	x	20	51	75	43	43	4.5	4.5	12	FP	-	1.6
1	x	½ ³	25	x	15	51	89	51	35	4.0	4.5	20	FP	-	1.7
1	x	¾ ⁴	25	x	20	51	89	51	43	4.0	4.5	20	FP	-	1.9
1	x	1	25	x	25	51	89	51	51	4.0	4.0	20	CP	FP	2.0
1½	x	½ ³	40	x	15	51	102	73	35	4.5	4.5	33	FP	-	2.1
1½	x	¾ ⁴	40	x	20	51	102	73	43	4.5	4.5	33	FP	-	2.4
1½	x	1	40	x	25	51	102	73	51	4.5	4.0	33	CP	FP	2.6
1½	x	1½	40	x	40	76	102	73	73	4.5	4.5	33	CP	FP	4.0
2	x	½ ³	50	x	15	51	114	92	35	4.8	4.5	44	FP	-	3.0
2	x	¾ ⁴	50	x	20	51	114	92	43	4.8	4.5	44	FP	-	3.3
2	x	1	50	x	25	51	114	92	51	4.8	4.0	44	CP	FP	3.5
2	x	1½	50	x	40	76	114	92	73	4.8	4.5	44	CP	FP	5.3
2	x	2	50	x	50	89	114	92	92	4.8	4.8	44	CP	FP	6.9
3	x	½ ³	80	x	15	51	140	127	35	6.5	4.5	66	FP	-	5
3	x	¾ ⁴	80	x	20	51	140	127	43	6.5	4.5	66	FP	-	5
3	x	1	80	x	25	51	140	127	51	6.5	4.0	66	CP	FP	5
3	x	1½	80	x	40	76	140	127	73	6.5	4.5	66	CP	FP	8
3	x	2	80	x	50	89	140	127	92	6.5	4.8	66	CP	FP	10

Instrument Tee															Construction Codes		
															Code	Steelwork	Lining
															CP	Cast Steel	PFA
															CT	Cast Steel	PTFE
															FP	Fabricated Steel	PFA
															FT	Fabricated Steel	PTFE
Nominal Bore						A	B	Ø C	Ø D	T1	T2	Ø E	Ø F	Construction		Weight	
Inches			mm			mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg	
4	x	¾	100	x	20	51	165	157	43	9.0	4.5	86	12	FP	-	8	
4	x	1	100	x	25	51	165	157	51	9.0	4.0	86	20	CP	FP	8	
4	x	1½	100	x	40	76	165	157	73	9.0	4.5	86	33	CP	FP	12	
4 ⁵	x	2	100	x	50	89	165	157	92	9.0	4.8	86	44	CP	FP	14	
6	x	½ ³	150	x	15	51	203	216	35	11.0	4.5	137	12	FP	-	9	
6	x	¾ ⁴	150	x	20	51	203	216	43	11.0	4.5	137	12	FP	-	9	
6	x	1	150	x	25	51	203	216	51	11.0	4.0	137	20	CP	FP	10	
6	x	1½	150	x	40	76	203	216	73	11.0	4.5	137	33	CP	FP	14	
6	x	2	150	x	50	89	203	216	92	11.0	4.8	137	44	CP	FP	18	
6 ⁶	x	3	150	x	80	150	203	216	127	11.0	6.5	137	66	FP	-	30	
8	x	1	200	x	25	51	229	270	51	10.0	4.0	186	20	FP	-	5	
8	x	1½	200	x	40	76	229	270	73	10.0	4.5	186	33	FP	-	8	
8	x	2	200	x	50	89	229	270	92	10.0	4.8	186	44	FP	-	10	
8	x	3	200	x	80	150	229	270	127	10.0	6.5	186	66	FP	-	18	
10	x	1	250	x	25	51	279	324	51	10.0	4.0	237	20	FP	-	18	
10	x	1½	250	x	40	76	279	324	73	10.0	4.5	237	33	FP	-	27	
10	x	2	250	x	50	89	279	324	92	10.0	4.8	237	44	FP	-	33	
12	x	1	300	x	25	51	305	381	51	10.0	4.0	287	20	FP	-	24	
12	x	1½	300	x	40	76	305	381	73	10.0	4.5	287	33	FP	-	36	
12	x	2	300	x	50	89	305	381	92	10.0	4.8	287	44	FP	-	43	
12 ⁷	x	3	300	x	80	150	305	381	127	10.0	6.5	287	66	FP	-	74	
14	x	1	350	x	25	51	356	413	51	10.5	4.0	317	20	FP	-	30	
14	x	1½	350	x	40	76	356	413	73	10.5	4.5	317	33	FP	-	44	
14	x	2	350	x	50	89	356	413	92	10.5	4.8	317	44	FP	-	53	
14	x	3	350	x	80	150	356	413	127	10.5	6.5	317	66	FP	-	89	

1 - Please note liner thicknesses are based on Virgin PFA, for other materials consult the liner tables in the manual.
2 - Bore is based on Virgin PFA, because of method of manufacture and steel tolerances this is a guide only, for other materials and thicknesses please consult the liner tables in the manual.
3 - On 1/2in branch a 3/4in pipe is used.
4 - On 3/4in branch a 1in pipe is used.
5 - Because of the need to pass through the line bolts the branch has a reduced bore in a 1.1/2in pipe.
6 - Because of the need to pass through the line bolts the branch has a reduced bore in a 2in pipe.
7 - Only with UNC bolting.

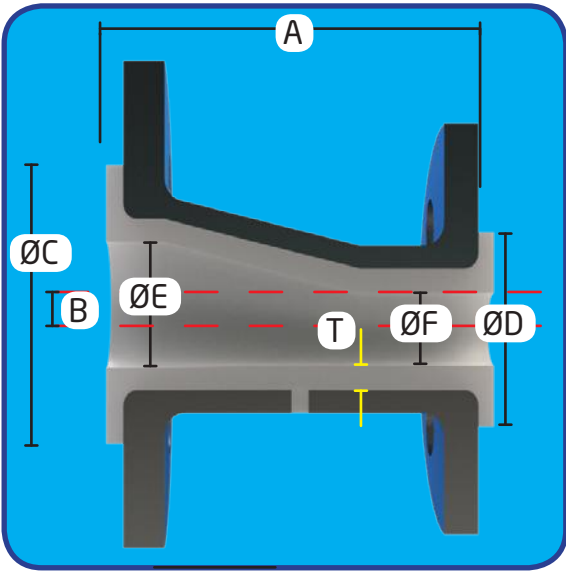


These provide for a gradual reduction in bore on the centreline of the pipeline, reducing (or growing) concentrically from one bore size to another through one or several size reductions. They are useful for the movement of slurries, where cavitation is present and on the discharge side of pumps.

Concentric Reducer										Construction Codes		
										Code	Steelwork	Lining
										CP	Cast Steel	PFA
										CT	Cast Steel	PTFE
										FP	Fabricated Steel	PFA
										FT	Fabricated Steel	PTFE
Nominal Bore										Construction		Weight
		Face to Face	Large NB Raised Face	Small NB Raised Face	Heavy Duty PFA Liner Thickness Nominal ¹	HiPerFlon PTFE Liner Thickness Nominal ¹	Large Bore Nominal ²	Small Bore Nominal ²		Standard	To Order	kg
Inches	mm	mm	mm	mm	mm	mm	mm	mm				
10 x 8	250 x 200	305	324	270	-	9.1	237	186	FT	-	-	49
12 x 4	300 x 100	356	381	157	10.0	-	287	66	FP	-	-	58
12 x 6	300 x 150	356	381	216	10.0	-	287	137	FP	-	-	62
12 x 8	300 x 200	356	381	270	-	10.4	287	186	FT	-	-	66

1 - Liner thicknesses are based on PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.

Concentric Reducer										Construction Codes		
										Code	Steelwork	Lining
										CP	Cast Steel	PFA
										CT	Cast Steel	PTFE
										FP	Fabricated Steel	PFA
										FT	Fabricated Steel	PTFE
Nominal Bore										Construction		Weight
		Face to Face	Large NB Raised Face	Small NB Raised Face	Heavy Duty PFA Liner Thickness Nominal ¹	HiPerFlon PTFE Liner Thickness Nominal ¹	Large Bore Nominal ²	Small Bore Nominal ²		Standard	To Order	kg
Inches	mm	mm	mm	mm	mm	mm	mm	mm				
¾ x ½	20 x 15	114	43	35	-	2.3	12	12	FT	-	-	1.3
1 x ½	25 x 15	114	51	35	-	3.2	20	12	FT	-	-	1.5
1 x ¾	25 x 20	114	51	43	-	3.2	20	12	FT	-	-	1.8
1½ x ¾	40 x 20	114	73	43	-	3.2	33	12	FT	-	-	2.3
1½ x 1	40 x 25	114	73	51	-	3.2	33	20	CT	FT	-	2.7
2 x 1	50 x 25	127	92	51	4.8	-	44	20	CP	FP	-	3.7
2 x 1½	50 x 40	127	92	73	4.8	3.2	44	33	CT	CP/FP/FT	-	4.2
3 x 1	80 x 25	152	127	51	6.5	-	66	20	CP	FP	-	6
3 x 1½	80 x 40	152	127	73	6.5	-	66	33	CP	FP	-	7
3 x 2	80 x 50	152	127	92	6.5	3.2	66	44	CT	CP/FP/FT	-	8
4 x 1	100 x 25	178	157	51	9.0	-	86	20	CP	FP	-	9
4 x 1½	100 x 40	178	157	73	9.0	-	86	33	CP	FP	-	10
4 x 2	100 x 50	178	157	92	9.0	-	86	44	CP	FP	-	11
4 x 3	100 x 80	178	157	127	9.0	4.5	86	66	CT	CP/FP/FT	-	13
6 x 2	150 x 50	229	216	92	11.0	-	137	44	CP	FP	-	17
6 x 3	150 x 80	229	216	127	11.0	-	137	66	CP	FP	-	19
6 x 4	150 x 100	229	216	157	11.0	5.5	137	86	CT	CP/FP/FT	-	20
8 x 3	200 x 80	279	270	127	10.0	-	186	66	FP	-	-	28
8 x 4	200 x 100	279	270	157	10.0	-	186	86	FP	-	-	30
8 x 6	200 x 150	279	270	216	-	8.5	186	137	FT	-	-	33
10 x 4	250 x 100	305	324	157	10.0	-	237	66	FP	-	-	40
10 x 6	250 x 150	305	324	216	-	9.1	237	137	FT	-	-	43

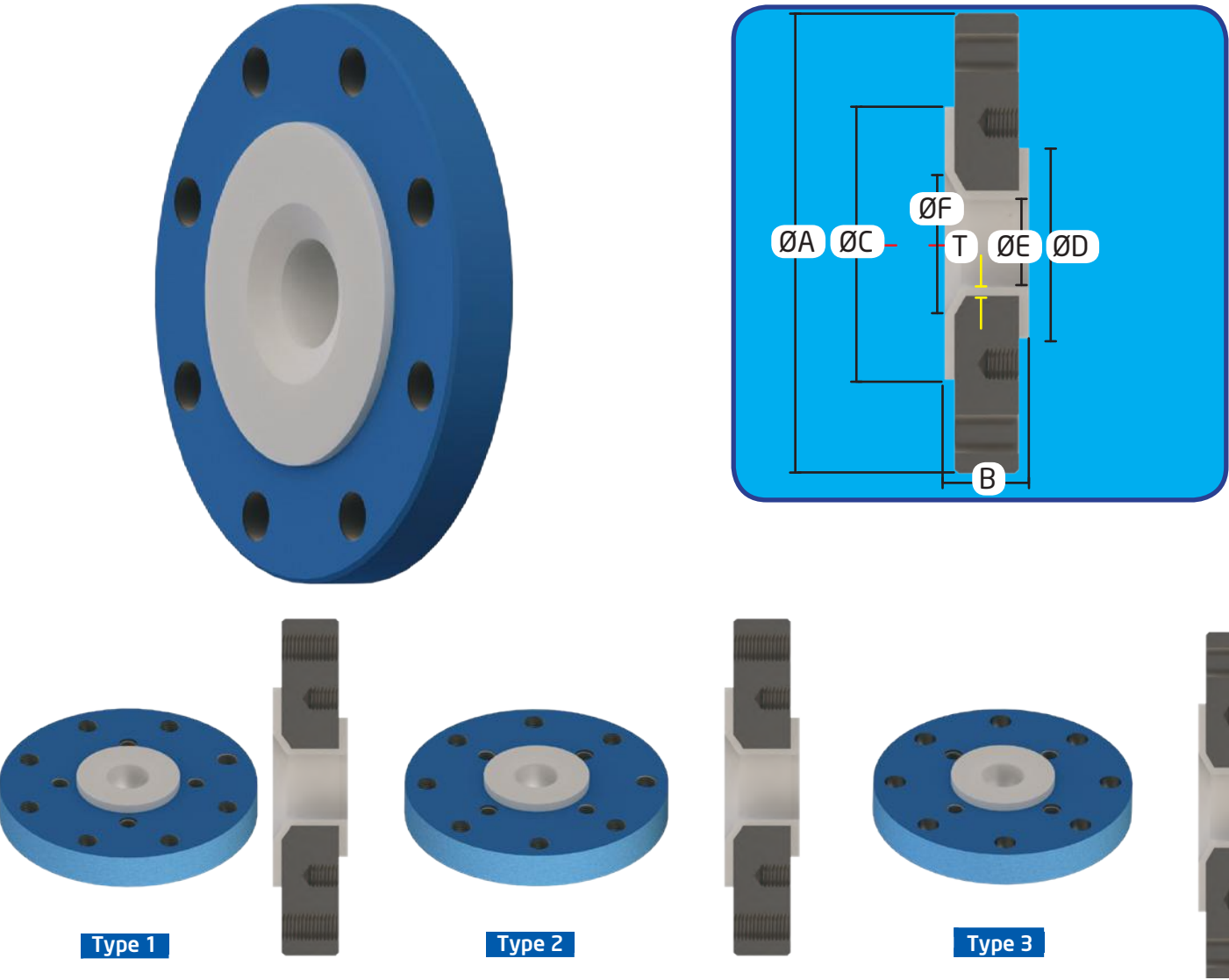


Eccentric reducers have a changing centreline for the bore, with one side remaining parallel. Eccentric reducers are used at the suction side of pumps to ensure air does not accumulate in the pipe. The gradual accumulation of air in a concentric reducer could result in a large bubble that could eventually cause the pump to stall or cause cavitation when drawn into the pump, with the flat side up this is avoided. Alternatively eccentric reducers can be useful with the flat side down to allow the complete draining of a pipeline.

Eccentric Reducer											Construction Codes		
Nominal Bore		Face to Face	Centreline Offset	Large NB Raised Face	Small NB Raised Face	Heavy Duty PFA Liner Thickness Nominal ¹	HiPerFlon PTFE Liner Thickness Nominal ¹	Large Bore Nominal ²	Small Bore Nominal ²		Code	Steelwork	Lining
											CP	Cast Steel	PFA
											CT	Cast Steel	PTFE
											FP	Fabricated Steel	PFA
											FT	Fabricated Steel	PTFE
											Construction		Weight
Inches	mm	mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg	
¾ x ½	20 x 15	114	3	43	35	-	2.3	12	12	FT	-	1.3	
1 x ½	25 x 15	114	6	51	35	4	3.2	20	12	FP	FT	1.5	
1 x ¾	25 x 20	114	3	51	43	-	3.2	20	12	FT	-	1.8	
1½ x ¾	40 x 20	114	11	73	43	-	3.2	33	12	FT	-	2.3	
1½ x 1	40 x 25	114	7	73	51	4.5	3.2	33	20	CP	FP/FT	2.7	
2 x 1	50 x 25	127	13	92	51	4.8	-	44	20	CP		3.7	
2 x 1½	50 x 40	127	6	92	73	4.8	3.2	44	33	CP	CT/FP/FT	4.2	
3 x 1	80 x 25	152	28	127	51	6.5	-	66	20	CP	-	6	
3 x 1½	80 x 40	152	20	127	73	6.5	-	66	33	CP	-	7	
3 x 2	80 x 50	152	14	127	92	-	3.2	66	44	FT	-	8	
4 x 1	100 x 25	178	40	157	51	9.0	-	86	20	FP	-	9	
4 x 1½	100 x 40	178	33	157	73	9.0	-	86	33	FP	-	10	
4 x 2	100 x 50	178	27	157	92	9.0	-	86	44	CP	-	11	
4 x 3	100 x 80	178	13	157	127	9.0	-	86	66	CP	-	13	
6 x 2	150 x 50	229	54	216	92	11.0	-	137	44	FP	-	17	
6 x 3	150 x 80	229	40	216	127	11.0	-	137	66	FP	-	19	
6 x 4	150 x 100	229	27	216	157	-	5.5	137	86	FT	-	20	
8 x 3	200 x 80	279	65	270	127	10.0	-	186	66	FP	-	28	
8 x 4	200 x 100	279	52	270	157	10.0	-	186	86	FP	-	30	
8 x 6	200 x 150	279	25	270	216	-	8.5	186	137	FT	-	33	
10 x 4	250 x 100	305	79	324	157	10.0	-	237	66	FP	-	40	
10 x 6	250 x 150	305	52	324	216	-	9.1	237	137	FT	-	43	

Eccentric Reducer										Construction Codes		
Nominal Bore		Face to Face	Centreline Offset	Large NB Raised Face	Small NB Raised Face	Heavy Duty PFA Liner Thickness Nominal¹	HiPerFlon PTFE Liner Thickness Nominal¹	Large Bore Nominal²	Small Bore Nominal²	Code	Steelwork	Lining
										CP	Cast Steel	PFA
										CT	Cast Steel	PTFE
										FP	Fabricated Steel	PFA
										FT	Fabricated Steel	PTFE
										Construction	Weight	
Inches	mm	mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg
10 x 8	250 x 200	305	27	324	270	-	9.1	237	186	FT	-	49
12 x 4	300 x 100	356	105	381	157	10.0	-	287	66	FP	-	58
12 x 6	300 x 150	356	78	381	216	10.0	-	287	137	FP	-	62
12 x 8	300 x 200	356	52	381	270	10.0	-	287	186	FP	-	66
12 x 10	300 x 250	356	25	381	324	-	10.4	287	237	FT	-	72
14 x 6	350 x 150	406	94	413	216	10.5	-	317	137	FP	-	81
14 x 8	350 x 200	406	68	413	270	10.5	-	317	186	FP	-	86
14 x 10	350 x 250	406	41	413	324	10.5	-	317	237	FP	-	91
14 x 12	350 x 300	406	16	413	381	-	8.3	317	287	FT	-	102

1 - Liner thicknesses are based on PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



A reducing flange is essentially a plate flange providing a sharp reduction in line bore of one or many size reductions.

A taper bore provides some transtion from one bore to another. These are generally PFA lined, but can be lined in PTFE. They provide a more space saving alternative to concentric reducers, but cannot present the same flow characteristics.

Reducing flanges can be grouped into three main configurations - type 1, 2 & 3. The configuration is dictated by the proximity of the small bore bolt holes to the large bore bolt holes. Each type is designed so that they do not clash and that the nuts can be fitted successfully. Type 3 flanges have through clearance holes for the large nominal bore bolts and blind threaded holes for the small nominal bore. These are used where there is a

significant reduction in bores. Where the reduction is not so great and the periphery of the smaller bore mating flange would impinge on the nuts then a type 2 flange is employed with all threaded bolt holes (through holes for the large nominal bore and blind holes for the small nominal bore) negating the use of nuts. Finally where the reduction in bores is quite small the bolt holes are all threaded with through holes for the large nominal bore and blind holes for the small nominal bore. These have to be staggered on/off centres so that they don't clash - a type 1 reducing flange.

As a general rule, a type 3 is the default design. if this cannot be achieved because of the two joining flanges geometry, a type 2 is specified, and if this doesn't

work, then a type 1.

If you have site reasons for wanting to select another style, then a type 1 or 2 will always work where a type 3 does and a type 1 where a type 2 does. As standard Type 2 and 3 bolt holes are off/off centres.

There is another style of reducing flange available where the inner pattern of holes is on a raised platform and the outer holes are scalloped from this. This enables one to use type 3 style drillings i.e. through bolts on the large side, removing the necessity to have double threaded holes on the reducing flange. This is useful where one is coming up against items such as a threaded pad flange on a vessel. CRP can produce these and many other special reducing flanges just call us to discuss.

Reducing Flange Taper Bore													Construction Codes		
Nominal Bore		Flange Type	Flange	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness¹	Minimum HiPerFlon PTFE Liner Thickness¹	Large Bore²	Small Bore²	Construction Codes				
											Code	Steelwork	Lining		
											CP	Cast Steel	PFA		
											CT	Cast Steel	PTFE		
											FP	Fabricated Steel	PFA		
												FT	Fabricated Steel	PTFE	
												Construction		Weight	
Inches	mm		mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg		
¾ x ½	20 x 15	Type 1	100	30	43	35	5	3	15	15	FP	FT	1.3		
1 x ½	25 x 15	Type 1	110	30	51	35	5	3	18	15	FP	FT	1.6		
1 x ¾	25 x 20	Type 1	110	30	51	43	5	3	18	15	FP	FT	1.6		
1½ x ½	40 x 15	Type 2	125	30	73	35	5	3	32	15	FP	FT	2.1		
1½ x ¾	40 x 20	Type 1	125	30	73	43	5	3	32	15	FP	FT	2.1		
1½ x 1	40 x 25	Type 1	125	30	73	51	5	3	32	18	FP	FT	2.0		
2 x ½	50 x 15	Type 2	150	30	92	35	5	3	43	15	FP	FT	3.0		
2 x ¾	50 x 20	Type 2	150	30	92	43	5	3	43	15	FP	FT	3.0		
2 x 1	50 x 25	Type 2	150	30	92	51	5	3	43	18	FP	FT	3.0		
2 x 1½	50 x 40	Type 1	150	30	92	73	5	3	43	32	FP	FT	2.9		
3 x ½	80 x 15	Type 3	190	35	127	35	5	3	70	15	FP	FT	6		
3 x ¾	80 x 20	Type 3	190	35	127	43	5	3	70	15	FP	FT	6		
3 x 1	80 x 25	Type 3	190	35	127	51	5	3	70	18	FP	FT	6		
3 x 1½	80 x 40	Type 2	190	35	127	73	5	3	70	32	FP	FT	6		
3 x 2	80 x 50	Type 1	190	35	127	92	5	3	70	43	FP	FT	6		
4 x ½	100 x 15	Type 3	230	35	157	35	5	5	93	15	FP	FT	9		
4 x ¾	100 x 20	Type 3	230	35	157	43	5	5	93	15	FP	FT	9		
4 x 1	100 x 25	Type 3	230	35	157	51	5	5	93	18	FP	FT	9		
4 x 1½	100 x 40	Type 3	230	35	157	73	5	5	93	32	FP	FT	9		
4 x 2	100 x 50	Type 3	230	35	157	92	5	5	93	43	FP	FT	9		
4 x 3	100 x 80	Type 1	230	35	157	127	5	5	93	70	FP	FT	8		
6 x ½	150 x 15	Type 3	280	40	216	35	5	5	145	15	FP	FT	16		
6 x ¾	150 x 20	Type 3	280	40	216	43	5	5	145	15	FP	FT	16		
6 x 1	150 x 25	Type 3	280	40	216	51	5	5	145	18	FP	FT	16		
6 x 1½	150 x 40	Type 3	280	40	216	73	5	5	145	32	FP	FT	16		
6 x 2	150 x 50	Type 3	280	40	216	92	5	5	145	43	FP	FT	16		
6 x 3	150 x 80	Type 3	280	40	216	127	5	5	145	70	FP	FT	15		
6 x 4	150 x 100	Type 2	280	40	216	157	5	5	145	93	FP	FT	15		
8 x ½	200 x 15	Type 3	345	40	270	35	5	5	196	15	FT	FP	25		
8 x ¾	200 x 20	Type 3	345	40	270	43	5	5	196	15	FT	FP	25		
8 x 1	200 x 25	Type 3	345	40	270	51	5	5	196	18	FT	FP	25		
8 x 1½	200 x 40	Type 3	345	40	270	73	5	5	196	32	FT	FP	25		
8 x 2	200 x 50	Type 3	345	40	270	92	5	5	196	43	FT	FP	25		
8 x 3	200 x 80	Type 3	345	40	270	127	5	5	196	70	FT	FP	24		
8 x 4	200 x 100	Type 3	345	40	270	157	5	5	196	93	FT	FP	24		
8 x 6	200 x 150	Type 2	345	40	270	216	5	5	196	145	FT	FP	21		
10 x ½	250 x 15	Type 3	405	35	324	35	5	5	250	15	FT	FP	35		
10 x ¾	250 x 20	Type 3	405	35	324	43	5	5	250	15	FT	FP	35		
10 x 1	250 x 25	Type 3	405	35	324	51	5	5	250	18	FT	FP	35		
10 x 1½	250 x 40	Type 3	405	35	324	73	5	5	250	32	FT	FP	35		
10 x 2	250 x 50	Type 3	405	35	324	92	5	5	250	43	FT	FP	35		
10 x 3	250 x 80	Type 3	405	35	324	127	5	5	250	70	FT	FP	34		

Reducing Flange Taper Bore



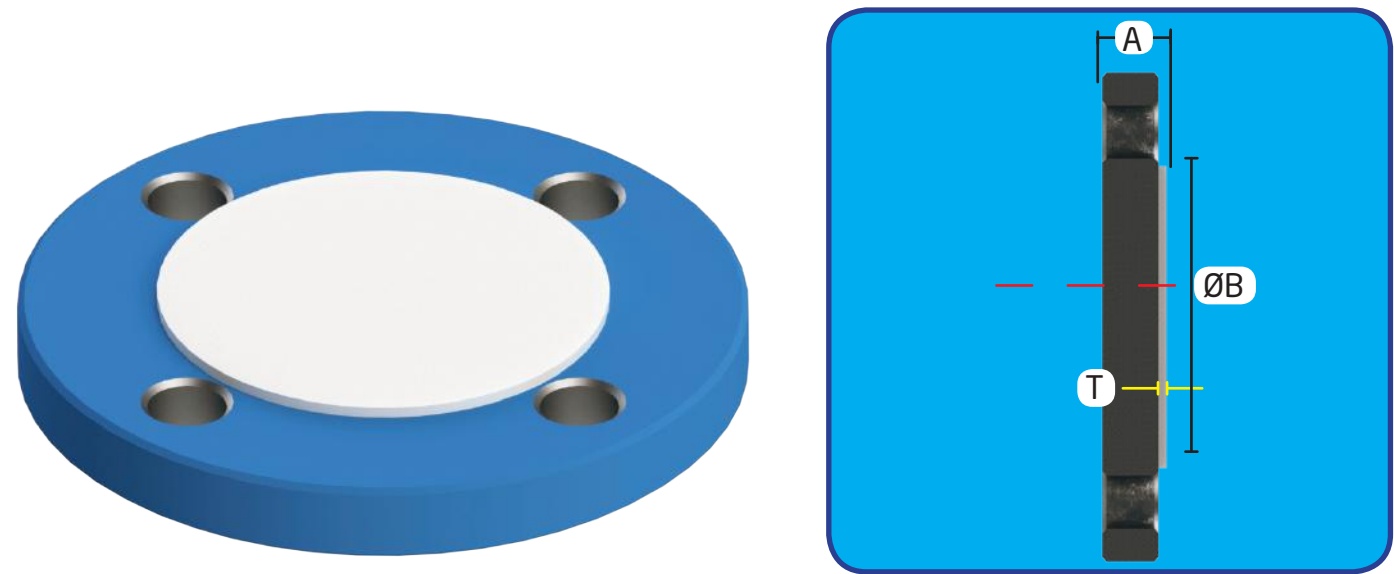
Reducing Flange Taper Bore



Reducing Flange Taper Bore													Construction Codes		
Nominal Bore		Flange Type	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness¹	Minimum HiPerFlon PTFE Liner Thickness¹	Large Bore²	Small Bore²	Construction		Weight	Code	Steelwork	Lining
													CP	Cast Steel	PFA
Inches	mm		mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg	CT	Cast Steel	PTFE
10	x 4	250	x 100	Type 3	405	35	324	157	5	5	250	93	FT	FP	34
10	x 6	250	x 150	Type 3	405	35	324	216	5	5	250	145	FT	FP	31
10	x 8	250	x 200	Type 2	405	35	324	270	5	5	250	196	FT	FP	27
12	x ½	300	x 15	Type 3	485	40	381	35	5	5	301	15	FT	FP	56
12	x ¾	300	x 20	Type 3	485	40	381	43	5	5	301	15	FT	FP	56
12	x 1	300	x 25	Type 3	485	40	381	51	5	5	301	18	FT	FP	56
12	x 1½	300	x 40	Type 3	485	40	381	73	5	5	301	32	FT	FP	55
12	x 2	300	x 50	Type 3	485	40	381	92	5	5	301	43	FT	FP	55
12	x 3	300	x 80	Type 3	485	40	381	127	5	5	301	70	FT	FP	55
12	x 4	300	x 100	Type 3	485	40	381	157	5	5	301	93	FT	FP	54
12	x 6	300	x 150	Type 3	485	40	381	216	5	5	301	145	FT	FP	51
12	x 8	300	x 200	Type 3	485	40	381	270	5	5	301	196	FT	FP	47
12	x 10	300	x 250	Type 2	485	40	381	324	5	5	301	250	FT	FP	41
14	x ½	350	x 15	Type 3	535	40	413	35	5	5	326	15	FT	FP	72
14	x ¾	350	x 20	Type 3	535	40	413	43	5	5	326	15	FT	FP	72
14	x 1	350	x 25	Type 3	535	40	413	51	5	5	326	18	FT	FP	72
14	x 1½	350	x 40	Type 3	535	40	413	73	5	5	326	32	FT	FP	71
14	x 2	350	x 50	Type 3	535	40	413	92	5	5	326	43	FT	FP	71
14	x 3	350	x 80	Type 3	535	40	413	127	5	5	326	70	FT	FP	70
14	x 4	350	x 100	Type 3	535	40	413	157	5	5	326	93	FT	FP	70
14	x 6	350	x 150	Type 3	535	40	413	216	5	5	326	145	FT	FP	67
14	x 8	350	x 200	Type 3	535	40	413	270	5	5	326	196	FT	FP	62
14	x 10	350	x 250	Type 3	535	40	413	324	5	5	326	250	FT	FP	56
14	x 12	350	x 300	Type 1	535	40	413	381	5	5	326	301	FT	FP	52
16	x ½	400	x 15	Type 3	595	40	470	35	5	5	377	15	FT	FP	94
16	x ¾	400	x 20	Type 3	595	40	470	43	5	5	377	15	FT	FP	94
16	x 1	400	x 25	Type 3	595	40	470	51	5	5	377	18	FT	FP	94
16	x 1½	400	x 40	Type 3	595	40	470	73	5	5	377	32	FT	FP	94
16	x 2	400	x 50	Type 3	595	40	470	92	5	5	377	43	FT	FP	94
16	x 3	400	x 80	Type 3	595	40	470	127	5	5	377	70	FT	FP	93
16	x 4	400	x 100	Type 3	595	40	470	157	5	5	377	93	FT	FP	92
16	x 6	400	x 150	Type 3	595	40	470	216	5	5	377	145	FT	FP	89
16	x 8	400	x 200	Type 3	595	40	470	270	5	5	377	196	FT	FP	84
16	x 10	400	x 250	Type 3	595	40	470	324	5	5	377	250	FT	FP	78
16	x 12	400	x 300	Type 3	595	40	470	381	5	5	377	301	FT	FP	71
16	x 14	400	x 350	Type 2	595	40	470	413	5	5	377	326	FT	FP	64
18	x ½	450	x 15	Type 3	635	40	533	35	5	5	425	15	FT	FP	112
18	x ¾	450	x 20	Type 3	635	40	533	43	5	5	425	15	FT	FP	112
18	x 1	450	x 25	Type 3	635	40	533	51	5	5	425	18	FT	FP	112
18	x 1½	450	x 40	Type 3	635	40	533	73	5	5	425	32	FT	FP	111
18	x 2	450	x 50	Type 3	635	40	533	92	5	5	425	43	FT	FP	111
18	x 3	450	x 80	Type 3	635	40	533	127	5	5	425	70	FT	FP	110
18	x 4	450	x 100	Type 3	635	40	533	157	5	5	425	93	FT	FP	109

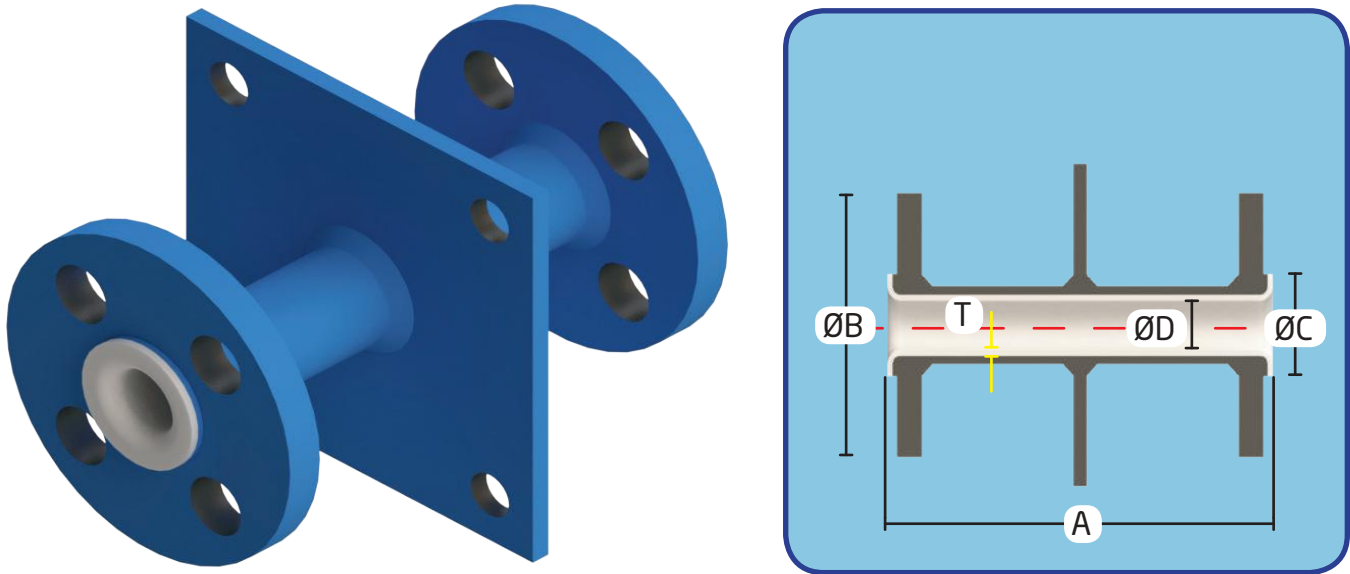
Reducing Flange Taper Bore													Construction Codes		
Nominal Bore		Flange Type	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness¹	Minimum HiPerFlon PTFE Liner Thickness¹	Large Bore²	Small Bore²	Construction		Weight	Code	Steelwork	Lining
													CP	Cast Steel	PFA
Inches	mm		mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg	CT	Cast Steel	PTFE
18	x 6	450	x 150	Type 3	635	40	533	216	5	5	425	145	FT	FP	106
18	x 8	450	x 200	Type 3	635	40	533	270	5	5	425	196	FT	FP	101
18	x 10	450	x 250	Type 3	635	40	533	324	5	5	425	250	FT	FP	95
18	x 12	450	x 300	Type 3	635	40	533	381	5	5	425	301	FT	FP	87
18	x 14	450	x 350	Type 2	635	40	533	413	5	5	425	326	FT	FP	81
18	x 16	450	x 400	Type 1	635	40	533	470	5	5	425	377	FT	FP	103
20	x ½	500	x 15	Type 3	700	53	584	35	5	5	473	15	FT	FP	153
20	x ¾	500	x 20	Type 3	700	53	584	43	5	5	473	15	FT	FP	153
20	x 1	500	x 25	Type 3	700	53	584	51	5	5	473	18	FT	FP	153
20	x 1½	500	x 40	Type 3	700	53	584	73	5	5	473	32	FT	FP	153
20	x 2	500	x 50	Type 3	700	53	584	92	5	5	473	43	FT	FP	153
20	x 3	500	x 80	Type 3	700	53	584	127	5	5	473	70	FT	FP	152
20	x 4	500	x 100	Type 3	700	53	584	157	5	5	473	93	FT	FP	151
20	x 6	500	x 150	Type 3	700	53	584	216	5	5	473	145	FT	FP	147
20	x 8	500	x 200	Type 3	700	53	584	270	5	5	473	196	FT	FP	142
20	x 10	500	x 250	Type 3	700	53	584	324	5	5	473	250	FT	FP	134
20	x 12	500	x 300	Type 3	700	53	584	381	5	5	473	301	FT	FP	126
20	x 14	500	x 350	Type 3	700	53	584	413	5	5	473	326	FT	FP	118
20	x 16	500	x 400	Type 2	700	53	584	470	5	5	473	377	FT	FP	143
20	x 18	500	x 450	Type 1	700	53	584	533	5	5	473	425	FT	FP	141
24	x ½	600	x 15	Type 3	815	57	692	35	5	5	571	15	FT	FP	229
24	x ¾	600	x 20	Type 3	815	57	692	43	5	5	571	15	FT	FP	229
24	x 1	600	x 25	Type 3	815	57	692	51	5	5	571	18	FT	FP	229
24	x 1½	600	x 40	Type 3	815	57	692	73	5	5	571	32	FT	FP	228
24	x 2	600	x 50	Type 3	815	57	692	92	5	5	571	43	FT	FP	228
24	x 3	600	x 80	Type 3	815	57	692	127	5	5	571	70	FT	FP	227
24	x 4	600	x 100	Type 3	815	57	692	157	5	5	571	93	FT	FP	226
24	x 6	600	x 150	Type 3	815	57	692	216	5	5	571	145	FT	FP	222
24	x 8	600	x 200	Type 3	815	57	692	270	5	5	571	196	FT	FP	216
24	x 10	600	x 250	Type 3	815	57	692	324	5	5	571	250	FT	FP	208
24	x 12	600	x 300	Type 3	815	57	692	381	5	5	571	301	FT	FP	198
24	x 14	600	x 350	Type 3	815	57	692	413	5	5	571	326	FT	FP	190
24	x 16	600	x 400	Type 3	815	57	692	470	5	5	571	377	FT	FP	218
24	x 18	600	x 450	Type 3	815	57	692	533	5	5	571	425	FT	FP	215
24	x 20	600	x 500	Type 2	815	57	692	584	5	5	571	473	FT	FP	212

1 - Please note liner thicknesses are based on Virgin PFA or PTFE, for other materials consult the liner tables in the manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual.



The blank flange is an end of pipe line component. Usually manufactured from a blank forged flange, the blank flange has a disc of PTFE bonded to the raised face. They may be employed in sub-systems such as sampling or at junctions which in the future may lead to other piping systems.

Blank Flange						Construction Codes		
						Code	Steelwork	Lining
Nominal Bore		Face to Face	Raised Face	HiPerFlon PTFE Liner Thickness				
Inches		A	Ø B	T	Construction	Weight		
mm	mm	mm	mm	mm	Standard	kg		
½	15	14	35	4	FT	0.5		
¾	20	15	43	4	FT	0.7		
1	25	17	51	4	FT	1.0		
1½	40	19	73	4	FT	1.6		
2	50	22	92	4	FT	2.5		
3	80	26	127	4	FT	5		
4	100	26	157	4	FT	7		
6	150	28	216	4	FT	12		
8	200	31	270	4	FT	20		
10	250	33	324	4	FT	29		
12	300	34	381	4	FT	44		
14	350	37	413	4	FT	60		
16	400	39	470	4	FT	77		
18	450	42	533	4	FT	96		
20	500	43	584	4	FT	126		
24	600	48	692	4	FT	191		

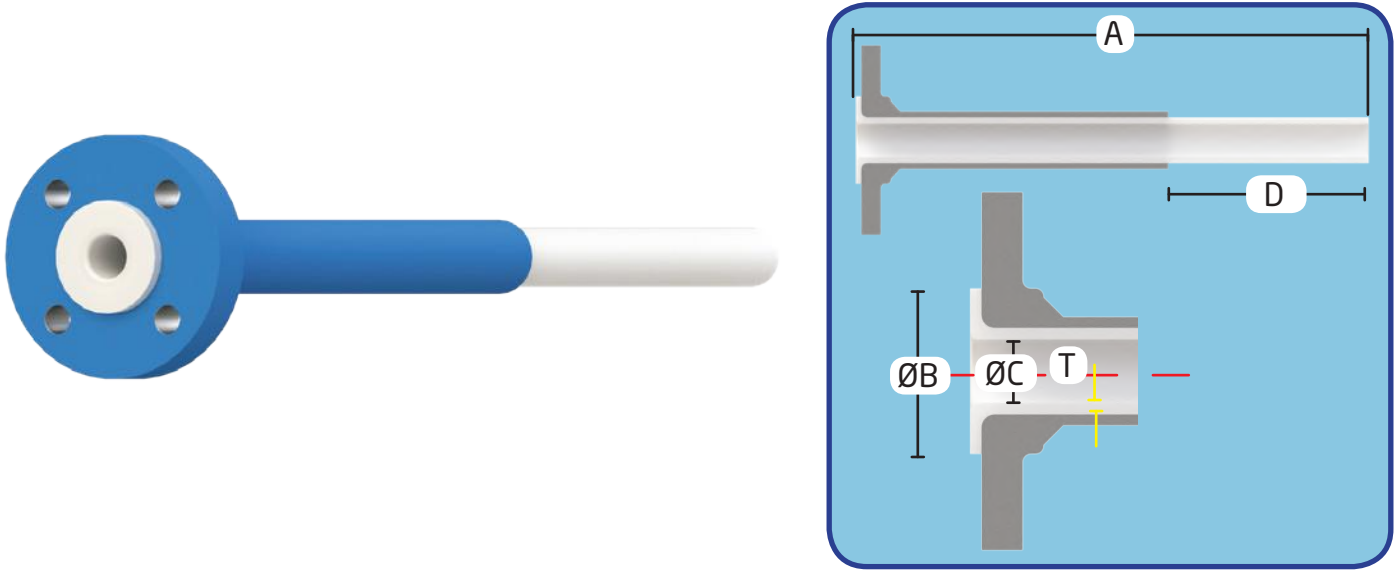


CRP offer a range of puddle flange spools, typically comprising of a standard pipe spool (with all of the usual spool flange options) with one additional “puddle flange” located along its length (typically in the middle). The spools are usually used in circumstances where a spool has to penetrate through a wall, a bund or similar. A hole in the wall has to be made that is sufficiently large to allow the flange on the end of the spool to pass through it, and then the additional puddle flange is used to close up the hole, and so the puddle flange is typically somewhat larger in size than the flanges on the ends of the spool.

Puddle flanges can be circular, square or other shapes to suit particular customer requirements, and supplied with or without bolt holes. The thickness of these flanges is driven by their purpose. If they are simply to close over a hole to prevent the passage of air, then they can be quite thin. However, if they are also used as part of the pipework support, or have to take some other structural load, then they can be supplied with a greater thickness to suit. As an option, puddle flange spools can be supplied with a split flange on one end. The advantage of this is that since the split flange can be removed while the spool is being fitted through the wall, and the flange then refitted, the hole in the wall only needs to be large enough to pass the spool stub end through, and the puddle flange can also be smaller.

Puddle Flange Spool							
Nominal Bore		Length		Flange Outside	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²
		Minimum	Maximum				
Inches	mm	mm	mm	mm	mm	mm	mm
½	15	155	6000	90	35	2.3	16
¾	20	170	6000	100	43	2.3	16
1	25	191	6000	110	51	3.2	20
1½	40	215	6000	125	73	3.2	34
2	50	243	6000	150	92	3.2	46
3	80	279	6000	190	127	3.2	70
4	100	307	6000	230	157	4.5	93
6	150	345	6000	280	216	5.5	143
8	200	385	3000	345	270	8.5	188
10	250	429	3000	405	324	9.1	247
12	300	473	3000	485	381	10.4	286
14	350	511	3000	535	413	8.3	319

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.



A drain leg is a single flanged pipe spool with an open end. The PTFE liner can be cut flush with the end, or protrude an amount to be specified by the customer. As standard the protrusion is 100mm, and can be cut on site to suit. Longer protrusions can be specified. These are typically used for running product into surface drains, the steel pipe being run up to the drain cover.

Drain Leg								
Nominal Bore		Length		Raised Face	HiPerFlon PTFE Liner Thickness ¹	Lined Bore Nominal ²	Protruding Length	Cut off Angle ³
		Minimum	Maximum					
		A						
Inches	mm	mm	mm	mm	mm	mm	mm	°
½	15	90	6000	35	2.3	16	100	90
¾	20	90	6000	43	2.3	16	100	90
1	25	90	6000	51	3.2	20	100	90
1½	40	95	6000	73	3.2	34	100	90
2	50	110	6000	92	3.2	46	100	90
3	80	120	6000	127	3.2	70	100	90
4	100	125	6000	157	4.5	93	100	90
6	150	140	6000	216	5.5	143	100	90
8	200	150	3000	270	8.5	188	100	90
10	250	165	3000	324	9.1	247	100	90
12	300	170	3000	381	10.4	286	100	90
14	350	190	3000	413	8.3	319	100	90

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.
3 - Angle measured from centre line of protruding liner spool.



It is possible to provide a source of heating or cooling to a lined piping system by using jackets around the equipment. Here the core pipe is completely surrounded by a jacket pipe. The process material travels through the lined pipe as normal, whilst the heating or cooling medium travels through the outer jacket. Jackets typically contain steam, hot water or oil. These can be operated at temperatures of up to the maximum operating temperature of the lining - 200°C or the required process temperature if lower. Jackets can also work successfully at cryogenic temperatures, as long as the steelwork is specified appropriately. On a straight pipe spool the jacket usually extends almost to the end of the pipe, leaving some room to introduce the necessary vent between the steel tube and the liner. If the line is to be subsequently insulated such vents require extensions to take them outside the lagging. Connections to the jacket can be flanged, threaded or whatever the customer specification requires. Fittings and Valves can also be jacketed, but it may be that their short length allows the process to remain heated, simply by insulating them.

Steam Tracing
Direct steam tracing can be used by running a steam pipe alongside the steel tube or fitting outside the liner, securing

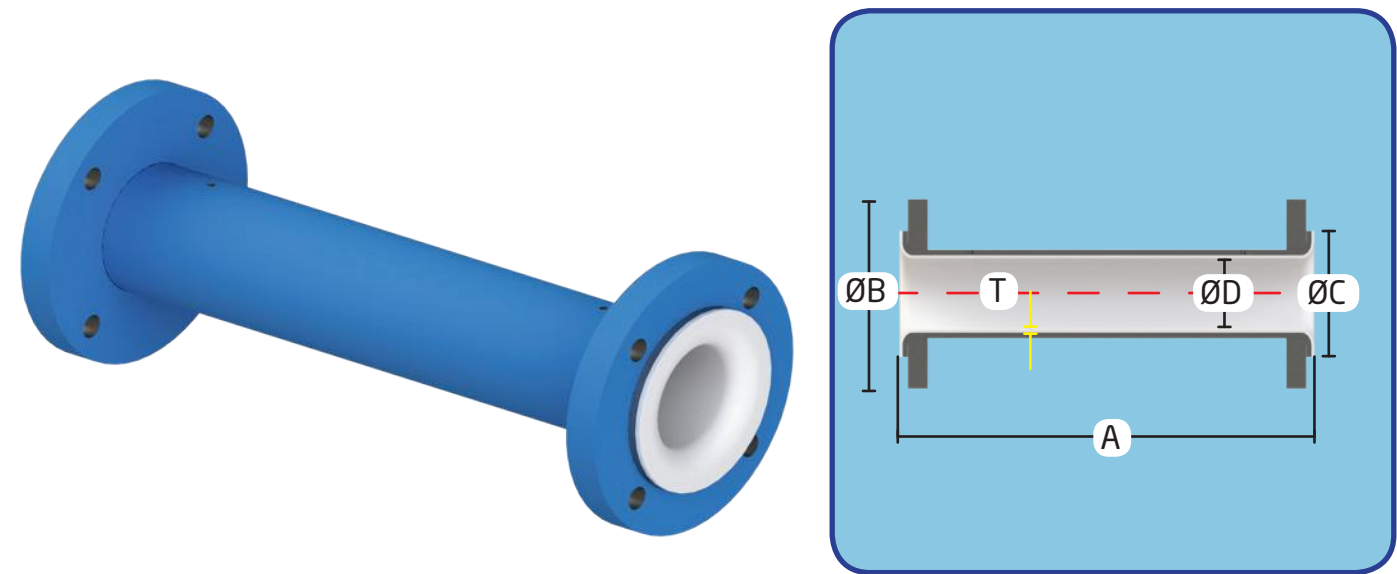
Fluid Tracing
As with steam tracing this can be used, more often for closer temperature control or for cooling control.

Electrical Tracing
Electrical tracing can be undertaken with heating tapes or cables, often used in conjunction with a heat conducting

it with steel strapping and insulating the line. It is important to limit the temperature to avoid damaging the liner and avoid creating localised hot spots

cement to aid dissipation. Again this can provide good temperature control, but often a low rate of temperature rise and

where the trace is in contact with the pipe. The advantages of jacketing are that heat can be applied evenly to the pipe without the danger of localised hot spots, which can lead to localised liner damage or liner expansion, both of which can lead to liner collapse. Also jacketing allows for a smooth ramp up of temperatures - a useful attribute given the poor heat conducting characteristics of PTFE and PFA. of course is a risk in certain ATEX zones.



A closing pipe spool is not actually a different product, however, it is a key part of an approach to designing and installing lined piping systems with a view to the best construction methodology, yet managing the potential tolerance build up issues and simple design and installation errors that are inevitable with large complex construction projects. When one has tolerance errors causing piping elements not to fit, it is possible and acceptable to use spacers to complete gaps that present themselves. However, this does not allow one to eliminate materials if a spool or other fitting is too long and of course it

introduces additional joints which are not desirable. The alternative approach is to specify closing or make-up pipe spools. Here, one identifies a relatively short length pipe spool on each horizontal or vertical run between elements that need to be fixed in space. This spool is identified on isometric drawings or drawing take-offs as a closing spool and is still given its nominal length on the isometric or take-off. However, CRP will not manufacture these particular spools at the time of general supply. When the plant is assembled up to this

point, a specific measurement is taken of the actual gap and CRP will then produce the spool required to final length and give it the relevant tag or other identifiers nominated at the time of original order. Closing spools jump any other production queues and can usually be manufactured in a 24-48 hour period. It helps reduce manufacturing lead times to specify these as Van Stone spools, to keep them short and of smaller nominal bores. If time is really an issue, then they can be supplied unpainted. Other spool styles can be manufactured as closing spools.

Van Stone Closing Pipe Spool							UltraHiPerFlon®			
Nominal Bore		Length		Flange Outside Diameter	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Superweight/ Heavy Duty UHP PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight	
		Minimum	Maximum						Flange Pack	Per metre
Inches	mm	mm	mm	mm	mm	mm	mm	mm	kg	kg
½	15	250	6000	90	35	2.3	2.3	16	1.0	2.0
¾	20	250	6000	100	43	2.3	2.3	16	1.3	2.0
1	25	250	6000	110	51	3.2	4.5	20	3.0	2.8
1½	40	250	6000	125	73	3.2	4.5	34	4.0	5.0
2	50	250	6000	150	92	3.2	4.5	46	6.0	6.5
3	80	250	6000	190	127	3.2	4.8	70	10	12.3
4	100	250	6000	230	157	4.5	5.0	93	12	16.0
6	150	500	6000	280	216	5.5	6.0	143	22	32.0
8	200	500	3000	345	270	8.5	8.5	188	27	54.0

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.

Introduction

Field flaring is a method by which finished pipe spools can be manufactured to length on site. In most cases this method is used for producing emergency spools in the case of a plant breakdown or for the convenience of small scale maintenance. It may also be used to produce the final closing spools for project work. Occasionally sites use it as a preferred

method for producing all of their spools, usually for historic reasons or a geographic need to be very self-sufficient. Before choosing to adopt field flaring as a site practice it is important to be aware of the downside of this. First, it is likely that the field manufactured spools are more expensive than factory finished spools. This is because the site work can never be as efficient as factory production and

there is more materials wastage. Secondly, the spools are not produced in a clean controlled factory environment with the level of process control that the factory can provide, nor can the traceability of materials be maintained easily. Finally, the field flare is only as good as the operator and the equipment he is working with. Having said this, it can still be a very useful method to have available. Standard sizes for field flare are 1 in to 4 in.

Sliding Fit Liner System

The sliding fit liner system is manufactured specially for field flare use and cannot use standard factory spools. Standard factory spools have liners fitted which are an interference fit with the steelwork - this provides support under vacuum conditions. The sliding fit liner is exactly the same as our factory finished spool liner. However the lined pipe spools go through a special size setting heat treatment cycle, prior to being dispatched. This makes the liner smaller in diameter, allowing them to be

removed on site to allow the steelwork to be fabricated and the liner reinserted. This system makes it easier to fabricate spools on site using welded, threaded or Van Stone flanging. Once reinserted the PTFE liner has a tremendous memory and will recover in the presence of heat back to its original diameter to provide vacuum resistance. The key disadvantage of this liner type is that in warm or hot climates - even the UK - the liners will recover over time and become difficult or impossible to

remove from the steel tube. There are three types of heat set sliding fit liner, varying by their flange configuration. These types are our No Flanges, Van Stone flanging one end and welded stub end with rotating flange one end. We recommend having one end flanged as it makes the production of the field flare quicker and less expensive.

Tight Fit Liner System

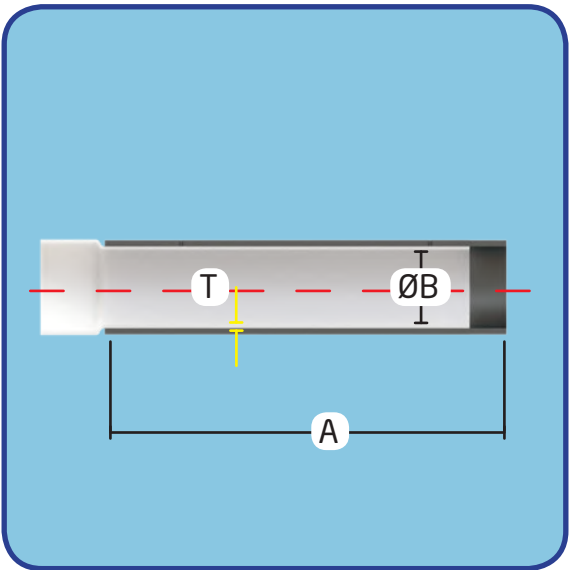
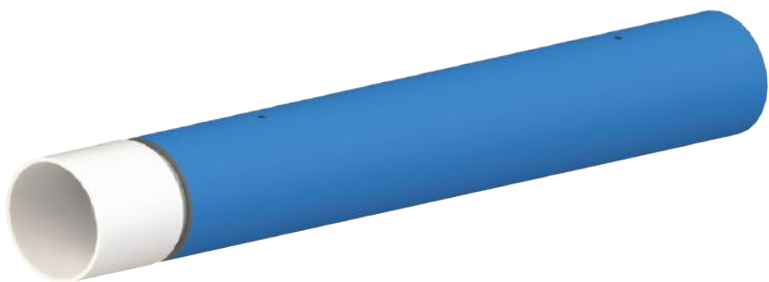
A tight fit liner system is manufactured specially for field flare use, because of the need to have vent holes in any spool that is produced as a result of field flaring. It is not possible to drill vent holes on site because of the potential damage to the liner. A spool type is available with vent holes drilled regularly along the length of the pipe to guarantee that any spool made from it has at least one vent hole; our specification ES1067. However, it is possible to use a standard factory finished spool to make a shorter tight fit field flare

spool by cutting it up, but it is essential to ensure that there is at least one vent hole in the spool piece to be used. This method does require some machinery for cutting and threading the pipe and there is a process risk of damaging the liner during the "parting off" activity. A key advantage of tight fit liner spools are that they work in all climatic conditions and will provide the same vacuum performance as a factory made spool. The disadvantages are that threaded flanges only can be used in the field, as it is not possible to weld onto the spool with liner

inside. Similarly it is not possible to fit lugs, studs, vent bosses or any sort of mounting bracket in the field. Also it is necessary to have a pipe threading and parting off machine in order to prepare the spool for flanging and flaring. CRP manufactures special "companion flanges" for use with these spools which not only provides the correct radius for flaring across at the flange face, but as importantly avoids the potential for a step between the pipe id and the flange id, which can be a stress raiser for the PTFE and cause premature failure.

Sliding Fit Liner		Tight Fit Liner	
✗	Not suitable for hot climate	✓	Can use in any climate
✗	Will recover after time depending on temperature	✓	Can be held on stock indefinitely
✓	Will provide same vacuum performance as factory made spool	✓	Will provide same vacuum performance as factory made spool
✓	Vent holes can be drilled on-site	✗	Need to ensure vent holes
✓	Can fit welded accessories	✗	Cannot fit studs, vent bosses etc.
✓	Can use Van Stone, Welded or Threaded Flange	✗	Can only use special threaded flanges
✓	Can have fixed or rotating flange	✗	Cannot have rotating flange easily
✓	Only requires a saw	✗	Requires parting off and threading machinery

Field Flare Pipe Spool Slide Fit No Flanges



The spool can be supplied in lengths up to 3000mm long, the spool can be cut down as many times as practical and used to manufacture many shorter lengths, each time the pipe spool flanged ends must be fabricated on site. Flanges can be

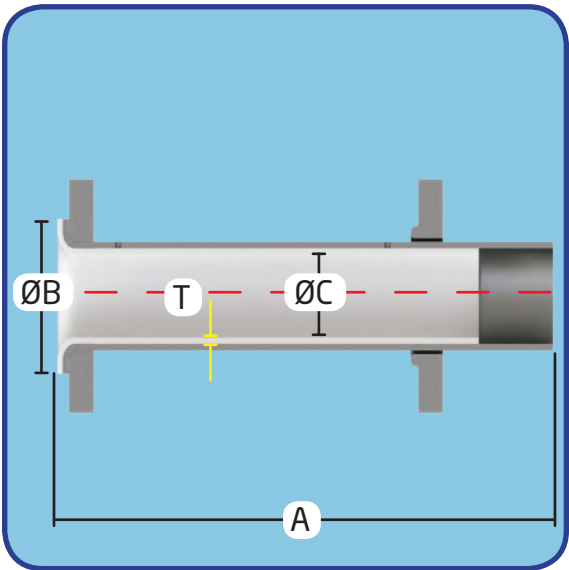
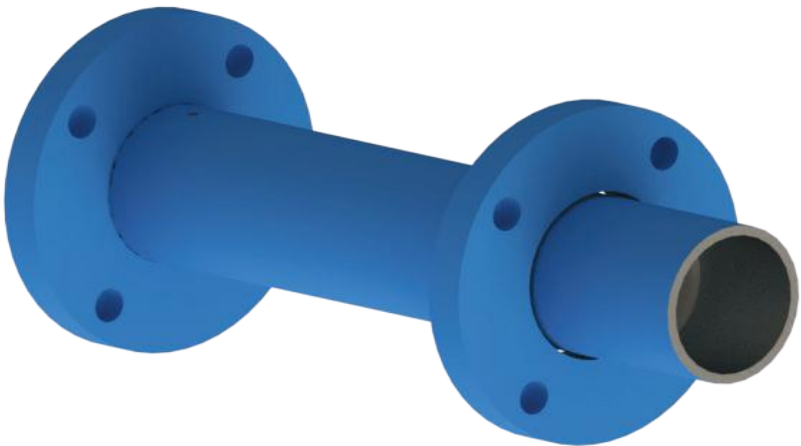
welded, used in conjunction with a welded stub end to provide a rotating flange or the pipe threaded and a threaded and hubbed flange fitted. Once the steelwork is finished the liner is introduced back into the steelwork and the PTFE cut to the

correct length and flared to produce the finished spool. CRP can supply all types of flanges and stub ends along with the piping to fabricate the spool.

Field Flare Spool Slide Fit - No Flanges						
Produces R/R, F/R or F/F						
Nominal Bore		Order Length	Maximum Finished Spool Length	HiPerFlon PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight per metre
		A		T	Ø B	
Inches	mm	mm	mm	mm	mm	kg
1	25	3000	2800	3.2	20	2.8
1½	40	3000	2800	3.2	34	5.0
2	50	3000	2800	3.2	46	6.5
3	80	3000	2800	3.2	70	12.3
4	100	3000	2800	4.5	93	16.0

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.

Field Flare Pipe Spool Slide Fit Van Stone Rotating Flange & Loose Slip On Flange



This field pipe spool has a fully factory finished Van Stone flanged end complete with rotating flange. The other end is supplied unfinished with a tacked on slip on weld flange. When ready to be

fabricated the PTFE is slid away from the unfinished end, the steel is sawn to the correct length, the flanged welded on and then the PTFE reintroduced and field flared completing the pipe spool leaving

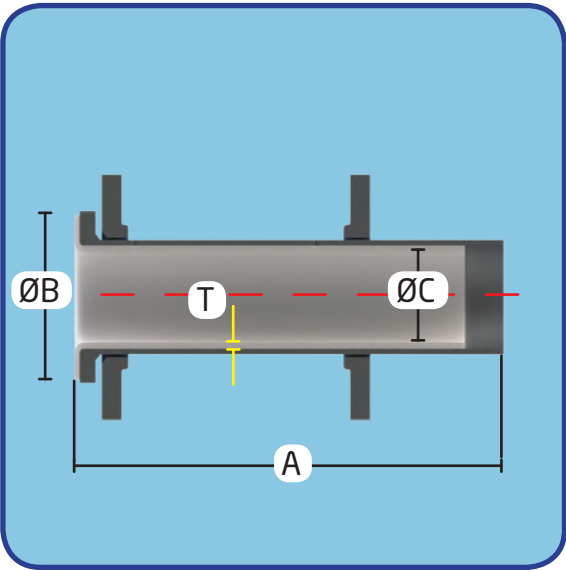
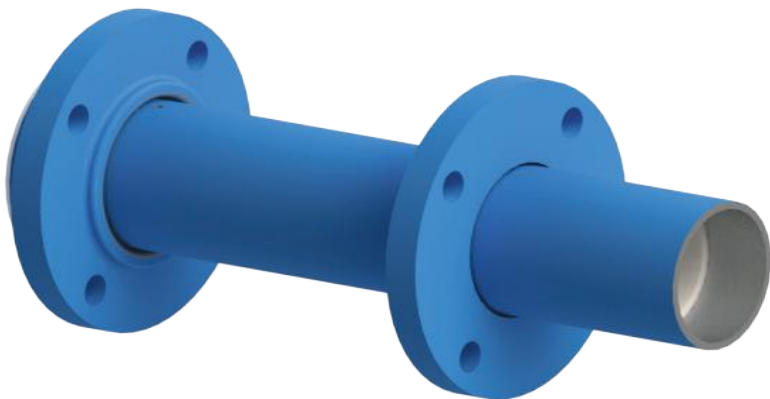
a pipe spool with fixed / rotating flanges ready for installation.

Field Flare Pipe Spool Slide Fit-Van Stone Rotating Flange and Loose Slip on Flange									
Produces F/R									
Nominal Bore		Order Length	Maximum Finished Spool Length	Flange Outside	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight	
		A		Ø B	Ø C	T	Ø D	Flange Pack	Per metre
Inches	mm	mm	mm	mm	mm	mm	mm	kg	kg
1	25	2900	2800	110	51	3.2	20	3	2.8
1½	40	2900	2800	125	73	3.2	34	4	5.0
2	50	2900	2800	150	92	3.2	46	6	6.5
3	80	2900	2800	190	127	3.2	70	10	12.3
4	100	2900	2800	230	157	4.5	93	12	16.0

1 - Please note liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Bore is based on virgin PTFE heavy duty liner, because of method of manufacture and steel tolerances this is a guide only, for other materials and thicknesses please consult the liner tables in the manual.

Field Flare Pipe Spool Slide Fit

Welded Rotating Flange & Loose Slip on Flange



This field flare pipe spool has a fully factory finished rotating flanged end with welded stub end. The other end is supplied unfinished with a tacked on slip on weld flange.

When ready to be fabricated the PTFE is slid away from the unfinished end, the steel is sawn to the correct length, the flanged welded on and then the PTFE reintroduced and field flared completing

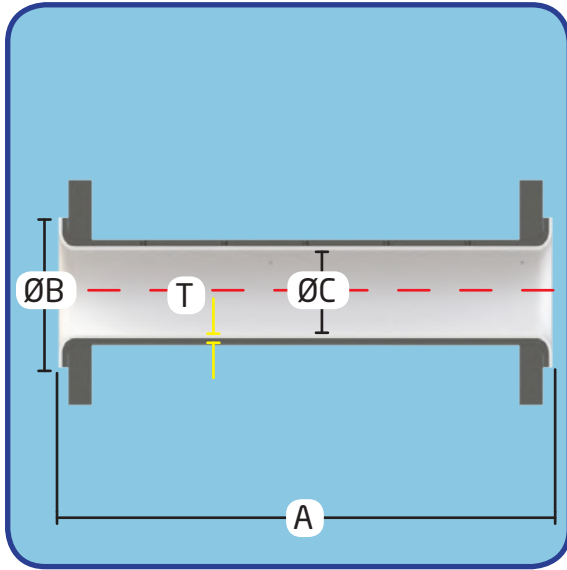
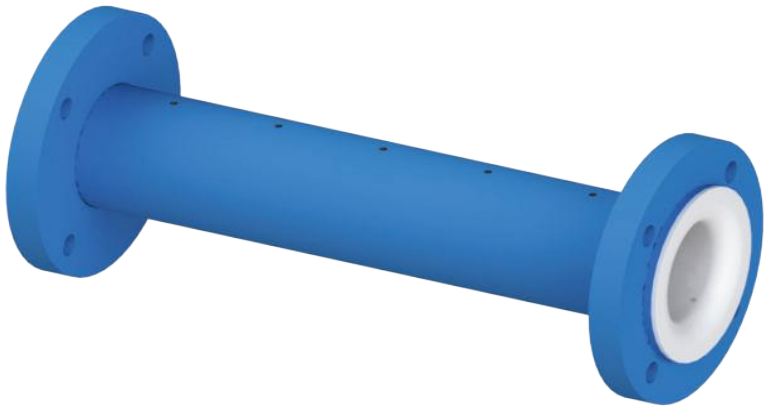
the pipe spool leaving a pipe spool with fixed / rotating flanges ready for installation.

Field Flare Spool Slide Fit- Welded Rotating Flange and Loose Slip on Flange									
Produces F/R									
Nominal Bore		Order Length	Maximum Finished Spool Length	Flange Outside	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	Lined Bore Nominal ²	Weight ³	
		A		Ø B	Ø C	T	Ø D		
Inches	mm	mm	mm	mm	mm	mm	mm	kg	kg
1	25	3000	2800	110	51	3.2	20	3	2.8
1½	40	3000	2800	125	73	3.2	34	4	5.0
2	50	3000	2800	150	92	3.2	46	6	6.5
3	80	3000	2800	190	127	3.2	70	10	12.3
4	100	3000	2800	230	157	4.5	93	12	16.0

1 - Please note liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Bore is based on virgin PTFE heavy duty liner, because of method of manufacture and steel tolerances this is a guide only,for other materials and thicknesses please consult the liner tables in the manual.
3- This does not include the weight of the flanges that will be required for installation.

Field Flare Pipe Spool Tight Fit

Van Stone Rotating Flanges



This spool can be supplied in 3000mm or 6000mm lengths. It has vent holes drilled at 300mm intervals and can be cut down as many times as is practical to manufacture many shorter lengths. Because this is a tight fit liner, it can only be used by having a threading and parting off machine to expose the liner for flaring and to provide

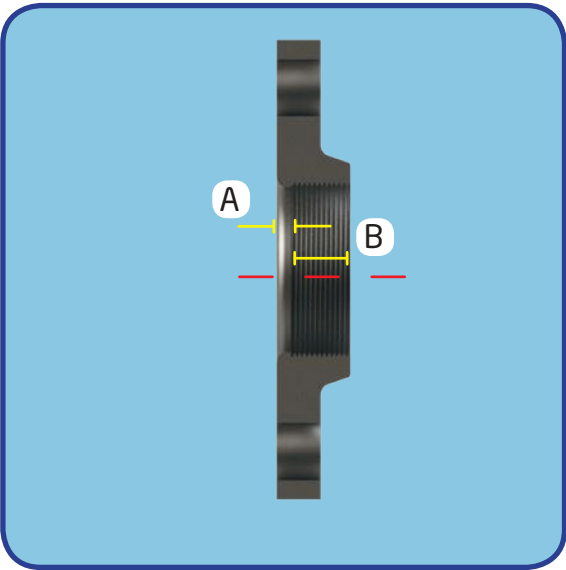
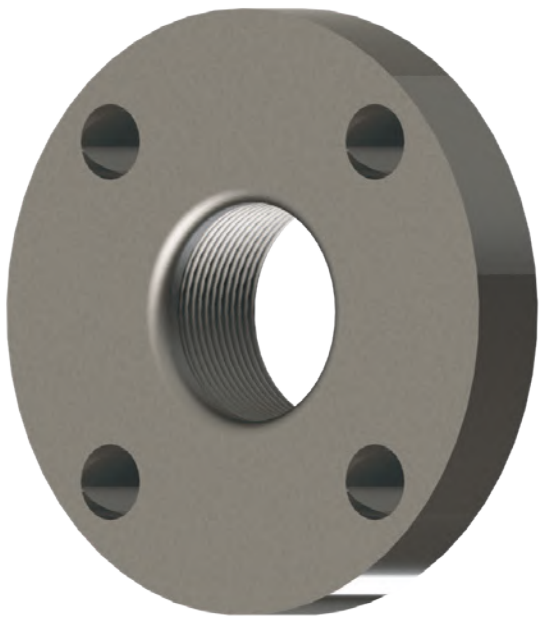
the thread for a flange. Only threaded flanges can be used. This product is ideal for use in hot climates where slide fit liners would not be suitable. CRP can supply special design threaded companion flanges to use with these spools.

Please note that this product does require

some machinery for cutting and threading the pipe and there is a process risk of damaging the liner during the "parting off" activity.

Field Flare Pipe Spool Tight Fit - Van Stone									
Produces F/R for use with Field Flare Threaded Flange									
Nominal Bore		Order Length ¹	Maximum Finished Spool Length	Flange Outside	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ²	Lined Bore Nominal ³	Weight	
		A		Ø B	Ø C	T	Ø D		
Inches	mm	mm	mm	mm	mm	mm	mm	kg	kg
1	25	3000 or 6000	2800 or 5800	110	51	3.2	20	12	20
1½	40	3000 or 6000	2800 or 5800	125	73	3.2	34	19	34
2	50	3000 or 6000	2800 or 5800	150	92	3.2	46	26	45
3	80	3000 or 6000	2800 or 5800	190	127	3.2	70	47	84
4	100	3000 or 6000	2800 or 5800	230	157	4.5	93	60	108

1 - Please note liner thicknesses are based on Virgin PTFE heavy duty liner for other materials consult the liner tables in the manual.
2 - Bore is based on virgin PTFE heavy duty liner, because of method of manufacture and steel tolerances this is a guide only,for other materials and thicknesses please consult the liner tables in the manual.



Companion flanges are used in conjunction with tight fit field flare pipe spools to enable the field fitting of a flange without welding which could serve to damage the liner inside the pipe. These flanges are specific to lined pipe, as they are

designed for threading onto the spool, but with a smooth radiussed transition from the pipe steel bore to the raised face. This is critical to prevent the liner becoming stressed when flared over this junction. It is important to thread the pipe

sufficiently to run the flange fully home. The table below shows the thread length on the flange and the amount by which to reduce the spool steel length to allow for the flange and lining - assuming flanges on both ends.

Field Flare Threaded Companion Flange						
Nominal Bore		Thread	Flange Face to Thread Start	HiPerFlon PTFE Flare Thickness	Cut Pipe Length to Finished Spool Length	Axial Length of Thread
			A			B
Inches	mm		mm	mm	mm	mm
1	25	1" BSPP	6.3	3.2	-19	18
1½	40	1½" BSPP	6.3	3.2	-19	22
2	50	2" BSPP	6.3	3.2	-19	25
3	80	3" BSPP	6.3	3.2	-19	32
4	100	4" BSPP	6.3	4.5	-22	33
6	150	6" BSPP	6.3	5.5	-24	40

Heated Tool Expanding Mandrel Flaring

This flaring system can work with either tight fit or sliding fit liners. The system works by first inserting an expanding mandrel into the bore of the liner to be flared. This presses the liner out to the inside of the steel tube and provides a threaded part onto which the tooling can be mounted. The flaring operation is carried out using aluminium flaring heads

that have been heated indirectly either using a gas burner or gas torch, electric hot plates, or a gas or electric oven. The flaring heads are supported on the expanding mandrel and are then slowly pressed on to the exposed PTFE allowing the heat from the flaring head to sink into the PTFE and allow it to be flared. The advantage of this type is that it is quite cost-effective in terms of equipment. It is possible to buy individual kits for each

nominal bore of 1in, 1.1/2in, 2in, 3in and 4in. The disadvantage is that it is not particularly quick in use, but is fine for occasional spools.

Hot Air Hub Pulling Flaring

This method is designed for working with tight fit liners, but with a small amount of additional tooling can work with sliding fit liners. The flaring operation is carried out by heating the PTFE liner directly using a hot air gun and special heating cones designed to provide the heat at the correct places. Once the liner is heated the flaring is undertaken first by using a hand held cone to push out the liner to around 45 degrees. Then a shaped tool is

used, pulled into place using a hub puller mounted on the flange. The key difference is that this method requires the PTFE to be pre-heated to its gel temperature, so requires the hot air equipment. The tooling is cold.

This method has the advantage of being significantly quicker than the heated tool method and less subject to operator error. The equipment is more expensive and is only available as a complete set for 1in to 4in. It is the ideal method for a customer

that wishes to manufacture a significant number of spools efficiently.

CRP recommends this as the method by which the most consistent product can be manufactured, having the most repeatable process.

Heated Tool Expanding Mandrel Flaring		Hot Air Hub Pulling Flaring	
✓	Lower cost	✗	Higher cost
✓	Can be purchased size by size	✗	All sizes purchased together
✗	Relatively Slow	✓	Much faster
✗	Requires careful use of skills	✓	More easily trained
✓	Will work with sliding and tight fit liners	✓	Will work with sliding and tight fit liners

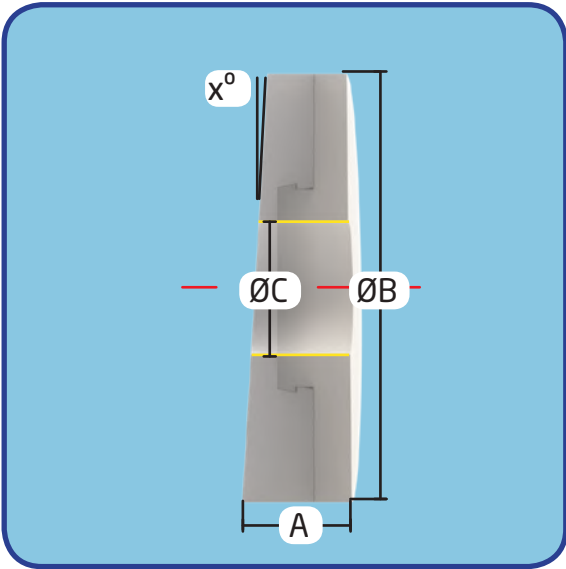


Training

It is critical that operators are properly trained and to this end we can offer

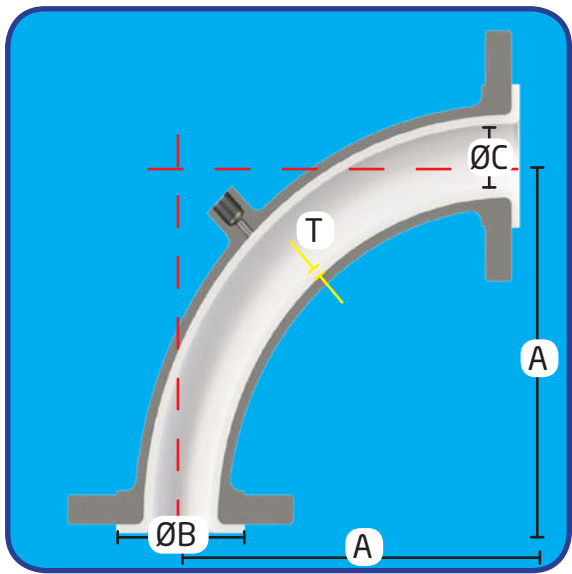
either in house or on-site training for your construction teams. This will ensure the piping is produced safely and correctly on

site. Please email enquiry@crp.co.uk for details.



The variable angle spacer comprises two interlocking PTFE wedges that can rotate from parallel to a maximum 7.5° (nominal bore dependent) to compensate for small gaps required to deal with a change in piping angle and ideal for the pipe fitters tool bag as they can assist with awkward installations.

Spacer Type 1 Variable Taper							
Nominal Bore		Length		Outside	Bore Nominal	Weight	Possible Angles
		Minimum	Maximum				
		A		Ø B	Ø C		
Inches	mm	mm	mm	mm	mm	kg/mm	°
1	25	11	25	64	20	0.006	0-7.5
1½	40	11	25	83	38	0.009	0-7.5
2	50	11	25	102	51	0.013	0-7.5
3	80	11	25	133	76	0.020	0-7.5
4	100	11	25	171	102	0.032	0-4
6	150	11	25	219	152	0.042	0-3

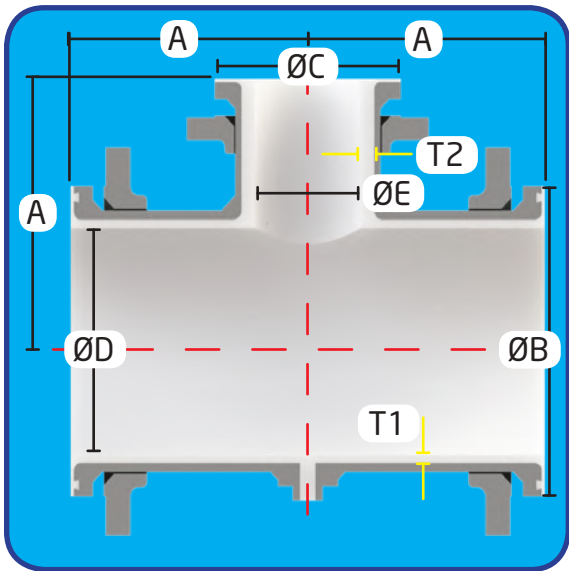


5D elbows have a significantly larger radius than standard elbows. This helps reduce the pressure drop around the bend and makes it easier for more viscous fluids such as slurries to pass without product hold-up. They can also serve to reduce the erosion of the lining if there are any abrasive materials in the fluid. These are lined in paste extruded PTFE.

90° Elbow 5D						Construction Codes	
Nominal Bore ³		Centre Line to Face	Raised Face	HiPerFlon PTFE Liner Thickness Nominal ¹	PTFE Liner Bore Nominal ²	Code	Steelwork
						FT	FT
Inches	mm	A	Ø B	T	Ø C	Construction	Weight
1	25	127	51	3.2	20	FT	2.5
1½	40	191	73	3.2	34	FT	4.7
2	50	254	92	3.2	46	FT	7.6
3	80	381	127	3.2	70	FT	15
4	100	508	157	4.5	93	FT	26
6	150	762	216	5.5	143	FT	63

Code	Steelwork	Lining
CP	Cast Steel	PFA
CT	Cast Steel	PTFE
FP	Fabricated Steel	PFA
FT	Fabricated Steel	PTFE

1 - Liner thicknesses are based on Virgin PTFE heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PTFE heavy duty liner and schedule 40 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a calibrated volume in the product please consult us.
3 - Larger sizes available on request.

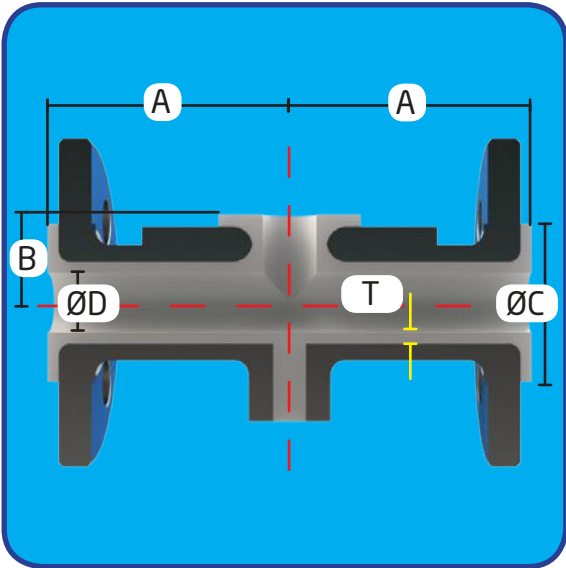
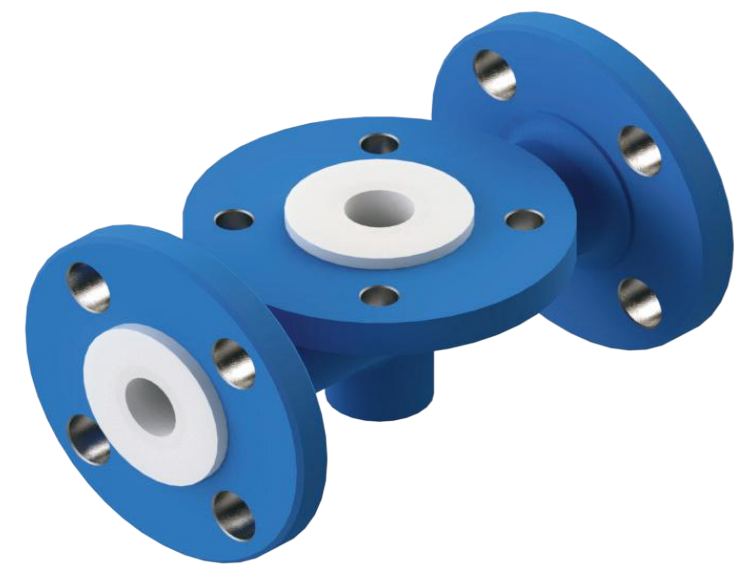


This design of tee has three rotating flanges captured behind stub ends. This design makes installation easy and provides versatility. The tee design is ideal as a stock item for maintenance requirements.

Reducing Tee Rotating Flanges									Construction Codes	
Nominal Bore		Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	Code	Lining
Inches	mm	A	B	Ø C	T1	T2	Ø D	Ø E	Construction	Weight
		mm	mm	mm	mm	mm	mm	mm	Standard	kg
¾ x ½	20 x 15	75	43	35	4.5	4.5	12	12	FP	2.0
1 x ½	25 x 15	89	51	35	4.0	4.5	20	12	FP	2.7
1 x ¾	25 x 20	89	51	43	4.0	4.5	20	12	FP	3.0
1½ x ½	40 x 15	102	73	35	4.5	4.5	33	12	FP	4.2
1½ x ¾	40 x 20	102	73	43	4.5	4.5	33	12	FP	4.5
1½ x 1	40 x 25	102	73	51	4.5	4.0	33	20	FP	4.8
2 x ½	50 x 15	114	92	35	4.8	4.5	44	12	FP	6.4
2 x ¾	50 x 20	114	92	43	4.8	4.5	44	12	FP	6.6
2 x 1	50 x 25	114	92	51	4.8	4.0	44	20	FP	6.9
2 x 1½	50 x 40	114	92	73	4.8	4.5	44	33	FP	7.7
3 x ½	80 x 15	140	127	35	6.5	4.5	66	12	FP	12
3 x ¾	80 x 20	140	127	43	6.5	4.5	66	12	FP	13
3 x 1	80 x 25	140	127	51	6.0	4.0	66	20	FP	13
3 x 1½	80 x 40	140	127	73	6.5	4.5	66	33	FP	14
3 x 2	80 x 50	140	127	92	6.5	4.8	66	44	FP	15
4 x ½	100 x 15	165	157	35	9.0	4.5	86	12	FP	18
4 x ¾	100 x 20	165	157	43	9.0	4.5	86	12	FP	19
4 x 1	100 x 25	165	157	51	9.0	4.0	86	20	FP	19
4 x 1½	100 x 40	165	157	73	9.0	4.5	86	33	FP	20
4 x 2	100 x 50	165	157	92	9.0	4.8	86	44	FP	21
4 x 3	100 x 80	165	157	127	9.0	4.5	86	66	FP	24
6 x ½	150 x 15	203	216	35	11.0	4.8	137	12	FP	31
6 x ¾	150 x 20	203	216	43	11.0	6.5	137	12	FP	31

Reducing Tee Rotating Flanges									Construction Codes	
Nominal Bore		Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	Code	Lining
Inches	mm	A	B	Ø C	T1	T2	Ø D	Ø E	Construction	Weight
		mm	mm	mm	mm	mm	mm	mm	Standard	kg
6 x 1	150 x 25	203	216	51	11.0	4.0	137	20	FP	32
6 x 1½	150 x 40	203	216	73	11.0	4.5	137	33	FP	33
6 x 2	150 x 50	203	216	92	11.0	4.8	137	44	FP	34
6 x 3	150 x 80	203	216	127	11.0	6.5	137	66	FP	37
6 x 4	150 x 100	203	216	157	11.0	9.0	137	86	FP	40
8 x 1	200 x 25	229	270	51	10.0	4.0	186	20	FP	48
8 x 1½	200 x 40	229	270	73	10.0	4.5	186	33	FP	49
8 x 2	200 x 50	229	270	92	10.0	4.8	186	44	FP	50
8 x 3	200 x 80	229	270	127	10.0	6.5	186	66	FP	54
8 x 4	200 x 100	229	270	157	10.0	9.0	186	86	FP	57
8 x 6	200 x 150	229	270	216	10.0	11.0	186	137	FP	63
10 x 1	250 x 25	279	324	51	10.0	4.0	237	20	FP	72
10 x 1½	250 x 40	279	324	73	10.0	4.5	237	33	FP	73
10 x 2	250 x 50	279	324	92	10.0	4.8	237	44	FP	74
10 x 3	250 x 80	279	324	127	10.0	6.5	237	66	FP	78
10 x 4	250 x 100	279	324	157	10.0	9.0	237	86	FP	82
10 x 6	250 x 150	279	324	216	10.0	11.0	237	137	FP	88
10 x 8	250 x 200	279	324	270	10.0	10.0	237	186	FP	96
12 x 1	300 x 25	305	381	51	10.0	4.0	287	20	FP	105
12 x 1½	300 x 40	305	381	73	10.0	4.5	287	33	FP	106
12 x 2	300 x 50	305	381	92	10.0	4.8	287	44	FP	107
12 x 3	300 x 80	305	381	127	10.0	6.5	287	66	FP	112
12 x 4	300 x 100	305	381	157	10.0	9.0	287	86	FP	115
12 x 6	300 x 150	305	381	216	10.0	11.0	287	137	FP	122
12 x 8	300 x 200	305	381	270	10.0	10.0	287	186	FP	130
12 x 10	300 x 250	305	381	324	10.0	10.0	287	237	FP	140
14 x 1	350 x 25	356	413	51	10.5	4.0	317	20	FP	143
14 x 1½	350 x 40	356	413	73	10.5	4.5	317	33	FP	144
14 x 2	350 x 50	356	413	92	10.5	4.8	317	44	FP	146
14 x 3	350 x 80	356	413	127	10.5	6.5	317	66	FP	150
14 x 4	350 x 100	356	413	157	10.5	9.0	317	86	FP	154
14 x 6	350 x 150	356	413	216	10.5	11.0	317	137	FP	162
14 x 8	350 x 200	356	413	270	10.5	10.0	317	186	FP	171
14 x 10	350 x 250	356	413	324	10.5	10.0	317	237	FP	182
14 x 12	350 x 300	356	413	381	10.5	10.0	317	287	FP	197

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



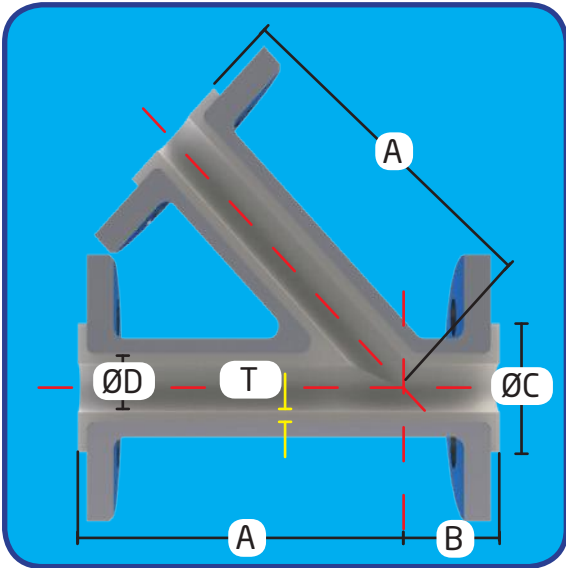
A short stack tee is the equivalent of an equal tee, but instead of a branch, a pad flange is mounted directly onto the main pipeline. This can be very useful if space is a limiting factor such as around the top of reactors. Also they are often used for mounting instruments into the main flow

and can make up a key part of manifold systems when space is at a premium. They are a key part of surface mounted sampling systems for large line sizes; where a sample can be taken directly from a pipeline without the need for a large flanged or wafer in-line sampling device.

The branch flange holes are supplied threaded UNC and the metric equivalents are available. Short stack tee's can also be manufactured as reducing tee's with the branch size smaller than the main bore.

Short Stack Tee							Construction Codes		
Nominal Bore		Centre Line to Face	Centre Line to Face	Raised Face	PFA Heavy Duty Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	Code	Steelwork	Lining
							CP	Cast Steel	PFA
							CT	Cast Steel	PTFE
							FP	Fabricated Steel	PFA
							FT	Fabricated Steel	PTFE
Construction		Weight							
Inches	mm	mm	mm	mm	mm	mm	Standard	kg	
1	25	89	30	51	4.0	20	CP	3.1	
1½	40	102	37	73	4.5	33	CP	5.1	
2	50	114	43	92	4.8	44	CP	8.2	
3	80	140	56	127	6.5	66	CP	17	
4	100	165	67	157	9.0	86	CP	24	
6	150	203	105	216	11.0	137	FP	42	

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.

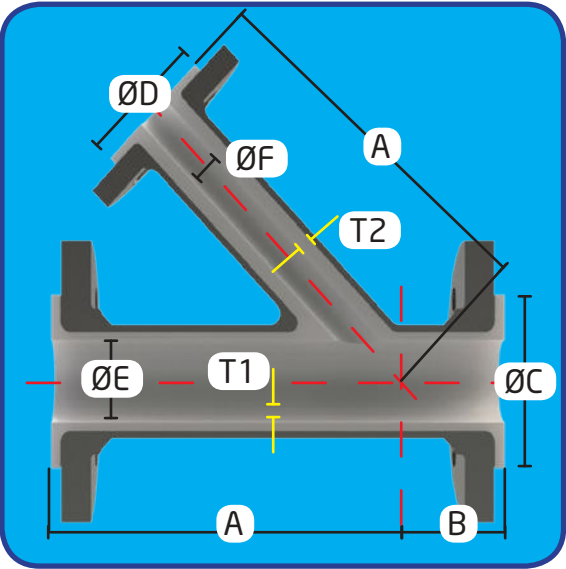


An equal lateral tee provides the same functionality as an equal tee with the exception that the branch leaves the main body at 45° close to one end of the main body. They are often used to provide

run-off from reactor outlets and to soften changes in flow direction creating less turbulent flow than the 90° branch of an equal tee.

Equal Lateral Tee							Construction Codes		
Nominal Bore		Centre Line to Face	Centre Line to Face	Raised Face	PFA Heavy Duty Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	Construction Codes		
							Code	Steelwork	Lining
							CP	Cast Steel	PFA
							CT	Cast Steel	PTFE
							FP	Fabricated Steel	PFA
FT	Fabricated Steel	PTFE							
Construction		Weight							
Inches	mm	mm	mm	mm	mm	mm	Standard	kg	
1	25	146	44	51	4.0	20	FP	3.5	
1½	40	178	51	73	4.5	33	FP	6.0	
2	50	203	64	92	4.8	44	FP	9.6	
3	80	254	76	127	6.5	66	FP	20	
4	100	305	76	157	9.0	86	FP	31	
6	150	368	89	216	11.0	137	FP	53	
8	200	444	114	270	10.0	186	FP	85	
10	250	521	127	324	10.0	237	FP	128	
12	300	622	140	381	10.0	287	FP	194	
14	350	686	152	413	10.5	317	FP	258	

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.

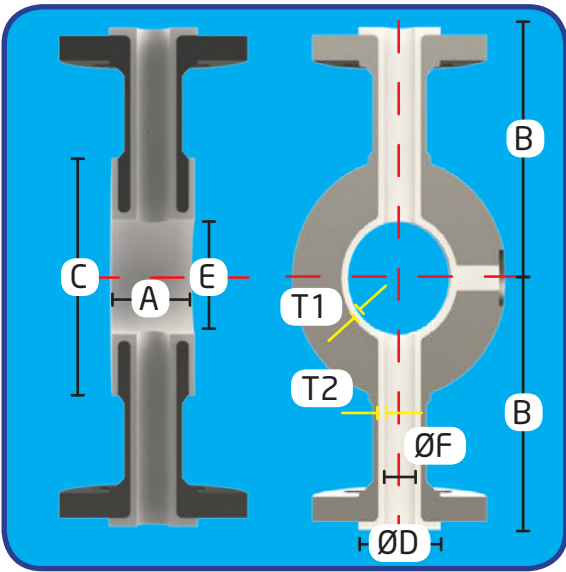


A reducing lateral tee provides the same functionality as an equal tee with the exception that the branch leaves the main body at 45° close to one end of the main body. They are often used to provide run-off from reactor outlets and to soften changes in flow direction creating less turbulent flow than the 90° branch of a reducing tee.

Reducing Lateral Tee										Construction Codes		
Nominal Bore		Centre Line to Face	Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	Code	Steelwork	Lining
										CP	Cast Steel	PFA
										CT	Cast Steel	PTFE
										FP	Fabricated Steel	PFA
										FT	Fabricated Steel	PTFE
Inches		mm	A	B	Ø C	Ø D	T1	T2	Ø E	Ø F	Construction	Weight
mm		mm	mm	mm	mm	mm	mm	mm	mm	mm	Standard	kg
1	x ½	25 x 15	146	44	51	35	4.0	4.5	20	12	FP	2.8
1	x ¾	25 x 20	146	44	51	43	4.0	4.5	20	12	FP	3.1
1½	x ½	40 x 15	178	51	73	35	4.5	4.5	33	12	FP	4.4
1½	x ¾	40 x 20	178	51	73	43	4.5	4.5	33	12	FP	4.8
1½	x 1	40 x 25	178	51	73	51	4.5	4.0	33	20	FP	5.1
2	x ½	50 x 15	203	64	92	35	4.5	4.5	44	12	FP	6.8
2	x ¾	50 x 20	203	64	92	43	4.5	4.5	44	12	FP	7.1
2	x 1	50 x 25	203	64	92	51	4.5	4.0	44	20	FP	7.5
2	x 1½	50 x 40	203	64	92	73	4.5	4.5	44	33	FP	8.4
3	x ½	80 x 15	254	76	127	35	6.5	4.5	66	12	FP	13
3	x ¾	80 x 20	254	76	127	43	6.5	4.5	66	12	FP	14
3	x 1	80 x 25	254	76	127	51	6.5	4.0	66	20	FP	14
3	x 1½	80 x 40	254	76	127	73	6.5	4.5	66	33	FP	15
3	x 2	80 x 50	254	76	127	92	6.5	4.8	66	44	FP	16
4	x ½	100 x 15	305	76	157	35	9.0	4.5	86	12	FP	20
4	x ¾	100 x 20	305	76	157	43	9.0	4.5	86	12	FP	20
4	x 1	100 x 25	305	76	157	51	9.0	4.0	86	20	FP	21
4	x 1½	100 x 40	305	76	157	73	9.0	4.5	86	33	FP	22
4	x 2	100 x 50	305	76	157	92	9.0	4.8	86	44	FP	23
4	x 3	100 x 80	305	76	157	127	9.0	6.5	86	66	FP	27
6	x ½	150 x 15	368	89	216	35	11.0	4.5	137	12	FP	33
6	x ¾	150 x 15	368	89	216	35	11.0	4.5	137	12	FP	34
6	x 1	150 x 25	368	89	216	51	11.0	4.0	137	12	FP	34

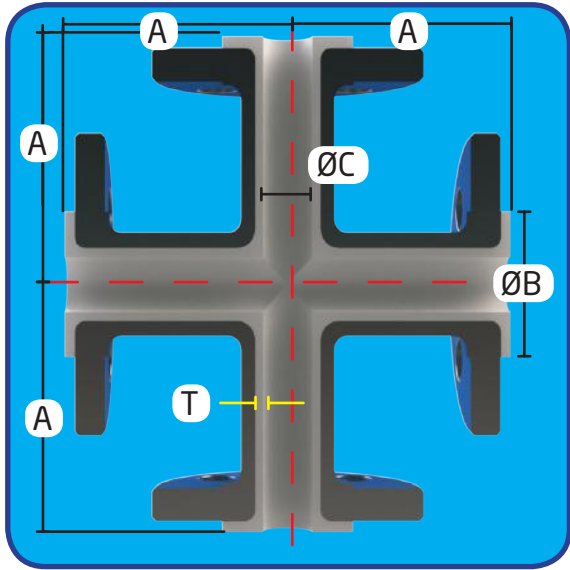
Reducing Lateral Tee										Construction Codes			
										Code	Steelwork	Lining	
Nominal Bore		Centre Line to Face	Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	CP	PFA		
										Cast Steel		PTFE	
										Cast Steel		PTFE	
										Fabricated Steel		PFA	
										FT	PTFE		
Inches		mm	mm	mm	mm	mm	mm	mm	mm	Construction		Weight	
										Standard	kg		
6	x 1½	150	x 40	368	89	216	73	11.0	4.5	137	33	FP	35
6	x 2	150	x 50	368	89	216	92	11.0	4.8	137	44	FP	37
6	x 3	150	x 80	368	89	216	127	11.0	6.5	137	66	FP	41
6	x 4	150	x 100	368	89	216	157	11.0	9.0	137	86	FP	45
8	x 1	200	x 25	444	114	270	51	10.0	4.0	186	20	FP	53
8	x 1½	200	x 40	444	114	270	73	10.0	4.5	186	33	FP	55
8	x 2	200	x 50	444	114	270	92	10.0	4.8	186	44	FP	56
8	x 3	200	x 80	444	114	270	127	10.0	6.5	186	66	FP	62
8	x 4	200	x 100	444	114	270	157	10.0	9.0	186	86	FP	66
8	x 6	200	x 150	444	114	270	216	10.0	11.0	186	137	FP	75
10	x 1	250	x 25	521	127	324	51	10.0	4.0	237	20	FP	79
10	x 1½	250	x 40	521	127	324	73	10.0	4.5	237	33	FP	80
10	x 2	250	x 50	521	127	324	92	10.0	4.8	237	44	FP	82
10	x 3	250	x 80	521	127	324	127	10.0	6.5	237	66	FP	88
10	x 4	250	x 100	521	127	324	157	10.0	9.0	237	86	FP	93
10	x 6	250	x 150	521	127	324	216	10.0	11.0	237	137	FP	103
10	x 8	250	x 200	521	127	324	270	10.0	10.0	237	186	FP	114
12	x 1	300	x 25	622	140	381	51	10.0	4.0	287	20	FP	119
12	x 1½	300	x 40	622	140	381	73	10.0	4.5	287	33	FP	120
12	x 2	300	x 50	622	140	381	92	10.0	4.8	287	44	FP	122
12	x 3	300	x 80	622	140	381	127	10.0	6.5	287	66	FP	129
12	x 4	300	x 100	622	140	381	157	10.0	9.0	287	86	FP	135
12	x 6	300	x 150	622	140	381	216	10.0	11.0	287	137	FP	147
12	x 8	300	x 200	622	140	381	270	10.0	10.0	287	186	FP	158
12	x 10	300	x 250	622	140	381	324	10.0	10.0	287	237	FP	174
14	x 1	350	x 25	686	152	413	51	10.5	4.0	317	20	FP	157
14	x 1½	350	x 40	686	152	413	73	10.5	4.5	317	33	FP	159
14	x 2	350	x 50	686	152	413	92	10.5	4.8	317	44	FP	161
14	x 3	350	x 80	686	152	413	127	10.5	6.5	317	66	FP	168
14	x 4	350	x 100	686	152	413	157	10.5	9.0	317	86	FP	174
14	x 6	350	x 150	686	152	413	216	10.5	11.0	317	137	FP	187
14	x 8	350	x 200	686	152	413	270	10.5	10.0	317	186	FP	199
14	x 10	350	x 250	686	152	413	324	10.5	10.0	317	237	FP	216
14	x 12	350	x 300	686	152	413	381	10.5	10.0	317	287	FP	237

1 - Liner thicknesses are based on Virgin PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on Virgin PFA heavy duty liner and schedule 40 or 30 steel pipe. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



Double branch instrument tees are in reality crosses with two ordinary branches attached to a wafer style line (a short line without flanges). They are used in place of crosses when space is an issue. If required for the mounting of instruments and a specific bore is required for an instrument please discuss this at the time of ordering as sizes are nominal.

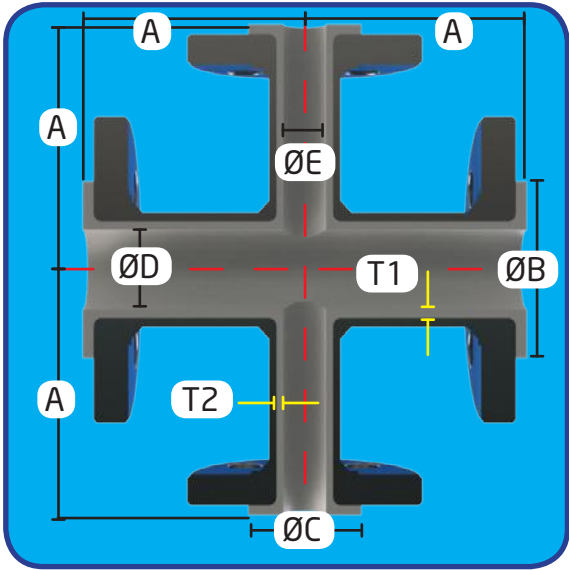
Double Branch Instrument Tee														Construction Codes		
Nominal Bore						Body Face to Face	Centre Line to Face Branch	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal¹	Branch Heavy Duty PFA Liner Thickness Nominal¹	Line PFA Liner Bore Nominal	Branch PFA Liner Bore Nominal	Code	Steelwork	Lining
														CP	Cast Steel	PFA
														CT	Cast Steel	PTFE
														FP	Fabricated Steel	PFA
														FT	Fabricated Steel	PTFE
A						B	Ø C	Ø D	T1	T2	Ø E	Ø F	Construction	Weight		
Inches		mm				mm	mm	mm	mm	mm	mm	mm	mm	Standard	kg	
½	x	½³	15	x	15	51	65	35	35	4.5	4.5	12	12	FP	1.5	
¾	x	½³	20	x	15	51	75	43	35	4.5	4.5	12	12	FP	1.8	
¾	x	¾⁴	20	x	20	51	75	43	43	4.5	4.5	12	12	FP	2.3	
1	x	½³	25	x	15	51	89	51	35	4.0	4.5	20	12	FP	2.4	
1	x	¾⁴	25	x	20	51	89	51	43	4.0	4.5	20	12	FP	2.7	
1	x	1⁵	25	x	25	51	89	51	51	4.0	4.0	20	20	FP	3.4	
1½	x	½³	40	x	15	51	102	73	35	4.5	4.5	33	12	FP	2.7	
1½	x	¾⁴	40	x	20	51	102	73	43	4.5	4.5	33	12	FP	3.3	
1½	x	1	40	x	25	51	102	73	51	4.5	4.0	33	20	FP	4.1	
1½	x	1½	40	x	40	76	102	73	73	4.5	4.5	33	33	FP	5.6	
2	x	½³	50	x	15	51	114	92	35	4.8	4.5	44	12	FP	3.6	
2	x	¾⁴	50	x	20	51	114	92	43	4.8	4.5	44	12	FP	4.2	
2	x	1	50	x	25	51	114	92	51	4.8	4.0	44	20	FP	5.0	
2	x	1½	50	x	40	76	114	92	73	4.8	4.5	44	33	FP	7.0	
2	x	2	50	x	50	89	114	92	92	4.8	4.8	44	44	FP	9.4	
3	x	½³	80	x	15	51	140	127	35	6.5	4.5	66	12	FP	5	
3	x	¾⁴	80	x	20	51	140	127	43	6.5	4.5	66	12	FP	6	
3	x	1	80	x	25	51	140	127	51	6.5	4.0	66	20	FP	7	
3	x	1½	80	x	40	76	140	127	73	6.5	4.5	66	33	FP	9	
3	x	2	80	x	50	89	140	127	92	6.5	4.8	66	44	FP	12	
3	x	3	80	x	80	150	140	127	127	6.5	6.5	66	66	FP	22	
4	x	½³	100	x	15	51	165	157	35	9.0	4.5	86	12	FP	8	
4	x	¾⁴	100	x	20	51	165	157	43	9.0	4.5	86	12	FP	9	
4	x	1	100	x	25	51	165	157	51	9.0	4.0	86	20	FP	10	



These provide an additional branch to an equal tee and are based on the same dimensional format. Special components of differing branch length or exit angle can be manufactured.

Equal Cross							Construction Codes		
Nominal Bore		Centre Line to Face	Raised Face	Heavy Duty PFA Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²		Code	Steelwork	Lining
							CP	Cast Steel	PFA
							CT	Cast Steel	PTFE
							FP	Fabricated Steel	PFA
							FT	Fabricated Steel	PTFE
Nominal Bore		A	Ø B	T	Ø C	Construction	Weight		
Inches	mm	mm	mm	mm	mm	Standard	kg		
½	15	65	35	4.5	12	FP	2.0		
¾	20	75	43	4.5	12	FP	3.1		
1	25	89	51	4.0	20	FP	4.3		
1½	40	102	73	4.5	33	FP	7.3		
2	50	114	92	4.8	44	FP	11.6		
3	80	140	127	6.5	66	FP	24		
4	100	165	157	9.0	86	FP	35		
6	150	203	216	11.0	137	FP	60		
8	200	229	270	10.0	186	FP	93		
10	250	279	324	10.0	237	FP	141		
12	300	305	381	10.0	287	FP	206		
14	350	356	413	10.5	317	FP	283		

1 - Liner thicknesses are based on PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.

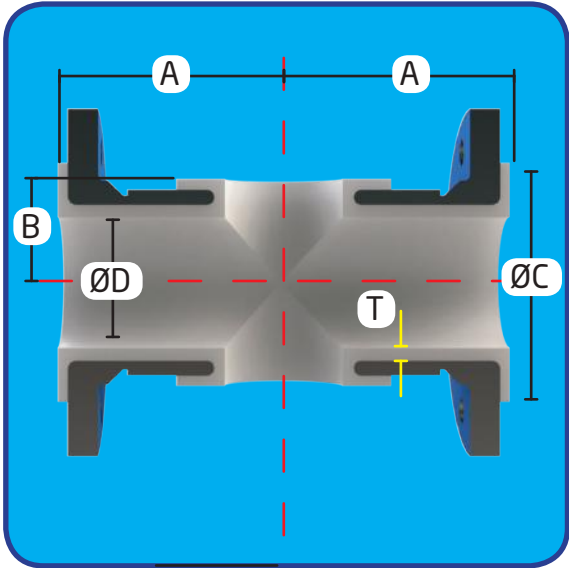


These provide an additional branch to a reducing tee and are based on the same dimensional format. Special components of differing branch length or exit angle can be manufactured.

Reducing Cross										Construction Codes		
Nominal Bore		Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch Heavy Duty PFA Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	Code	Steelwork	Lining	
									CP	Cast Steel	PFA	
									CT	Cast Steel	PTFE	
									FP	Fabricated Steel	PFA	
									FT	Fabricated Steel	PTFE	
A		Ø B	Ø C	T1	T2	Ø D	Ø E	Materials	Weight			
Inches	mm	mm	mm	mm	mm	mm	mm	mm	Standard	kg		
¾ x ½	20 x 15	75	43	35	4.5	4.5	12	12	FP	2.6		
1 x ½	25 x 15	89	51	35	4.0	4.5	20	12	FP	3.2		
1 x ¾	25 x 20	89	51	43	4.0	4.5	20	12	FP	3.8		
1½ x ½	40 x 15	102	73	35	4.5	4.5	33	12	FP	4.8		
1½ x ¾	40 x 20	102	73	43	4.5	4.5	33	12	FP	5.3		
1½ x 1	40 x 25	102	73	51	4.5	4.0	33	20	FP	5.9		
2 x ½	50 x 15	114	92	35	4.8	4.5	44	12	FP	6.9		
2 x ¾	50 x 20	114	92	43	4.8	4.5	44	12	FP	7.5		
2 x 1	50 x 25	114	92	51	4.8	4.0	44	20	FP	8.1		
2 x 1½	50 x 40	114	92	73	4.8	4.5	44	33	FP	9.6		
3 x ½	80 x 15	140	127	35	6.5	4.5	66	12	FP	13		
3 x ¾	80 x 20	140	127	43	6.5	4.5	66	12	FP	14		
3 x 1	80 x 25	140	127	51	6.5	4.0	66	20	FP	14		
3 x 1½	80 x 40	140	127	73	6.5	4.5	66	33	FP	16		
3 x 2	80 x 50	140	127	92	6.5	4.8	66	44	FP	18		
4 x ½	100 x 15	165	157	35	9.0	4.5	86	12	FP	19		
4 x ¾	100 x 20	165	157	43	9.0	4.5	86	12	FP	20		
4 x 1	100 x 25	165	157	51	9.0	4.0	86	20	FP	20		
4 x 1½	100 x 40	165	157	73	9.0	4.5	86	33	FP	22		
4 x 2	100 x 50	165	157	92	9.0	4.8	86	44	FP	24		
4 x 3	100 x 80	165	157	127	9.0	6.5	86	66	FP	30		
6 x ½	150 x 15	203	216	35	11.0	4.5	137	12	FP	32		
6 x ¾	150 x 20	203	216	43	11.0	4.5	137	12	FP	32		

Reducing Cross												Construction Codes		
Nominal Bore		Centre Line to Face	Line Raised Face	Branch Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Branch Heavy Duty PFA Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Bore Nominal ²	Code	Steelwork	Lining			
									CP	Cast Steel	PFA			
									CT	Cast Steel	PTFE			
									FP	Fabricated Steel	PFA			
									FT	Fabricated Steel	PTFE			
Inches		mm	A	Ø B	Ø C	T1	T2	Ø D	Ø E	Materials	Weight			
mm		mm	mm	mm	mm	mm	mm	mm	mm	Standard	kg			
6	x 1½	150 x 40	203	216	73	11.0	4.5	137	33	FP	35			
6	x 2	150 x 50	203	216	92	11.0	4.8	137	44	FP	37			
6	x 3	150 x 80	203	216	127	11.0	6.5	137	66	FP	44			
6	x 4	150 x 100	203	216	157	11.0	9.0	137	86	FP	50			
8	x 1	200 x 25	229	270	51	10.0	4.0	186	20	FP	49			
8	x 1½	200 x 40	229	270	73	10.0	4.5	186	33	FP	51			
8	x 2	200 x 50	229	270	92	10.0	4.8	186	44	FP	54			
8	x 3	200 x 80	229	270	127	10.0	6.5	186	66	FP	61			
8	x 4	200 x 100	229	270	157	10.0	9.0	186	86	FP	67			
8	x 6	200 x 150	229	270	216	10.0	11.0	186	137	FP	79			
10	x 1	250 x 25	279	324	51	10.0	4.0	237	20	FP	74			
10	x 1½	250 x 40	279	324	73	10.0	4.5	237	33	FP	76			
10	x 2	250 x 50	279	324	92	10.0	4.8	237	44	FP	78			
10	x 3	250 x 80	279	324	127	10.0	6.5	237	66	FP	86			
10	x 4	250 x 100	279	324	157	10.0	9.0	237	86	FP	93			
10	x 6	250 x 150	279	324	216	10.0	11.0	237	137	FP	106			
10	x 8	250 x 200	279	324	270	10.0	10.0	237	186	FP	122			
12	x 1	300 x 25	305	381	51	10.0	4.0	287	20	FP	107			
12	x 1½	300 x 40	305	381	73	10.0	4.5	287	33	FP	109			
12	x 2	300 x 50	305	381	92	10.0	4.8	287	44	FP	112			
12	x 3	300 x 80	305	381	127	10.0	6.5	287	66	FP	120			
12	x 4	300 x 100	305	381	157	10.0	9.0	287	86	FP	127			
12	x 6	300 x 150	305	381	216	10.0	11.0	287	137	FP	141			
12	x 8	300 x 200	305	381	270	10.0	10.0	287	186	FP	157			
12	x 10	300 x 250	305	381	324	10.0	10.0	287	237	FP	177			
14	x 1	350 x 25	356	413	51	10.5	4.0	317	20	FP	145			
14	x 1½	350 x 40	356	413	73	10.5	4.5	317	33	FP	148			
14	x 2	350 x 50	356	413	92	10.5	4.8	317	44	FP	150			
14	x 3	350 x 80	356	413	127	10.5	6.5	317	66	FP	159			
14	x 4	350 x 100	356	413	157	10.5	9.0	317	86	FP	167			
14	x 6	350 x 150	356	413	216	10.5	11.0	317	137	FP	183			
14	x 8	350 x 200	356	413	270	10.5	10.0	317	186	FP	200			
14	x 10	350 x 250	356	413	324	10.5	10.0	317	237	FP	222			
14	x 12	350 x 300	356	413	381	10.5	10.0	317	287	FP	253			

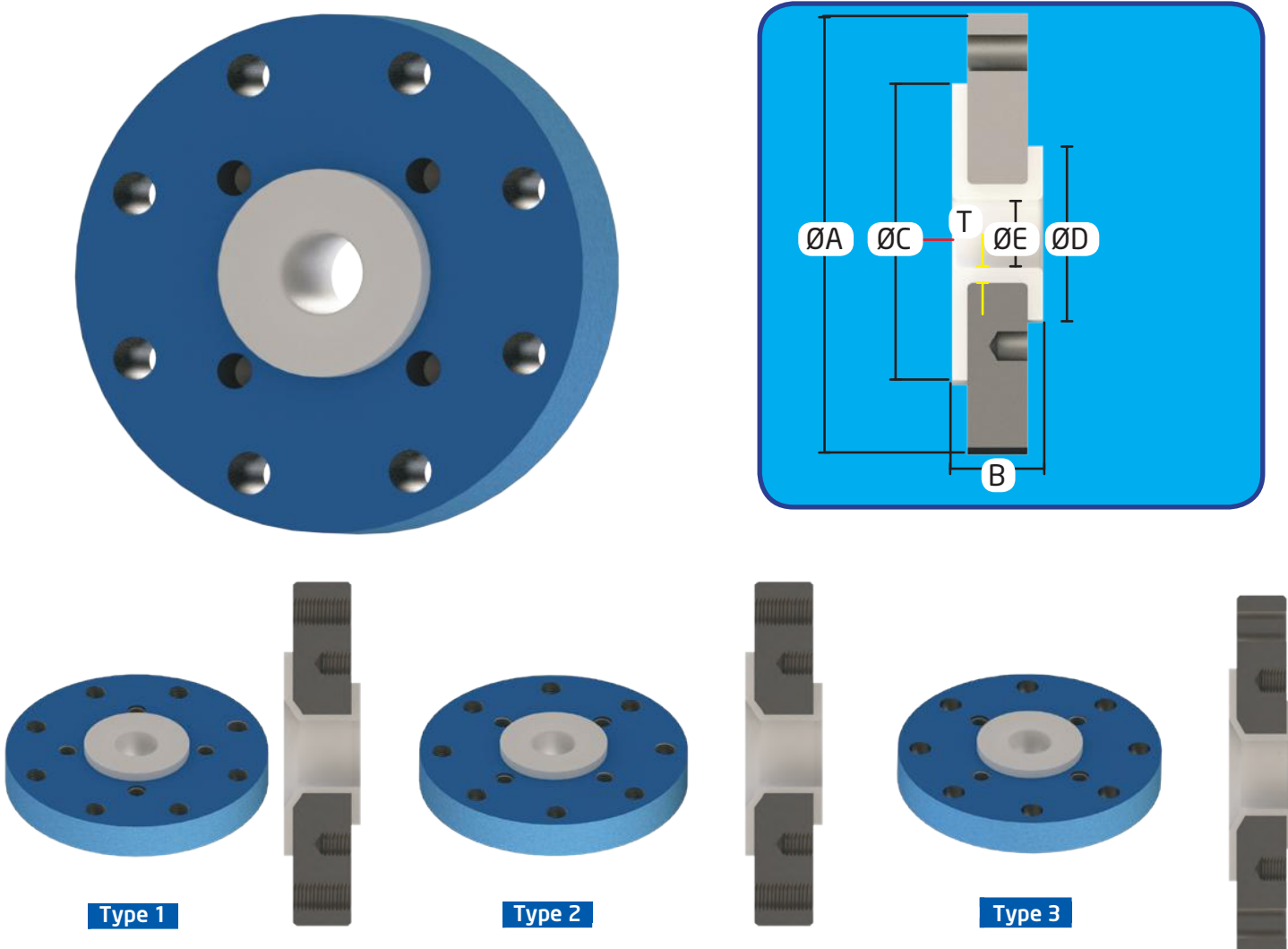
1 - Liner thicknesses are based on PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



A short stack cross provides the more space saving, so tends to be selected where space is at a premium.

Short Stack Cross							Construction Codes		
		Centre Line to Face	Centre Line to Face	Raised Face	Heavy Duty PFA Liner Thickness Nominal ¹	PFA Liner Bore Nominal ²	Code	Steelwork	Lining
							CP	Cast Steel	PFA
							CT	Cast Steel	PTFE
							FP	Fabricated Steel	PFA
							FT	Fabricated Steel	PTFE
Nominal Bore		A	B	Ø C	T	Ø D	Materials		Weight
Inches	mm	mm	mm	mm	mm	mm	Standard	kg	
1	25	89	30	51	4.0	20	FP	3.9	
1½	40	102	37	73	4.5	33	FP	6.6	
2	50	114	43	92	4.8	44	FP	10.6	
3	80	140	56	127	6.5	66	FP	21	
4	100	165	67	157	9.0	86	FP	31	
6	150	203	105	216	11.0	137	FP	53	

1 - Liner thicknesses are based on PFA heavy duty liner. For other materials consult the liner dimension tables in this manual.
2 - Nominal bores are based on schedule 40 or 30 steel pipe and PFA heavy duty liner. Because of the method of manufacture and steel tolerances this can be a guide only. For other materials and thicknesses please consult the liner dimension tables in this manual. If you require a precise dimension for instrument, mixer or other insertion or a calibrated volume in the product please consult us.



A reducing flange is essentially a plate flange providing a sharp reduction in line bore of one or many size reductions.

A parallel bore gives the most abrupt transition from one bore to the next, but can be specified where more support to other materials is required from the flange. These are often used against brick lined piping.

These are generally PTFE lined, but can be lined in PFA. They provide a more space saving alternative to concentric reducers, but cannot present the same flow characteristics.

Reducing flanges can be grouped into three main configurations - type 1, 2 & 3. The configuration is dictated by the proximity of the small bore bolt holes to the large bore bolt holes. Each type is designed so that they do not clash and that the nuts can be fitted successfully. Type 3 flanges have through clearance

holes for the large nominal bore and blind threaded holes for the small nominal bore. These are used where there is a significant reduction in bores. Where the reduction is not so great and the periphery of the smaller bore mating flange would impinge on the nuts then a type 2 flange is employed with all threaded bolt holes (through holes for the large nominal bore and blind holes for the small nominal bore) negating the use of nuts. Finally where the reduction in bores is quite small the bolt holes are all threaded with through holes for the large nominal bore and blind holes for the small nominal bore. These have to be staggered on/off centres so that they don't clash - a type 1 reducing flange.

As a general rule, a type 3 is the default design. if this cannot be achieved because of the two joining flanges geometry, a type 2 is specified, and if this doesn't

work, then a type 1.

If you have site reasons for wanting to select another style, then a type 1 or 2 will always work where a type 3 does and a type 1 where a type 2 does. As standard Type 2 and 3 bolt holes are off/off centres.

There is another style of reducing flange available where the inner pattern of holes is on a raised platform and the outer holes are scalloped from this. This enables one to use type 3 style drillings i.e. through bolts on the large side, removing the necessity to have double threaded holes on the reducing flange. This is useful where one is coming up against items such as a threaded pad flange on a vessel. CRP can produce these and many other special reducing flanges just call us to discuss.

Reducing Flange Parallel Bore												Construction Codes		
Nominal Bore		Flange Type	Flange	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness¹	Minimum HiPerFlon PTFE Liner Thickness¹	Bore Nominal²		Code	Steelwork	Lining	
											CP	Cast Steel	PFA	
											CT	Cast Steel	PTFE	
											FP	Fabricated Steel	PFA	
											FT	Fabricated Steel	PTFE	
Inches	mm		Ø A	B	Ø C	Ø D	T	T	Ø E		Construction		Weight	
			mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg		
¾ x ½	20 x 15	Type 1	100	30	43	35	5	3	15	FP	FT	1.3		
1 x ½	25 x 15	Type 1	110	30	51	35	5	3	15	FP	FT	1.6		
1 x ¾	25 x 20	Type 1	110	30	51	43	5	3	15	FP	FT	1.6		
1½ x ½	40 x 15	Type 2	125	30	73	35	5	3	15	FP	FT	2.1		
1½ x ¾	40 x 20	Type 1	125	30	73	43	5	3	15	FP	FT	2.1		
1½ x 1	40 x 25	Type 1	125	30	73	51	5	3	18	FP	FT	2.0		
2 x ½	50 x 15	Type 2	150	30	92	35	5	3	15	FP	FT	3.0		
2 x ¾	50 x 20	Type 2	150	30	92	43	5	3	15	FP	FT	3.0		
2 x 1	50 x 25	Type 2	150	30	92	51	5	3	18	FP	FT	3.0		
2 x 1½	50 x 40	Type 1	150	30	92	73	5	3	32	FP	FT	2.9		
3 x ½	80 x 15	Type 3	190	35	127	35	5	3	15	FP	FT	6		
3 x ¾	80 x 20	Type 3	190	35	127	43	5	3	15	FP	FT	6		
3 x 1	80 x 25	Type 3	190	35	127	51	5	3	18	FP	FT	6		
3 x 1½	80 x 40	Type 2	190	35	127	73	5	3	32	FP	FT	6		
3 x 2	80 x 50	Type 1	190	35	127	92	5	3	43	FP	FT	6		
4 x ½	100 x 15	Type 3	230	35	157	35	5	5	15	FP	FT	9		
4 x ¾	100 x 20	Type 3	230	35	157	43	5	5	15	FP	FT	9		
4 x 1	100 x 25	Type 3	230	35	157	51	5	5	18	FP	FT	9		
4 x 1½	100 x 40	Type 3	230	35	157	73	5	5	32	FP	FT	9		
4 x 2	100 x 50	Type 3	230	35	157	92	5	5	43	FP	FT	9		
4 x 3	100 x 80	Type 1	230	35	157	127	5	5	70	FP	FT	8		
6 x ½	150 x 15	Type 3	280	40	216	35	5	5	15	FP	FT	16		
6 x ¾	150 x 20	Type 3	280	40	216	43	5	5	15	FP	FT	16		
6 x 1	150 x 25	Type 3	280	40	216	51	5	5	18	FP	FT	16		
6 x 1½	150 x 40	Type 3	280	40	216	73	5	5	32	FP	FT	16		
6 x 2	150 x 50	Type 3	280	40	216	92	5	5	43	FP	FT	16		
6 x 3	150 x 80	Type 3	280	40	216	127	5	5	70	FP	FT	15		
6 x 4	150 x 100	Type 2	280	40	216	157	5	5	93	FP	FT	15		
8 x ½	200 x 15	Type 3	345	40	270	35	5	5	15	FT	FP	25		
8 x ¾	200 x 20	Type 3	345	40	270	43	5	5	15	FT	FP	25		
8 x 1	200 x 25	Type 3	345	40	270	51	5	5	18	FT	FP	25		
8 x 1½	200 x 40	Type 3	345	40	270	73	5	5	32	FT	FP	25		
8 x 2	200 x 50	Type 3	345	40	270	92	5	5	43	FT	FP	25		
8 x 3	200 x 80	Type 3	345	40	270	127	5	5	70	FT	FP	24		
8 x 4	200 x 100	Type 3	345	40	270	157	5	5	93	FT	FP	24		
8 x 6	200 x 150	Type 2	345	40	270	216	5	5	145	FT	FP	21		
10 x ½	250 x 15	Type 3	405	35	324	35	5	5	15	FT	FP	35		
10 x ¾	250 x 20	Type 3	405	35	324	43	5	5	15	FT	FP	35		
10 x 1	250 x 25	Type 3	405	35	324	51	5	5	18	FT	FP	35		
10 x 1½	250 x 40	Type 3	405	35	324	73	5	5	32	FT	FP	35		
10 x 2	250 x 50	Type 3	405	35	324	92	5	5	43	FT	FP	35		

Reducing Flange Parallel Bore



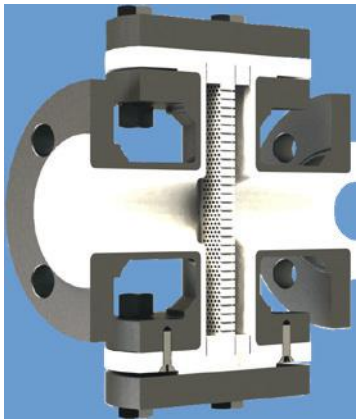
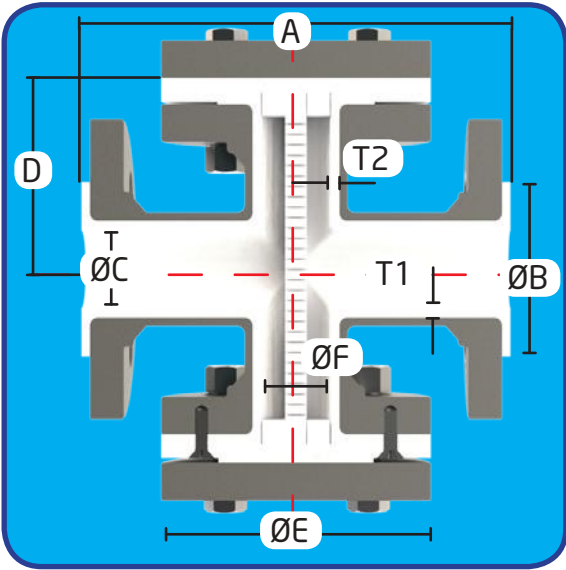
Reducing Flange Parallel Bore



Reducing Flange Parallel Bore													Construction Codes		
Nominal Bore				Flange Type	Flange	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness ¹	Minimum HiPerFlon PTFE Liner Thickness ¹	Bore Nominal ²		Code	Steelwork	Lining
													CP	Cast Steel	PFA
													CT	Cast Steel	PTFE
													FP	Fabricated Steel	PFA
Inches	mm		mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	Weight		
10	x 3	250	x 80	Type 3	405	35	324	127	5	5	70	FT	FP	34	
10	x 4	250	x 100	Type 3	405	35	324	157	5	5	93	FT	FP	34	
10	x 6	250	x 150	Type 3	405	35	324	216	5	5	145	FT	FP	31	
10	x 8	250	x 200	Type 2	405	35	324	270	5	5	196	FT	FP	27	
12	x ½	300	x 15	Type 3	485	40	381	35	5	5	15	FT	FP	56	
12	x ¾	300	x 20	Type 3	485	40	381	43	5	5	15	FT	FP	56	
12	x 1	300	x 25	Type 3	485	40	381	51	5	5	18	FT	FP	56	
12	x 1½	300	x 40	Type 3	485	40	381	73	5	5	32	FT	FP	55	
12	x 2	300	x 50	Type 3	485	40	381	92	5	5	43	FT	FP	55	
12	x 3	300	x 80	Type 3	485	40	381	127	5	5	70	FT	FP	55	
12	x 4	300	x 100	Type 3	485	40	381	157	5	5	93	FT	FP	54	
12	x 6	300	x 150	Type 3	485	40	381	216	5	5	145	FT	FP	51	
12	x 8	300	x 200	Type 3	485	40	381	270	5	5	196	FT	FP	47	
12	x 10	300	x 250	Type 2	485	40	381	324	5	5	250	FT	FP	41	
14	x ½	350	x 15	Type 3	535	40	413	35	5	5	15	FT	FP	72	
14	x ¾	350	x 20	Type 3	535	40	413	43	5	5	15	FT	FP	72	
14	x 1	350	x 25	Type 3	535	40	413	51	5	5	18	FT	FP	72	
14	x 1½	350	x 40	Type 3	535	40	413	73	5	5	32	FT	FP	71	
14	x 2	350	x 50	Type 3	535	40	413	92	5	5	43	FT	FP	71	
14	x 3	350	x 80	Type 3	535	40	413	127	5	5	70	FT	FP	70	
14	x 4	350	x 100	Type 3	535	40	413	157	5	5	93	FT	FP	70	
14	x 6	350	x 150	Type 3	535	40	413	216	5	5	145	FT	FP	67	
14	x 8	350	x 200	Type 3	535	40	413	270	5	5	196	FT	FP	62	
14	x 10	350	x 250	Type 3	535	40	413	324	5	5	250	FT	FP	56	
14	x 12	350	x 300	Type 1	535	40	413	381	5	5	301	FT	FP	52	
16	x ½	400	x 15	Type 3	595	40	470	35	5	5	15	FT	FP	94	
16	x ¾	400	x 20	Type 3	595	40	470	43	5	5	15	FT	FP	94	
16	x 1	400	x 25	Type 3	595	40	470	51	5	5	18	FT	FP	94	
16	x 1½	400	x 40	Type 3	595	40	470	73	5	5	32	FT	FP	94	
16	x 2	400	x 50	Type 3	595	40	470	92	5	5	43	FT	FP	94	
16	x 3	400	x 80	Type 3	595	40	470	127	5	5	70	FT	FP	93	
16	x 4	400	x 100	Type 3	595	40	470	157	5	5	93	FT	FP	92	
16	x 6	400	x 150	Type 3	595	40	470	216	5	5	145	FT	FP	89	
16	x 8	400	x 200	Type 3	595	40	470	270	5	5	196	FT	FP	84	
16	x 10	400	x 250	Type 3	595	40	470	324	5	5	250	FT	FP	78	
16	x 12	400	x 300	Type 3	595	40	470	381	5	5	301	FT	FP	71	
16	x 14	400	x 350	Type 2	595	40	470	413	5	5	326	FT	FP	64	
18	x ½	450	x 15	Type 3	635	40	533	35	5	5	15	FT	FP	112	
18	x ¾	450	x 20	Type 3	635	40	533	43	5	5	15	FT	FP	112	
18	x 1	450	x 25	Type 3	635	40	533	51	5	5	18	FT	FP	112	
18	x 1½	450	x 40	Type 3	635	40	533	73	5	5	32	FT	FP	111	
18	x 2	450	x 50	Type 3	635	40	533	92	5	5	43	FT	FP	111	
18	x 3	450	x 80	Type 3	635	40	533	127	5	5	70	FT	FP	110	

Reducing Flange Parallel Bore													Construction Codes		
145Nominal Bore196				Flange Type	Flange	Face to Face	Large NB Raised Face	Small NB Raised Face	Minimum Heavy Duty PFA Liner Thickness¹	Minimum HiPerFlon PTFE Liner Thickness¹	Bore Nominal²		Code	Steelwork	Lining
													CP	Cast Steel	PFA
													CT	Cast Steel	PTFE
													FP	Fabricated Steel	PFA
													FT	Fabricated Steel	PTFE
													Construction		Weight
Inches		mm			mm	mm	mm	mm	mm	mm	mm	mm	Standard	To Order	kg
18	x 4	450	x 100	Type 3	635	40	533	157	5	5	93	FT	FP	109	
18	x 6	450	x 150	Type 3	635	40	533	216	5	5	145	FT	FP	106	
18	x 8	450	x 200	Type 3	635	40	533	270	5	5	196	FT	FP	101	
18	x 10	450	x 250	Type 3	635	40	533	324	5	5	250	FT	FP	95	
18	x 12	450	x 300	Type 3	635	40	533	381	5	5	301	FT	FP	87	
18	x 14	450	x 350	Type 2	635	40	533	413	5	5	326	FT	FP	81	
18	x 16	450	x 400	Type 1	635	40	533	470	5	5	377	FT	FP	103	
20	x ½	500	x 15	Type 3	700	53	584	35	5	5	15	FT	FP	153	
20	x ¾	500	x 20	Type 3	700	53	584	43	5	5	15	FT	FP	153	
20	x 1	500	x 25	Type 3	700	53	584	51	5	5	18	FT	FP	153	
20	x 1½	500	x 40	Type 3	700	53	584	73	5	5	32	FT	FP	153	
20	x 2	500	x 50	Type 3	700	53	584	92	5	5	43	FT	FP	153	
20	x 3	500	x 80	Type 3	700	53	584	127	5	5	70	FT	FP	152	
20	x 4	500	x 100	Type 3	700	53	584	157	5	5	93	FT	FP	151	
20	x 6	500	x 150	Type 3	700	53	584	216	5	5	145	FT	FP	147	
20	x 8	500	x 200	Type 3	700	53	584	270	5	5	196	FT	FP	142	
20	x 10	500	x 250	Type 3	700	53	584	324	5	5	250	FT	FP	134	
20	x 12	500	x 300	Type 3	700	53	584	381	5	5	301	FT	FP	126	
20	x 14	500	x 350	Type 3	700	53	584	413	5	5	326	FT	FP	118	
20	x 16	500	x 400	Type 2	700	53	584	470	5	5	377	FT	FP	143	
20	x 18	500	x 450	Type 1	700	53	584	533	5	5	425	FT	FP	141	
24	x ½	600	x 15	Type 3	815	57	692	35	5	5	15	FT	FP	229	
24	x ¾	600	x 20	Type 3	815	57	692	43	5	5	15	FT	FP	229	
24	x 1	600	x 25	Type 3	815	57	692	51	5	5	18	FT	FP	229	
24	x 1½	600	x 40	Type 3	815	57	692	73	5	5	32	FT	FP	228	
24	x 2	600	x 50	Type 3	815	57	692	92	5	5	43	FT	FP	228	
24	x 3	600	80	Type 3	815	57	692	127	5	5	70	FT	FP	227	
24	x 4	600	100	Type 3	815	57	692	157	5	5	93	FT	FP	226	
24	x 6	600	150	Type 3	815	57	692	216	5	5	145	FT	FP	222	
24	x 8	600	200	Type 3	815	57	692	270	5	5	196	FT	FP	216	
24	x 10	600	250	Type 3	815	57	692	324	5	5	250	FT	FP	208	
24	x 12	600	300	Type 3	815	57	692	381	5	5	301	FT	FP	198	
24	x 14	600	350	Type 3	815	57	692	413	5	5	326	FT	FP	190	
24	x 16	600	400	Type 3	815	57	692	470	5	5	377	FT	FP	218	
24	x 18	600	450	Type 3	815	57	692	533	5	5	425	FT	FP	215	
24	x 20	600	500	Type 2	815	57	692	584	5	5	473	FT	FP	212	

1 - Please note liner thicknesses are based on Virgin PTFE, for other materials consult the liner tables in the manual.
2 - Bore is based on Virgin PTFE, because of method of manufacture and steel tolerances this is a guide only, for other materials and thicknesses please consult the liner tables in the manual.



These are crosses with a PTFE strainer plate down the centre of them to filter the mixture flowing through it. Various hole sizes and free area are available. Please note whilst we've tried to get as close as possible to 100% open area to help negate the pressure drop across the PTFE plate for larger sizes this is not possible.

Strainer Cross														Construction Codes		
		Line Face to Face	Raised Face	Line Heavy Duty PFA Liner Thickness Nominal ¹	Line PFA Liner Bore Nominal ²	Branch PFA Liner Nominal Bore		Branch Centre Line to Face	Branch Outer Diameter	Branch PFA Heavy Duty Liner Thickness Nominal ¹	Branch PFA Liner Bore Nominal ²	Construction	Max Open Area	Code	Steelwork	Lining
														CP	Cast Steel	PFA
														CT	Cast Steel	PTFE
														FP	Fabricated Steel	PFA
														FT	Fabricated Steel	PTFE
Inches	mm	mm	mm	mm	mm	Inches	mm	mm	mm	mm	mm	Standard	mm ²	Open Area	Weight	
1	25	178	51	4.0	20	2	50	114	60	4.8	44	FP	746	247	7.5	
1½	40	204	73	4.5	33	3	80	140	89	6.5	66	FP	1610	188	12.8	
2	50	228	92	4.8	44	3	80	140	89	6.5	66	FP	1610	106	20.1	
3	80	300	127	6.5	66	6	150	203	168	11.0	137	FP	5655	165	44	
4	100	340	157	9.0	86	8	200	229	219	10.0	186	FP	8875	153	67	
6	150	406	216	11.0	137	10	250	279	273	10.0	237	FP	14883	101	117	
8	200	500	270	10.0	186	14	350	356	356	10.5	317	FP	25486	94	190	
10	250	558	324	10.0	237	14	350	356	356	10.5	317	FP	25486	58	279	
12	300	610	381	10.0	287	14	350	356	356	10.5	317	FP	25486	39	404	
14	350	712	413	10.5	317	14	350	356	356	10.5	317	FP	25486	32	556	

There is a significant choice when it comes to special items. The table below indicates some of the most popular variants on lined pipe and fittings, whilst the photographs on the next page show some of the capability of the business. CRP does not see itself as a "catalogue" company. Our approach is one of problem solving and just because

it hasn't been made before doesn't mean that it isn't required or cannot be made. Please discuss your corrosion problems with us and let us find a solution if we can.

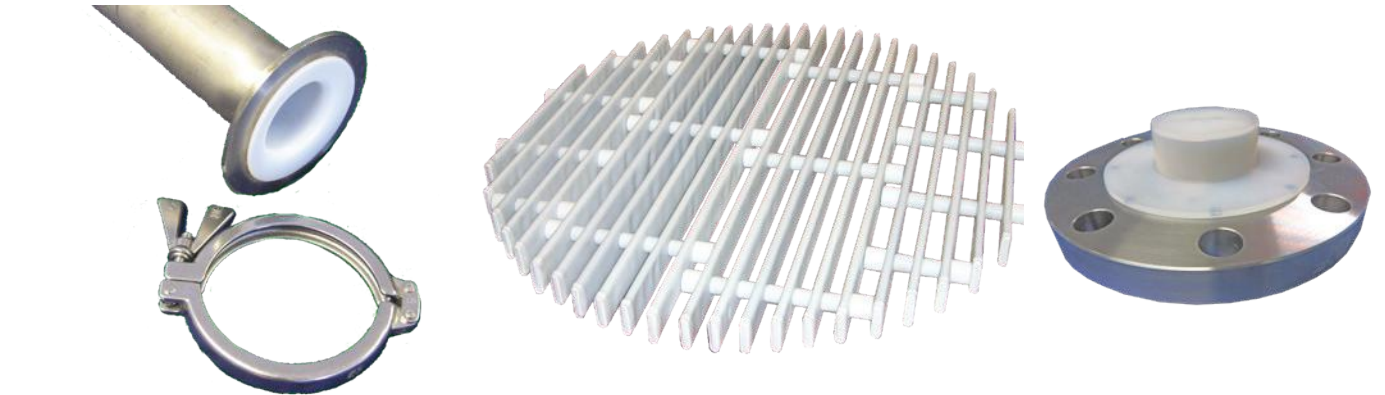
Spool & Fitting Options	
Lining	HiPerFlon PTFE
	UHP PTFE
	Static-Dissipating PTFE
	Static-Dissipating PFA
	Super Vacuum Resistant (SVR)
Flanges	Fixed/Rotating
	Rotating/Rotating
	Different bolt centres e.g. ON/OFF
	Metric drillings
	Non-standard bolt hole orientation
	Mixed flanges
	Flange not perpendicular to pipe
Flange Design	ASME B16.5 Class 300
	DIN PN10/16
	JIS
	Customer special
Geometry	Longer or shorter radius
	Non standard centreline to face dimensions
	Non standard face to face dimensions
	Different angles
	Dissimilar centreline to face on each leg
	Lugged wafer fittings
Flare Face	Full face lining
Housing Materials	Stainless steels
	Low temperature carbon steel
	Exotic metals



Multibranch Reactor Charging Manifold Double Branch Reducing Tee 180 Degree Elbow



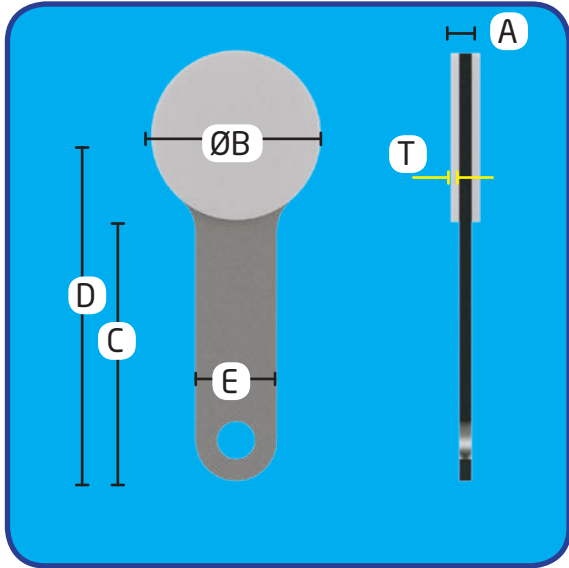
Reducing Crosss with Offset Branches Support Foot Azeotropic Separation Vessel Instrument Probe Housing



Tri-Clamp PTFE Lined Spool PTFE-Incoloy Column Support Grid PFA Top Hat Blank Flange



Filtration System Charge Pot Azeotropic Separation Vessel



A handy aid for blanking off pumps, valves and sections of piping; the function of blanking spades or paddle blanks is to separate shut-off plant systems from pressurised or operational systems and protect parts of systems from being subjected to higher pressures than their rated cut-off pressure. Blanking spades can also be used in connection with test pressurisation. They can also provide an additional layer of protection during maintenance work, guarding against leaking valves or the negligent opening of

an isolation valve.

A wafer fitting, the disc is sized to fit inside the bolt circle for the relevant nominal bore. Both sides of the fitting have PTFE bonded to a stainless steel plate. A hole in the handle is for tagging the item if required. They are also available fully lined including the handle.

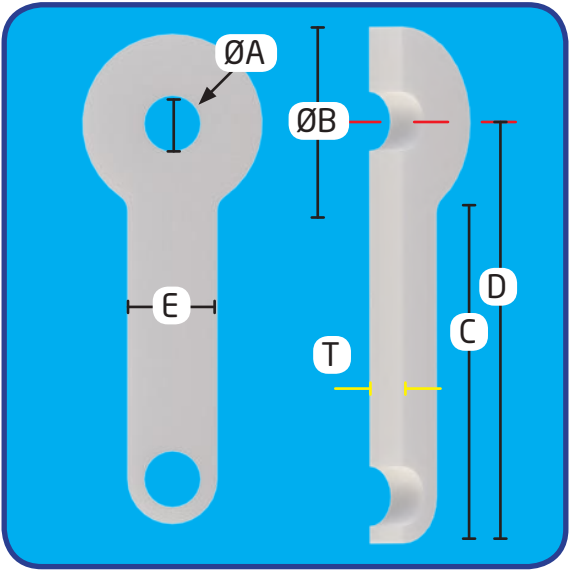
Ring spacers or paddle spacers can also be provided to maintain the piping position at times when blanking spades are not in use. These have a handle and outside

diameter as the blanking spade but a bore to suit the pipe line internal diameter.

CRP blanking spades are manufactured as a 7mm thick assembly to facilitate their use in existing piping systems through prising two flanges apart. However on larger nominal bores this thickness is insufficient to take the full potential line pressure and we recommend the selection of spectacle blinds.

Blanking Spade											
Nominal Bore		Face to Face	Spade OD	PTFE Liner Thickness	Handle Length	Length to Centre	Handle Width	Construction	Max Pressure Rating Class 150	Actual Max Pressure Ratings ¹	Weight
		A	Ø B	T	C	D	E		bar (g)	bar (g)	kg
Inches	mm	mm	mm	mm	mm	mm	mm				
½	15	7	44	2	80	102	26	SS/PTFE	19.6	31.0	0.1
¾	20		54		83	110		SS/PTFE	19.6	31.0	0.1
1	25		62		117	148		SS/PTFE	19.6	31.0	0.1
1½	40		81		116	156		SS/PTFE	19.6	31.0	0.2
2	50		100		112	162		SS/PTFE	19.6	22.0	0.3
3	80		132		112	178		SS/PTFE	10.0	10.0	0.4
4	100		170		109	194		SS/PTFE	5.9	5.9	0.7
6	150		217		112	220		SS/PTFE	2.6	2.6	1.2
8	200		274		113	250		SS/PTFE	1.5	1.5	2
10	250		337		132	300		SS/PTFE	0.9	0.9	3
12	300	7	407	2	137	340	26	SS/PTFE	0.6	0.6	4
14	350		447		147	370		SS/PTFE	0.5	0.5	5
16	400		511		145	400		SS/PTFE	0.4	0.4	7

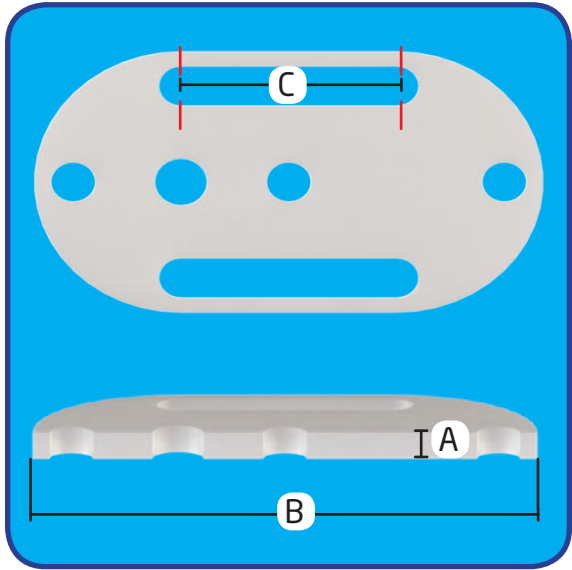
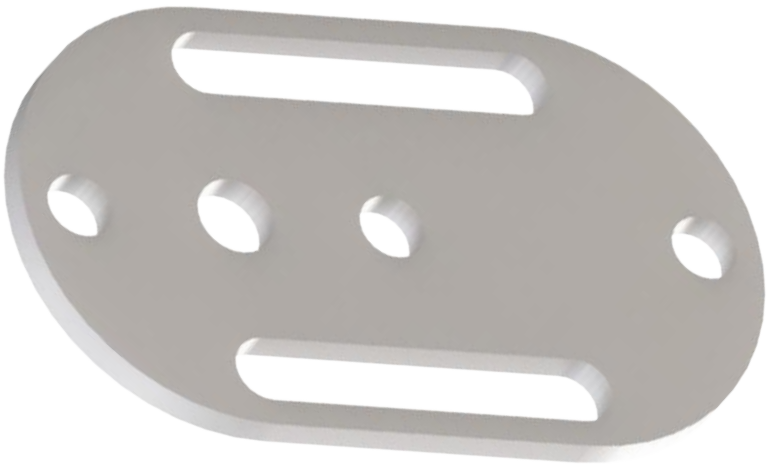
1 - Maximum pressures when used in systems rated higher than 150lb (10 bar(g)).



Orifice plates can be used for measuring flow rate, reducing line pressure or restricting flow. These are generally manufactured in solid PTFE with a hole sized to suit the application. The handle hole is usually made to the same diameter to indicate what is in the line. Thicknesses are customer specified and are determined by the pressure rating, typically between 3 and 25mm. They are also available for higher pressure ratings as a PFA lined stainless steel component.

Orifice Plate								
Nominal Bore		Maximum Hole ¹	Plate OD	Handle Length	Length to Centre	Handle Width		Max Weight
		Ø A	Ø B	C	D	E		
Inches	mm	mm	mm	mm	mm	mm	Construction	kg
½	15	12	42	131	152	20	PTFE	0.1
¾	20	12	51	130	156	20	PTFE	0.1
1	25	20	61	130	161	20	PTFE	0.1
1½	40	33	80	130	170	20	PTFE	0.2
2	50	44	99	128	178	30	PTFE	0.3
3	80	56	130	130	195	40	PTFE	0.4
4	100	69	169	130	215	40	PTFE	0.6
6	150	91	217	112	220	40	PTFE	0.9
8	200	111	274	113	250	40	PTFE	1.4

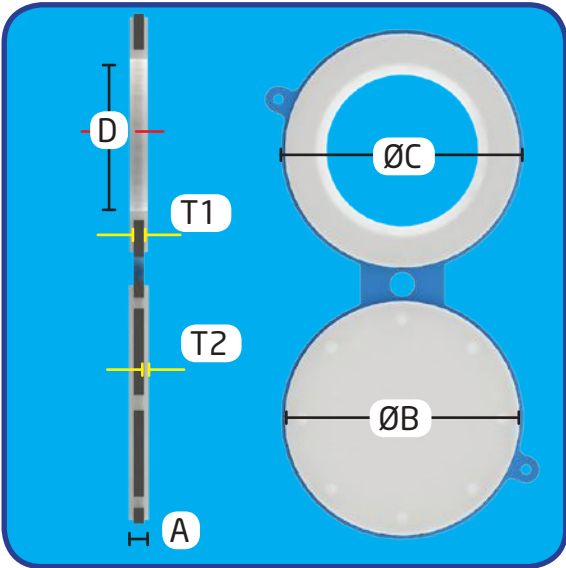
1 - Hole size is customer specified.



Sliding blinds are a more permanent form of blanking spade, combining the function of the blanking spade with that of a ring spacer. They are built into the pipeline as a wafer fitting and require the flange bolting to be loosened in order for it to be slid into either position. Manufactured from solid PTFE in their open state they allow unhindered flow through the pipeline, when slid into their closed position they effectively seal the pipeline. They have the advantage over blanking spades of it being quite clear as to whether the blind is in the open or closed position. The slotted holes fit the bolting and align the blind. For a more robust permanent blind please select the Spectacle Blind.

Sliding Blind									
Nominal Bore		Face to Face	Blind Height	Blind Travel	Pressure Rating 23°C	Pressure Rating 100°C	Pressure Rating 200°C		Weight
		A	B	C	bar (g)	bar (g)	bar (g)		kg
Inches	mm	mm	mm	mm	bar (g)	bar (g)	bar (g)	Construction	kg
½	15	10	89	60	19.6 ^{1,2}	17.7 ²	13.8 ²	PTFE	0.2
¾	20	10	99	70	19.6 ²	17.7 ²	13.8 ²	PTFE	0.3
1	25	10	108	79	19.6 ²	17.7 ²	13.8 ²	PTFE	0.4
1½	40	10	127	98	19.6 ²	11.5	6.4	PTFE	0.5
2	50	16	152	121	19.6 ²	17.7 ²	9.9	PTFE	0.8
3	80	16	190	152	17.8	8.1	4.5	PTFE	2.0
4	100	27	229	191	19.6 ²	13.4	7.4	PTFE	5.0
6	150	27	279	241	12.9	5.9	3.3	PTFE	7.5
8	200	27	343	298	7.3	3.3	1.8	PTFE	11
10	250	25	430	445	4.6	2.1	1.2	PTFE	18
12	300	27	483	529	3.3	1.5	0.8	PTFE	26

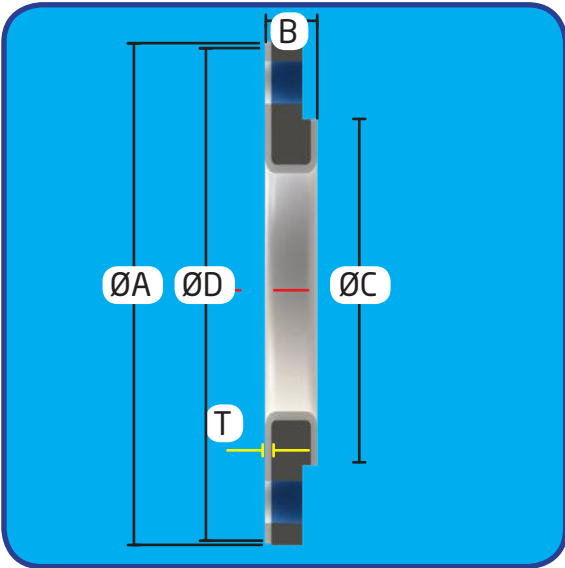
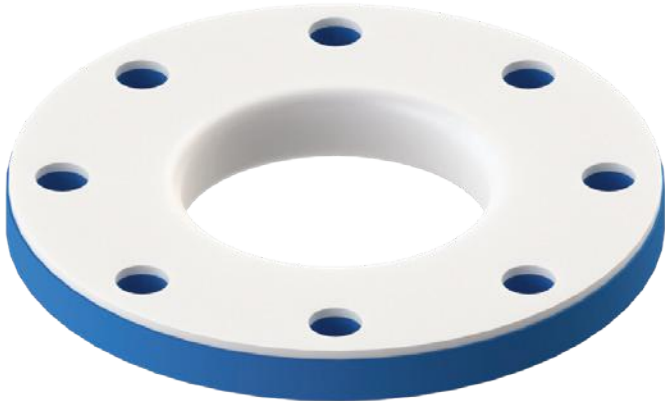
1 - Please note pressures are thickness dependant, if you require a higher pressure rating please contact us.
2 - The pressure rating of the sliding blind is greater than the pressure rating of the same size of Class 150 flange, so pressure ratings shown are for the flange. These items are highlighted in green.



Spectacle blinds are a more permanent form of blanking spade, designed to be left installed within the pipeline. The spectacle blind or Figure 8 blank is a wafer fitting designed to swivel around

one of the flange bolts. They have the advantage over blanking spades of it being quite clear as to whether the blind is in the open or closed position. The CRP design is extremely robust with a

stainless steel core lined in PFA and does not suffer from PTFE movement of the flared faces which can occur with other designs preventing the blind from being inserted after a period out of line .



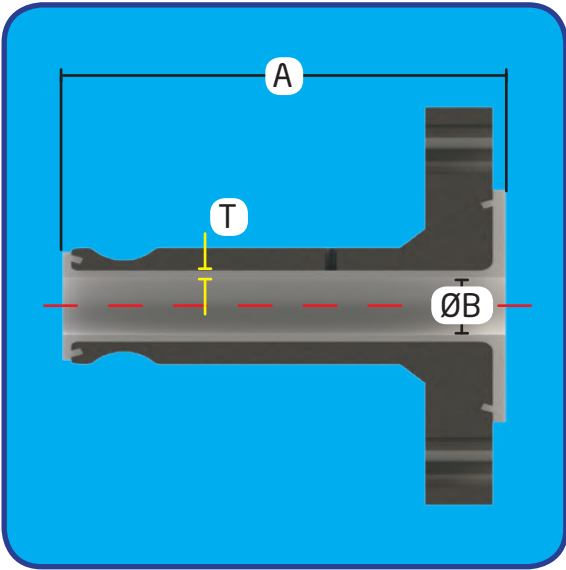
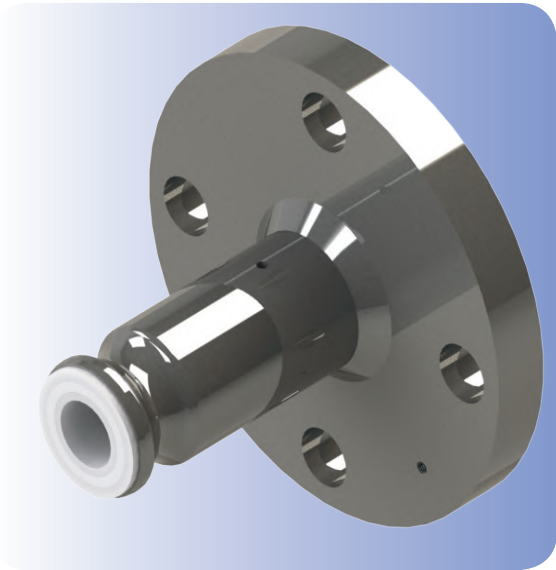
Occasionally lined piping is joined to weaker dissimilar flange materials. A common application is to join to GRP/FRP or thermoset and thermoplastic plastic flanges. These may be piping elements or often valves. It is a mistake to consider that one can achieve a seal simply by

fitting a gasket. This is because such products usually have a flat face that needs to seal on to the lined piping. When bolted up in service this flat face bends along the edge of the PTFE or PFA raised face and does not achieve a seal on this lip. Further tightening just bends the

weak flange and damages the soft PTFE or PFA raised face. The solution to this is to fit a full face adapter flange which is lined across the full face.

Spectacle Blind												
Nominal Bore		Face to Face	Raised Face	Steelwork Outer	Steelwork Thickness	PFA Liner Bore Nominal	Steelwork Inner	PFA Liner Thickness Nominal	Rotation Centre to Edge	Spin Centre to centre	Construction	Weight kg
		A	Ø B	Ø C	T1	Ø D	Ø E	T2				
Inches	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		
½	15	11	35	44	6	13	18	2.5	70	30	SS/PFA	0.1
¾	20	11	43	54	6	16	22	2.5	80	35	SS/PFA	0.2
1	25	14	51	64	6	19	27	4.0	87	39	SS/PFA	0.3
1½	40	14	73	83	6	33	41	4.0	108	49	SS/PFA	0.5
2	50	14	92	102	6	44	53	4.0	130	61	SS/PFA	0.7
3	80	14	127	134	6	66	78	4.0	161	76	SS/PFA	1.2
4	100	16	157	172	8	86	102	4.0	200	96	SS/PFA	2.2
6	150	22	216	219	13	137	154	4.8	248	121	SS/PFA	4.6
8	200	28	270	276	15	186	203	6.5	305	149	SS/PFA	9
10	250	28	324	337	20	250	260	4.0	367	181	SS/PFA	12
12	300	28	381	406	20	290	300	4.0	438	216	SS/PFA	19
14	350	28	413	447	20	327	337	4.0	482	238	SS/PFA	24
16	400	33	470	511	25	377	387	5.0	546	269	SS/PFA	28

Full Face Adapter Flange								Construction Codes		
Nominal Bore		Flange OD	Face to Face	Raised Face Diameter	PFA Full Face Diameter	Heavy Duty PFA Liner Thickness Nominal	Construction	Code	Steelwork	Lining
								CP	Cast Steel	PFA
Inches	mm	Ø A	Ø B	Ø C	Ø D	T		CT	Cast Steel	PTFE
½	15	90	21	35	88	5.0	FP	FT	Fabricated Steel	PFA
¾	20	100	23	43	98	5.0	FP			
1	25	110	24	51	108	5.0	FP			
1½	40	125	28	73	123	5.0	FP			
2	50	150	29	92	148	5.0	FP			
3	80	190	34	127	188	5.0	FP			
4	100	230	33	157	228	5.0	FP			
6	150	280	35	216	278	5.0	FP			
8	200	345	38	270	343	5.0	FP			
10	250	405	40	324	403	5.0	FP			
12	300	485	42	381	483	5.0	FP			



Introduction

Inappropriate or no venting can lead to premature failure of lined piping and therefore cause both unnecessary plant cost and present a safety hazard. CRP has an all-inclusive approach for managing both permeant and non-permeant services and insulated and uninsulated lines. This will provide longevity in service - assisting in preventing liner failure and external steelwork corrosion.

Venting Function

Venting is required in the two key PTFE lined pipe and fittings specifications ASTM F1545 and DIN2874. There are two user reasons for venting:

- First, to vent the space between

liner and steelwork of any material (liquid or gas) that may collect behind the liner. Such liquid or gas build up can occur by means of permeation through the liner. Permeation rates can be significantly affected by the choice of which PTFE or PFA to use - CRP would always recommend PFA for pipe fittings and UltraHiPerFlon (UHP) for PTFE lined piping. However, even with such lining systems it is still necessary to guard against the effects of permeation.

Secondly, as an early indicator of failure. In the unlikely event of a liner failure the steel housing is likely to corrode evenly within the pipe and cause a catastrophic and unannounced failure of the complete

pipe. With a venting system, the leaking materials should show at the vent first, providing some opportunity to take the equipment out of service before massive failure.

Basic Vent Hole

CRP as standard provides 5mm vent holes versus the more traditional 3mm (1/8"). These are much more effective, being less likely to get blocked by paint, steel corrosion or the crystallisation of permeant media and therefore prevent catastrophic failure through liner collapse.

Hose adaptors are used to connect hoses to piping systems, they are usually made using stainless steel and PFA. Typically the hose adaptor connects to the hose using a tri-clamp, threaded, camlock or

other hose fitting, leaving a flanged end to connect to the fixed PTFE lined piping system. The data below is for male camlock connectors - the least expensive quick release hose coupling, but a variety

of industry standard hose fittings can be fitted, however one must consider whether the fitting geometry allows for PFA lining.

Camlock Hose Adapter						
Camlock Nominal Size		Length	Lined Bore Nominal	PFA Liner Thickness	Construction	Weight
		A	Ø B	T		
Inches	mm	mm	mm	mm		kg
½	15	100	15.0	3.0	Stainless/PFA	2.9
¾	20	100	15.0	5.2	Stainless/PFA	3.1
1	25	100	18.0	2.3	Stainless/PFA	3.7
1½	40	110	27.0	2.5	Stainless/PFA	5.1
2	50	110	36.0	3.0	Stainless/PFA	6.2
3	80	110	54.0	4.3	Stainless/PFA	8



Cut steel pipe showing PTFE lined collapse through blocked vent holes

Corrosion of the vent hole area following permeation and no particular corrosion protection



Selection

The key consideration is whether the duty is for a permeating or non-permeating duty. If the duty is non-permeating then the venting system only needs to provide the leak detection function. However, if it is permeating then it has to be capable of managing the removal of permeant materials from the inside of the item without weakening the steelwork. If not, the steelwork will be weakened to the point of making it unsafe as in the photograph previously.

Once the duty has been determined one

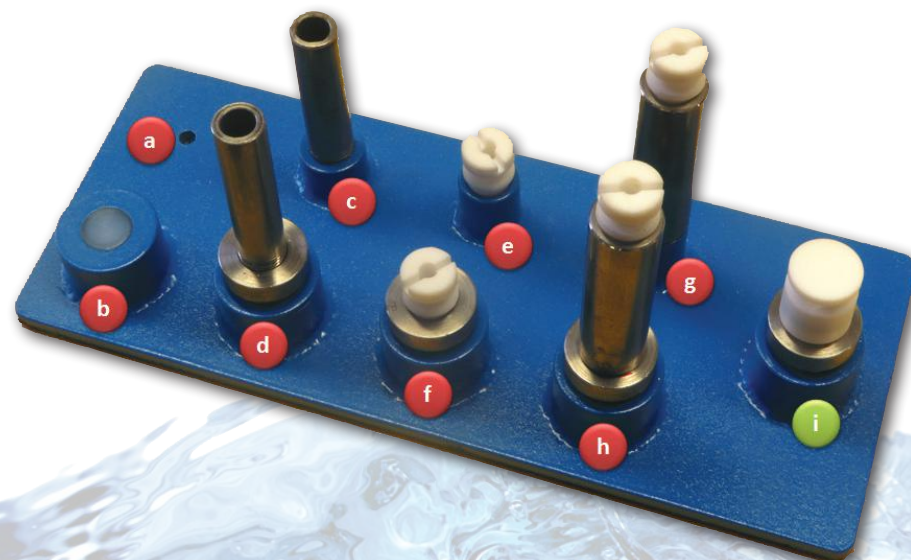
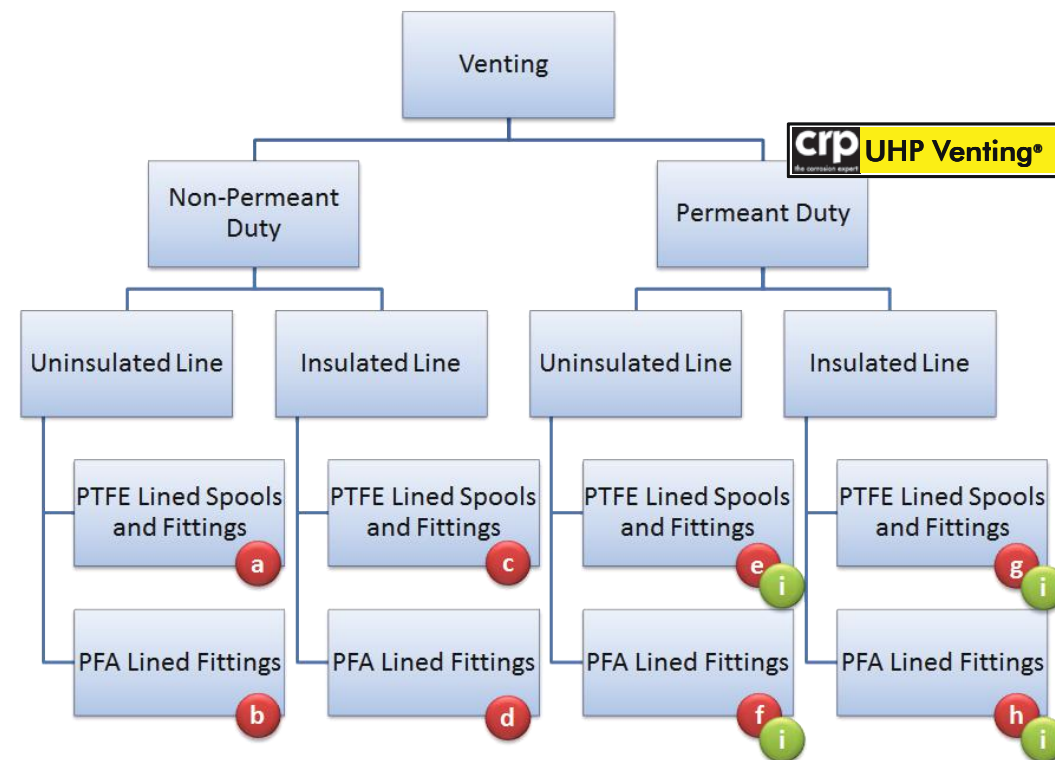
needs to decide if the line is to be insulated or not. Insulation may be selected for process control reasons - keeping the process cold or hot, or to assist in managing permeation by moving the dew point out of the lining material. Either way whether the line is or is not carrying a permeant media it is necessary to carry the vent to the outside of the insulation such that leakage or permeation is not discharged within the insulation.

Some variation in the system is then driven by whether the component is PTFE or PFA lined and in the case of pipe spools

by their length.

CRP Designation

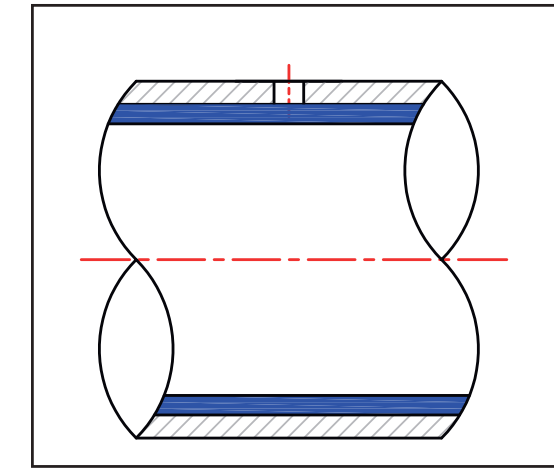
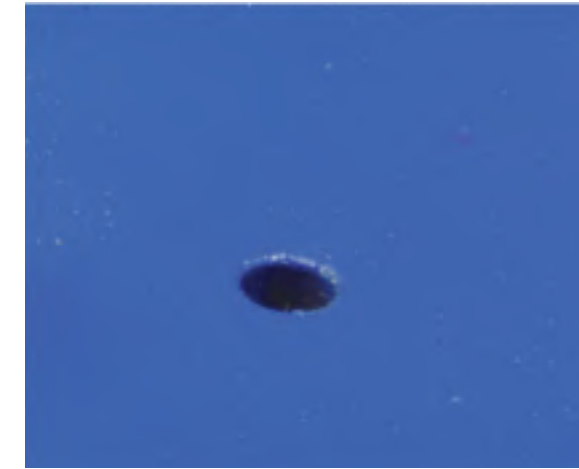
If your requirement is for a non-permeant duty and is uninsulated, then you need not advise specially, we will provide our standard venting automatically (a+b below). If non-permeant, but insulated (c+d below), If permeant, then specify UHP venting - our generic term for the permeant service venting system, again advising us whether lines are uninsulated (e+f below) or insulated (g+h below). The variable angle vent (i below) can be retrofitted onto any PTFE vent plug.



PTFE Lined Spools and Fittings [a]

PTFE lined fittings generally have a single 5mm vent hole located centrally on the item, whilst pipe spools less than 500mm in length also have a single vent hole. Longer spools have two holes on the same side of the spool 150mm from the

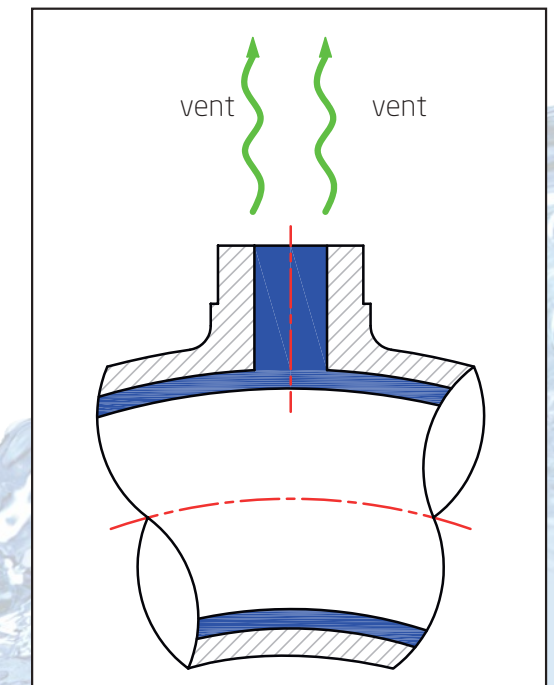
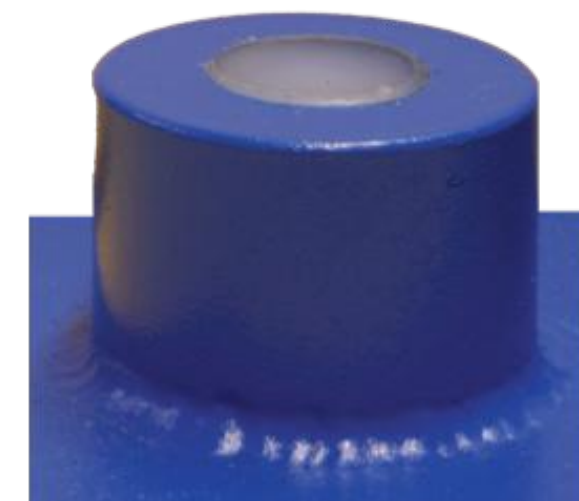
rear side of the flange face. Venting on one side enables the spool to be rotated to put the venting in the most advantageous position and the location longitudinally is chosen to make the routing of vents through insulation jackets easy.



PFA Lined Fittings Vent [b]

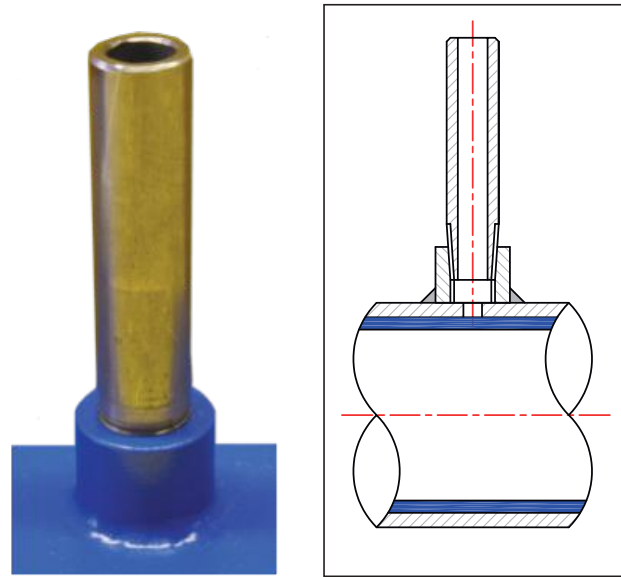
The injection port on a PFA fitting works as a vent in its own right, with a route to

atmosphere around the circumference of the PFA.



PTFE Lined Pipe Spools and Fittings [c]

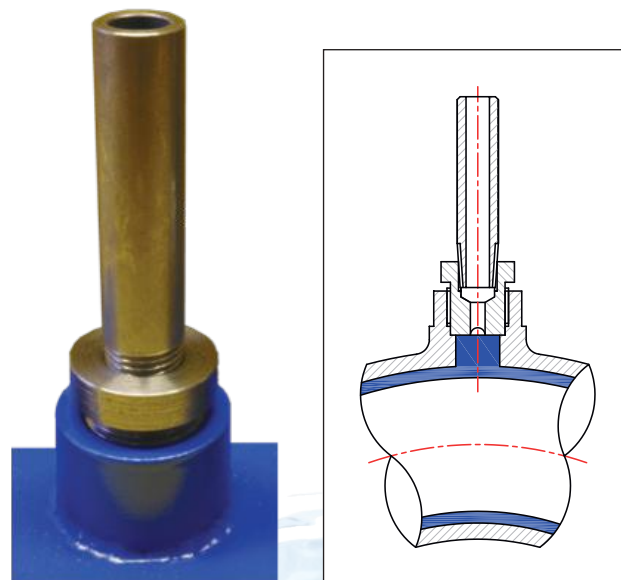
A simple threaded 1/4" BSPP half coupling is welded over each 5mm vent hole and a carbon steel taper threaded pipe is provided to screw into this. The assembled length is 70mm but special lengths can be supplied.



PFA Lined Fittings [d]

A steel reducer is fitted to the PFA injection boss of the fitting and a carbon steel 1/4" BSPT threaded pipe is provided to screw into this. The reducer has a cross slot in a flat bottomed base to provide a route from the lining/steel boundary to atmosphere.

The assembled length is 85mm, but special lengths can be supplied.

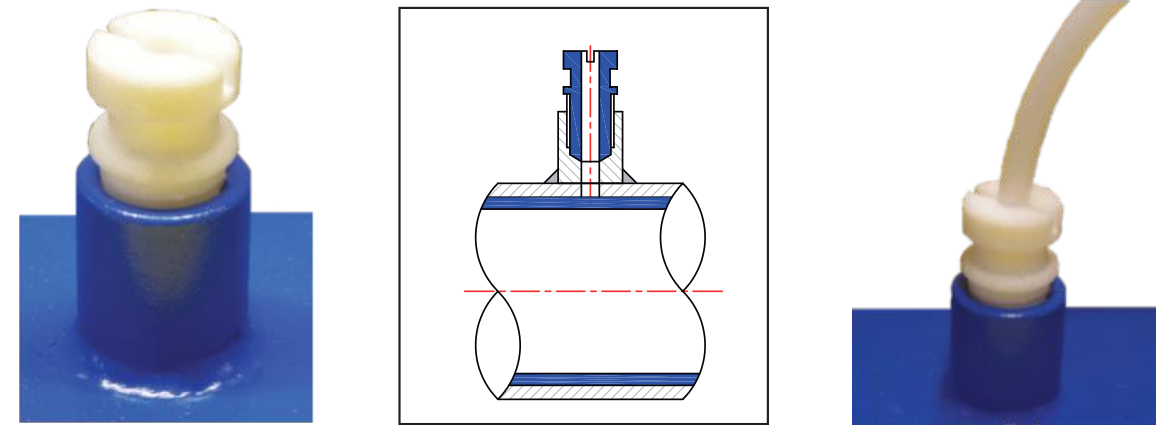


PTFE Lined Pipe Spools and Fittings [e]

A purpose made 5mm hole vent boss is welded to the pipe, with a tapered internal geometry to prevent any dead space arising in the assembly. Into this is

fitted a PTFE vent plug, with a screwdriver slot for fixing and a drip lip to prevent potentially corrosive liquor vented from the plug running back along the outside of

the plug and corroding the vent boss. This system for managing permeation in the following sections (e - i) is referred to as UHP Venting.



This is designed to accept a 5mm PTFE tube for carrying any corrosive liquor to

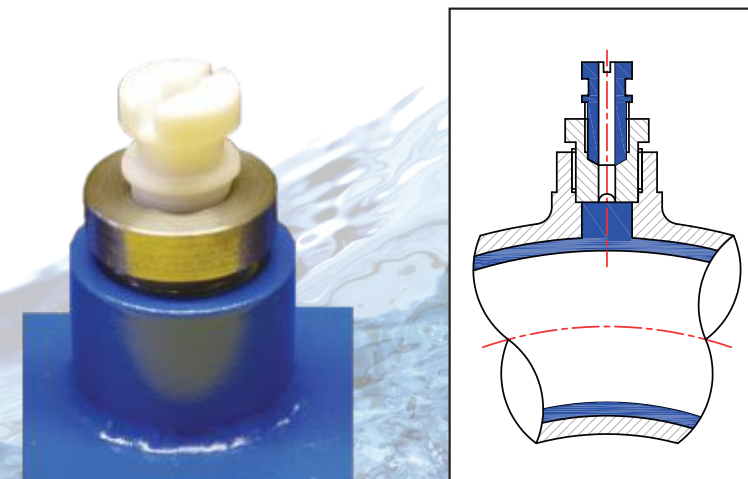
somewhere more harmless to the plant.

PFA Lined Fittings [f]

The injection port on a PFA lined fitting works as a vent in its own right, with a route to atmosphere around the circumference of the PFA. No other measures are required as permeation through PFA lined fittings is none or very

limited. For those customers requiring support for the PFA injection boss a steel adaptor is fitted to the injection port incorporating a flat bottom and cross slot in the base. This prevents the vent route from sealing and avoids dead space within

the fitting. A PTFE vent plug is fitted to this adaptor. This design therefore manages permeation if present, together with providing mechanical support for the PFA injection boss.

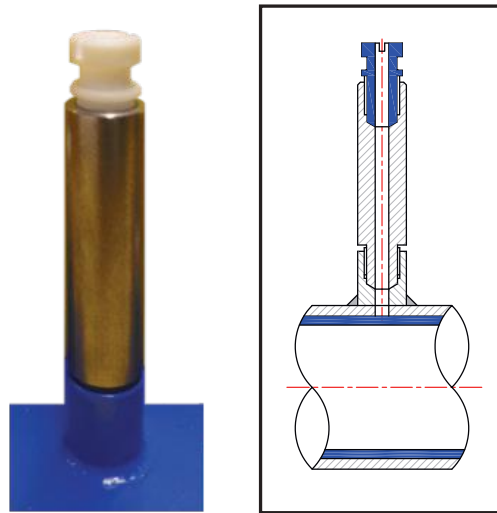


PTFE Lined Pipe Spools and Fittings [g]

A purpose made 5mm hole vent boss is welded to the pipe, with a tapered internal geometry to prevent any dead space arising in the assembly. A steel vent extension is fitted with the same geometry as the vent

boss. Into this is fitted a PTFE vent plug, with a screwdriver slot for fixing and a drip lip to prevent potentially corrosive liquor vented from the plug running back along the outside of the plug and corroding the

vent boss. The assembled length of the steel vent extension is 80mm but special lengths can be supplied.

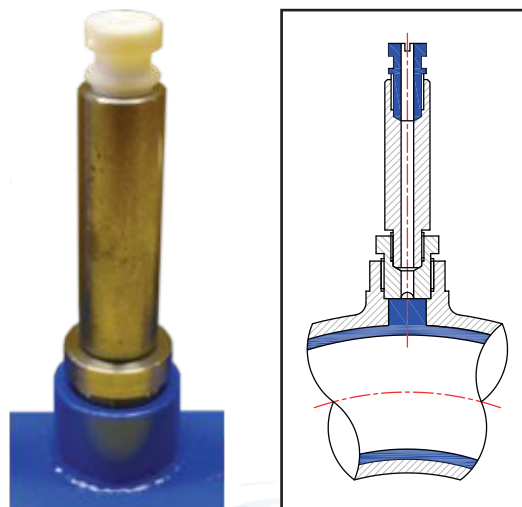


PFA Lined Fittings [h]

A steel adaptor is fitted to the injection port and incorporates a flat bottom and cross slot in the base. The new adaptor has a 5mm hole to prevent blockage. A

vent extension with a 5mm hole is fitted and the new style PTFE vent plug with 5mm hole, drip lip mounted above. The assembled length of the steel vent

extension is 90mm but, special lengths can be supplied.



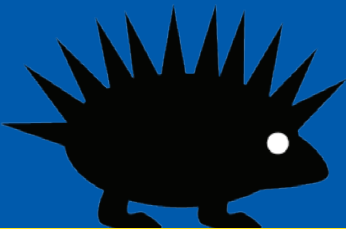
Variable Angle Vent [i]

It is not always possible to direct the vents on lined piping away from walkways, stairwells or open floors. Also vents are often positioned pointing upwards which can allow atmospheric moisture to pool in the hole. This can assist corrosion and cause staff to think they have a process

leak when they don't. To resolve these a vent has been developed which simply clips onto the top of the PTFE vent plug and can be directed in any particular direction with a simple twist. The vent is designed with a drip lip to prevent corrosive liquor running down the side of the plug and corroding

the vent boss. Again, this is designed to accept a 5mm PTFE tube for carrying any corrosive liquor to somewhere more harmless to the plant.





It is good practice to ensure electrical continuity and good bonding to earth of all lined piping on site to prevent any build up of static charge or in the case of any electrical equipment failure prevent any metallic components from becoming live and causing an electrical shock to any operator. In particular a static charge can build to several tens of thousands of volts which can spark and ignite flammable atmospheres with catastrophic results.

The generally accepted value of resistance to avoid problems with plant charging is that there should never be more than 10Ω resistance between any point on the plant and ground. One solution to plant earthing is to use earthing studs or lugs.

Earthing Studs and Lugs

All of the piping products we offer at CRP can be supplied complete with earthing studs - typically M6 x 20mm or earthing lugs generally to the customers own specification

For pipes spools longer than 500mm we would recommend an earthing stud

/ lug is located at each end of the spool. It commonly accepted that all separate parts of a spool or fitting have a stud / lug welded in place, for example whilst a spool three metres long with one rotating flange might have three studs - one on each flange and one on the pipe close to the rotating flange, a cross with all rotating flanges should have five studs - one on each flange and one on the body.

When installed on site the studs / lugs are joined to the adjacent components using common earth jumping connectors much the same as unlined piping and finally properly bonded to a good plant earth.

Please note that it is important not to confuse plant earthing with static dissipation and the use of static-dissipating piping does not negate the need to earth the piping, indeed it is even more critical as any charge dissipated through the steelwork still needs to find an earth.

Conversely, earthing the piping will not on its own manage static charging within the

piping - please see the section on static dissipating (anti-static) lined piping.

Spikies

Spikies used on rotating flanges and star washers employed on bolted joints can provide good earth continuity without the need for studs, lugs or earthing straps. Please see the relevant page.

Fixed Flanges

Although fixed flanges and star washers may remove the need for spikies or earthing straps, their exclusive use has the disadvantage of the challenges of installing pipe spools with fixed/ fixed flanges which cannot accomodate accumulated misalignment that will occur in installation. Please check local regulations for earthing standards.

In order to address the issue of earthing rotating flanged components CRP has developed its range of Spikies®.

Spikies® are simply slipped into place between the loose flange and stub end on a pipe spool or fitting, and the joint made using star washers and studs as on a fixed flange joint. Once in place the centring lugs ensure that the raised points on the Spikies® are positioned to bite into

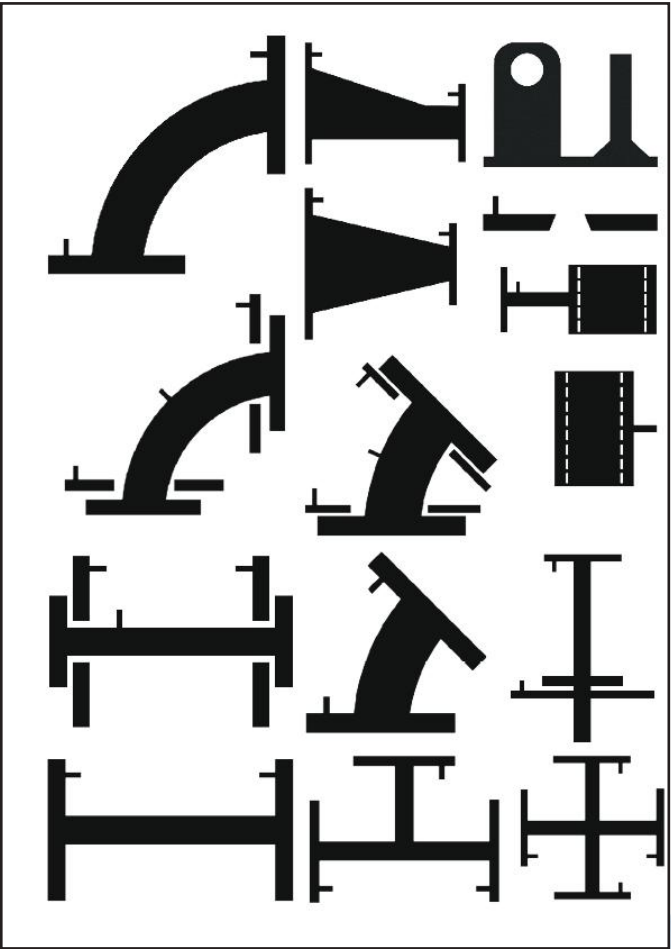
the front of the flange face and the back of the stub end, thus providing earth continuity from rotating flange to fitting / spool.

The extensive design, development and testing programme for Spikies® has ensured that the optimum spring steel substrate and nickel corrosion protection coating materials have been used, along with a design that makes Spikies® a

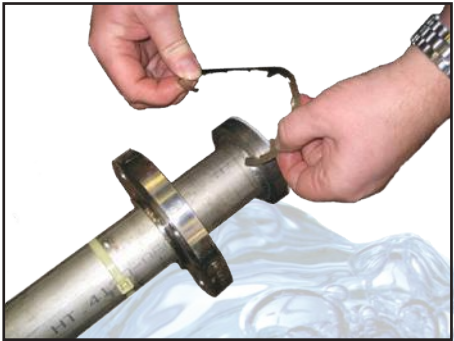
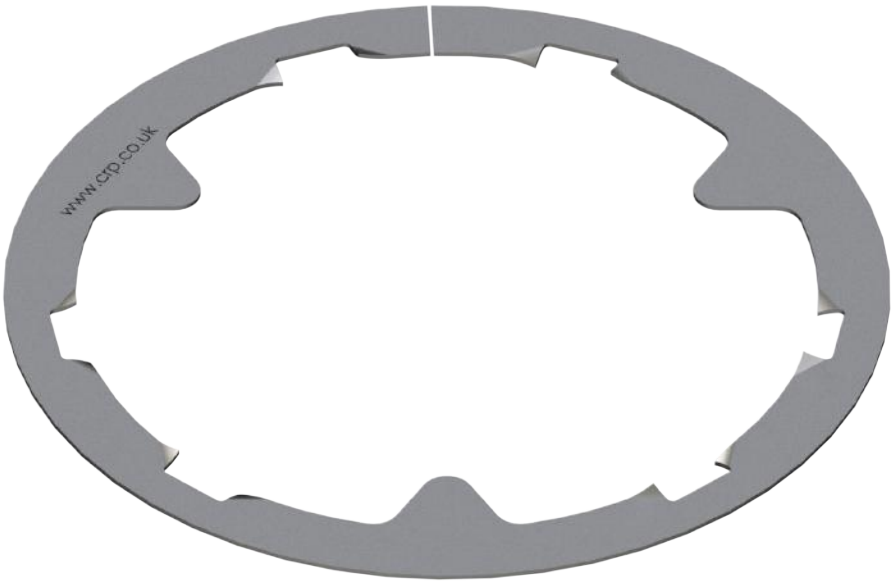
truly durable fit and forget solution to process plant pipework earth continuity issues. The spokie provides a robust and cost effective solution to achieving earth continuity between the pipe body and a rotating flange. It can be supplied factory fitted or can easily be retro-fit in the field.

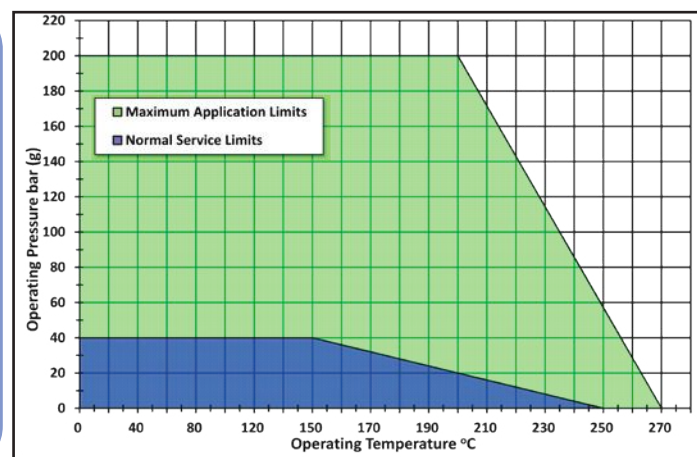
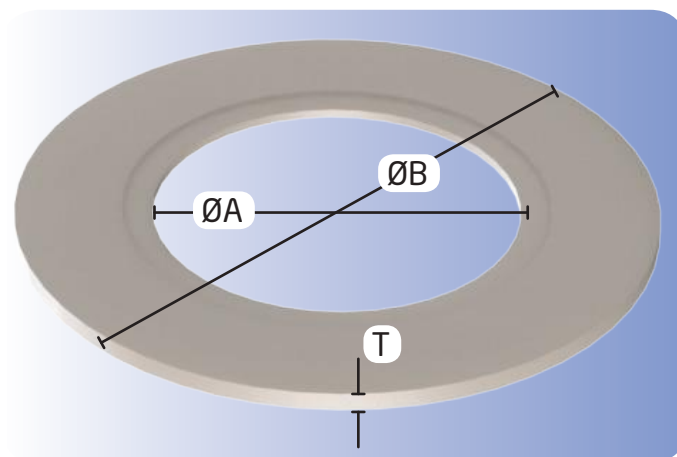
Nominal Bore		To suit Pipe NB
Inches	mm	NPS ¹
½	15	¾
¾	20	
1	25	1
1.1/4	32	1.1/4
1½	40	1½
2	50	2
3	80	3
4	100	4
6	150	6
8	200	8
10	250	10
12	300	12

1 - NPS is Nominal Pipe Size as per ASME B36.1 and ASME B36.19.



Standard Stud or Lug Positioning





Overview

Fluorogask represents the state of the art in gasket technology, a pre-compressed piping gasket produced wholly from multi-directionally expanded PTFE. It is designed for use across the pharmaceutical and chemicals industry combining the corrosion performance and inertness of PTFE with a physical construction that produces an excellent gasket material.

PTFE and PFA lined piping systems do

not usually require gaskets for securely closing their joints. However, there are exceptions to this rule where joints are made and broken regularly, where lined equipment is joined to dissimilar materials or simply when gasketing has been selected as a site wide standard.

Fluorogask fulfills not only the gasketing needs of a lined piping system, but can also be used as the gasket of choice across all piping applications. Capable of meeting all types of flange standards, having almost

universal corrosion resistance and handling a wide temperature, pressure and vacuum range they have countless applications. The multi-directional expanded PTFE improves the mechanical properties of PTFE making it highly conformable enabling it to achieve incredible tightness across a comprehensive range of materials and joint types.

Typical Joint Materials

PTFE and PFA Lined
Glass Lined
GRP/FRP (Please consult)
Glass (Please consult)
Plastic
Metal

Performance

The highly conformable material enables it to seal at low torques and makes it ideal for fragile or glass lined flanges. It is even capable of sealing most damaged flange surfaces.

Its wide application across piping systems enables a large degree of site standardisation and the comfort of knowing that an incorrect gasket hasn't been fitted.

PTFE is non-ageing, weather and UV resistant and can provide a long service life without the need for retorquing.

A pre-compressed core to the gasket reduces diffusion, cross-contamination and migration.

Installation

Manufactured to the requirements of ASME B16.21 the gasket fits the inside bolt circle making it easy to centre and clear that there is a gasket present.

The multi-directionally expanded PTFE has exceptional mechanical strength allowing operation with minimal creep at elevated temperatures.

It is dimensionally stable with the gasket size remaining the same when under load.

The pre-compressed core to the gasket increases its rigidity.

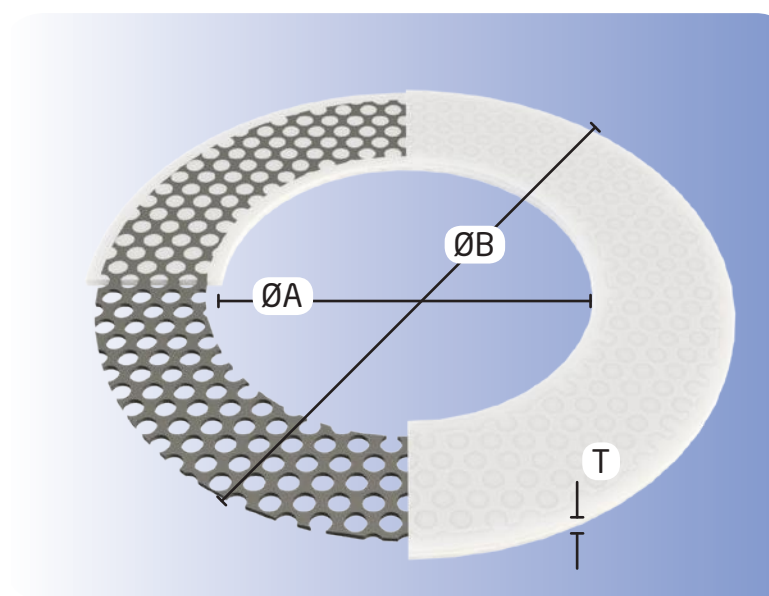
Used gaskets can be removed easily and without residue on the flange surfaces.

Food and Pharmaceutical Use

Manufactured according to GMP requirements and being both FDA and EU1935/2004 compliant the gasket can be used in both the food and pharmaceutical industry.

The pre-compressed bore prevents cross-contamination as pores are not present to trap media.

The gasket can withstand both CIP and SIP processes.



Toughgask reusable gaskets can be used in nearly all applications to seal metallic flange joints. They are far superior and cost effective compared with other designs such as envelope gaskets as they are reusable many times. They are extremely robust and very easy to install.

The Toughgask gasket offers superior performance than a standard virgin PTFE

gasket as its inherent stainless steel core prevents cold flow of the PTFE which can lead to joint failure.

Due to the use of PTFE with its universal corrosion resistance the gasket can aid greatly with site standardisation being suitable for a varied range of applications across the plant.

Lined piping systems do not generally

require gaskets to seal between the flange joints; the PTFE / PFA flange faces provide the seal.

This gasket is suitable for unlined systems and is not specifically designed for lined piping. For gaskets in lined piping service please see our Fluorogask literature.

Toughgask						
Nominal Bore		Thickness	ID	OD	Torque	Weight
		T	ØA	ØB		
Inches	mm	mm	mm	mm	Nm	gm
½	15	2.5	21	45	20	7
¾	20	2.5	27	57	20	11
1	25	2.5	33	66	20	14
1½	40	2.5	48	85	20	21
2	50	2.5	60	104	27	31
2½	65	2.5	73	123	34	42
3	80	2.5	89	136	34	45
4	100	2.5	114	174	47	73
6	150	2.5	168	222	60	89
8	200	2.5	219	279	68	127
10	250	2.5	273	339	75	171
12	300	2.5	324	409	82	264
14	350	3.0	356	450	95	386
16	400	3.0	406	514	102	506
18	450	3.0	457	549	108	471
20	500	3.0	508	606	115	556
24	600	3.0	610	717	122	723

Introduction

Safety Shields are designed to minimise the impact of a leak or spray out from a piping system joint through pressure dissipation. In the case of a small leak the temporary containment they give can provide valuable time to enable detection of the leak and shut down the system before it becomes more serious. In the case of a catastrophic failure causing spray out, the safety shield serves to reduce the effect of the system line pressure and route the leak along the pipe rather than directly at you or your colleagues.

Safety Shields can therefore act as a key part of a risk reduction programme for use with equipment conveying hazardous materials, be they chemicals, high temperature fluids or flammable products.

They can assist in achieving the safety requirement of the Pressure Equipment Directive.

Their application can be plant wide if there is a high level of risk across a site, or specific to lines handling dangerous substances or lines in potentially hazardous locations such as above or alongside walkways.

Flange Shields

Flange shields are available as standard for ASME and DIN flanges for all popular nominal bores and can be manufactured for sizes up to 40 inches (DN 1000).

The most universal and popular product comprises two layers of woven PTFE coated fibreglass cloth for the side pieces and a high temperature FEP viewing window. The draw cords and sewing threads are manufactured from Nomex® the flame resistant meta-aramid. The viewing strip enables complete visual inspection and the product is fire, tear and UV resistant with a continuous operating temperature of 200°C, and near universal chemical resistance.

A product option is to have a PTFE drain attached. This can route any leak to site containment using PTFE tubing as a push fit. This is popular in high traffic areas or where sensitive electronic equipment is in the vicinity. Alternatively it can act as a drain for leaks, a vent for rainwater or moisture or as an emissions test port. It is also possible to fit pH indicator paper to indicate the presence of acids or alkalis.



Flange Shield



Flange Shield with PTFE Drain



Bellows Shields

The shield style for bellows is a double layer PTFE coated woven fibreglass cloth, with a clear high temperature FEP viewing window. The special FEP provides nearly universal chemical and UV light resistance and a 200°C upper performance. As standard these are available for 2-5 convulsion bellows with ASME or DIN flanges in all nominal bores up to 40 inches (DN 1000).

As non-metallic bellows generally only have a single layer of PTFE or rubber between the media and the outside world and as by definition they are subject to flexible movement throughout their lives, we strongly recommend safety shields on bellows applications. These shields are suitable for PTFE, rubber and metallic bellows and are of course designed to function with the range of movements expected in the bellows.

Valve Shields

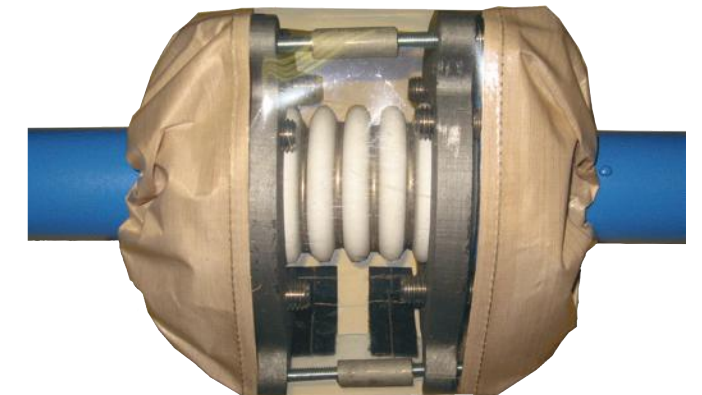
As a universal choice for valve shields we recommend the PTFE woven glass cloth shield with a clear high temperature FEP viewing window. Valve shields are available for all types of valve including ball, check, butterfly, gate, plug, diaphragm, control and globe with bonnet shields available for gate and globe valves to enable operation. Shields are also available for covering instrumentation, actuators and electronics to protect them from local atmospheric conditions. Because valve dimensions vary from manufacturer to manufacturer even on the same style of valve it is necessary to provide information on the specific valve types.

High Temperature and Pressure Flange Shields

For 1100°C and 200 Bar performance there is a 316 stainless steel shield available.

The stainless steel band securely clamps around the flange (different widths are available). A layer of stainless steel netting around the inside diameter of the shield dissipates any pressurised spray by directing it around the flange circumference. This shield is again designed for fitting without tools, has smooth corners to avoid sharp edges and is designed for the flange bolting to remain visible when fitted.

3 Convolution Bellows Shield



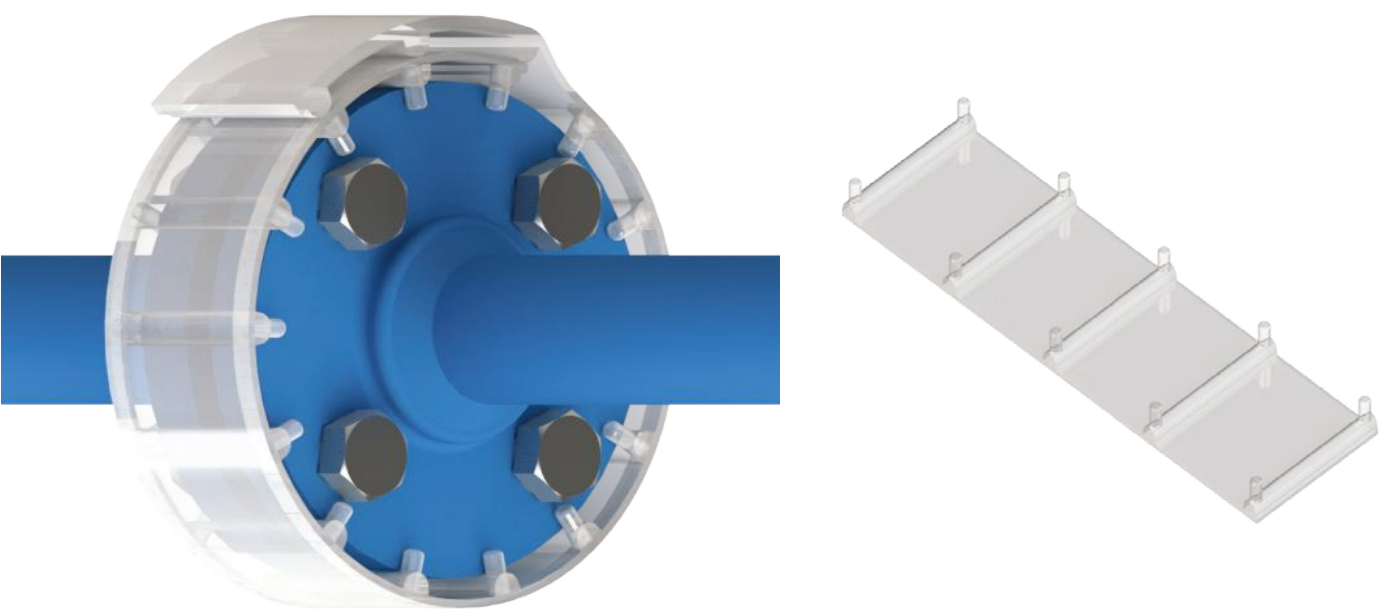
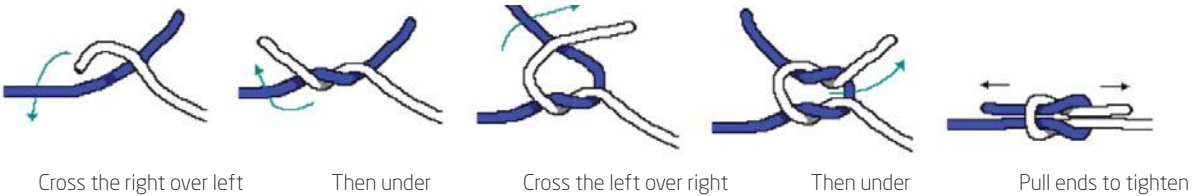
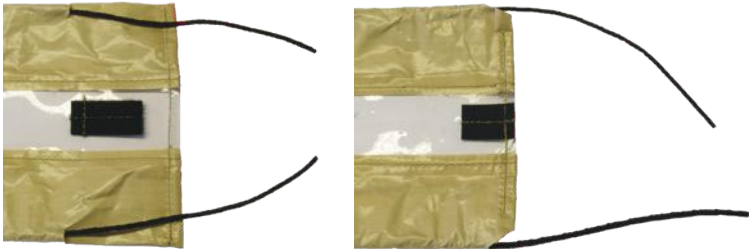
PTFE coated Valve Shield for a Ball Valve



Stainless Steel High Temperature and Pressure Flange Shield

Construction
All of the fabric shields come with Velcro fastenings securely sewn onto the shield fabric. This enables one person to wrap the shield around the flange connection

and complete the fastening in a short time. Well retained drawcords give an easy means of closing the shield. Once wrapped around the components the safety shield can be securely tied using the drawcords and a simple reef knot enabling installation by one person in less than a minute.



Flange protection tape is used to protect personnel from uncontrolled spray out from a failing flange joint. They should always be considered when installing any piping system carrying toxic or corrosive chemicals. By controlling the leak and protecting personnel and surrounding plant from chemical contact they can save both money and can be a key part of any risk mitigation for personnel.

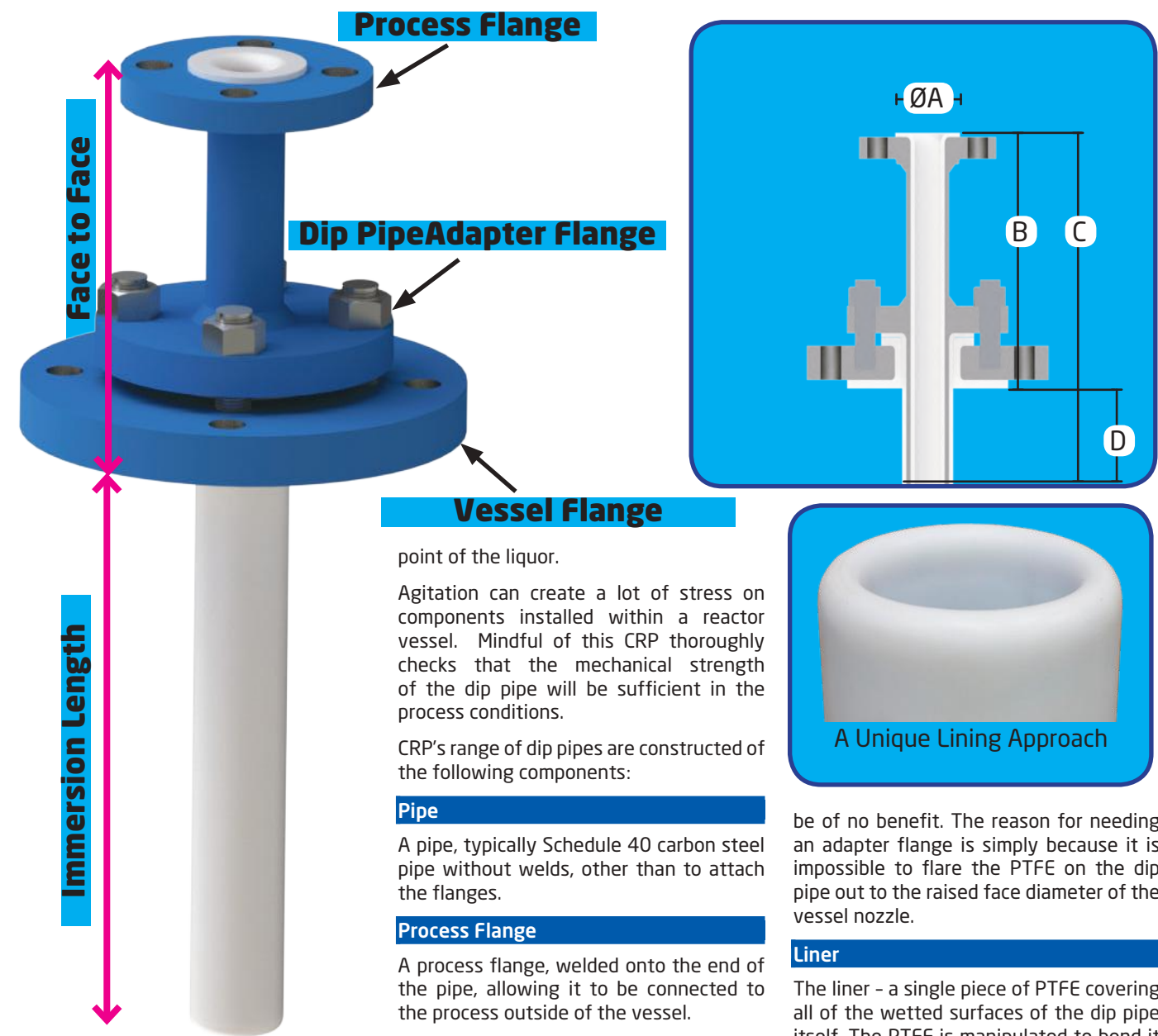
The flange tape is supplied in a roll, making

it ideal as a maintenance stores item, each width covering a range of flange to flange sizes. The correct length is simply cut from the roll, wrapped around the flange joint and secured with a small stainless steel self-tapping screw.

The basic function is one of deflecting the spray out from the joint, significantly reducing the chance of a pressurised spray hitting personnel. The spray shield is suitable for piping at temperatures

from -40° to 110°C and manufactured in polypropylene it will withstand a broad range of exposure to chemical environments. Available in 50 metre rolls - or smaller lengths if required there are five widths in the range, but three of the sizes cover the bulk of sizes. Of course this is not just a lined piping product and can be used successfully with many piping materials involving flanged joints.

Flange Protection Tape						
Nominal Bore		Required Length	Tape Width			Weight Per Metre
			F/F	F/R	R/R	
Inches	mm	mm	mm	mm	mm	gm
½	15	360	50	50	70	70
¾	20	390	50	50	70	70
1	25	400	50	50	70	70
1½	40	460	50	70	70	70
2	50	540	50	70	100	100
3	80	660	70	70	100	100
4	100	780	70	100	100	100
6	150	940	70	100	100	100
8	200	1140	70	100	140	140
10	250	1340	70	100	140	140
12	300	1580	100	100	140	140
14	350	1740	100	140	140	140
16	400	1940	100	140	140	140
18	450	2060	100	140	140	140
20	500	2260	100	140	180	180
24	600	2620	140	140	180	180



Dip pipes have a wide array of uses. Typically they are used to charge a reactor below the liquid level, to extract samples from the reactor as part of one of our sampling systems, or to extract liquid from a vessel without the need of a side or bottom outlet.

CRP dip pipes are manufactured from a carbon steel fabricated construction with a continuously lined paste extrusion PTFE liner referred to as an CLDP. One piece of PTFE liner covers and protects both the inside and outside of the dip pipe. Our advanced manufacturing techniques enable us to produce a dip without any pinched or welded ends eliminating a potential source of failure.

Dip pipes can be supplied straight or curved to precisely position the discharge

point of the liquor.

Agitation can create a lot of stress on components installed within a reactor vessel. Mindful of this CRP thoroughly checks that the mechanical strength of the dip pipe will be sufficient in the process conditions.

CRP's range of dip pipes are constructed of the following components:

- Pipe
- A pipe, typically Schedule 40 carbon steel pipe without welds, other than to attach the flanges.
- Process Flange
- A process flange, welded onto the end of the pipe, allowing it to be connected to the process outside of the vessel.
- Vessel Flange
- The vessel "flange". This flange is attached part way along the dip pipe to allow it to be connected onto a port in the top of the vessel. With a CLDP it is usually necessary to make the vessel flange from two parts.
- (i) a flange welded to the dip pipe itself and shows as welded above
 - (ii) an adapter flange, bolted to the flange on the dip pipe.
- Adapter Flange
- This adapter flange is much the same as a reducing flange, except that its bore is larger than on an equivalent reducing flange, since it has to allow the lined dip pipe through it rather than be the same as the lined bore of the smaller nominal bore size of the reducing flange. Also, they are parallel bore - a tapered bore would

be of no benefit. The reason for needing an adapter flange is simply because it is impossible to flare the PTFE on the dip pipe out to the raised face diameter of the vessel nozzle.

Liner

The liner - a single piece of PTFE covering all of the wetted surfaces of the dip pipe itself. The PTFE is manipulated to bend it back on itself to allow this to be done. The main advantage is that there are no welds in the PTFE to act as a weak point in the construction. Please note that the adapter flange is usually PFA moulded.

General Design

Dip pipes are available in the size range 1" - 6" nominal bore.

They are rated from -29°C to +200°C at full ASME150 line pressure (i.e. same range as for spools).

All dip pipes are full vacuum rated. For 3", 4" and 6" nominal bore an inner vacuum liner is fitted to ensure that the liner doesn't collapse under vacuum at high temperature. We can supply vacuum liners for the smaller dip pipes too, although

they are not necessary.

Dip pipes have a single vent hole in the steel pipe, typically equispaced between the vessel and process flanges.

We can offer dip pipes made of stainless steel, and also manufactured from Schedule 80 pipe.

Typically the face-to-face length of a dip pipe is 150mm, although we can make this longer and also somewhat shorter.

The process flange can be fixed (usual) or rotating.

The maximum total length of dip pipe that can be manufacture is about 3000mm.

For lined vessels, the vessel flange usually needs to be two sizes larger than the nominal bore of the dip pipe, although sometimes a dip pipe will fit down a nozzle only one size larger than the dip pipe. (Typically a nozzle is made of Schedule 40 pipe, with approximately 4mm per side of glass lining. CRP dip pipes are made of Schedule 40 pipe with 3mm per side (approximately) of lining up the outside, and with something of a bull nose at the tip. Usually a one pipe size difference between nozzle and dip pipe is insufficient to cope with these two layers of linings).

Curved dip pipes can be produced (not in

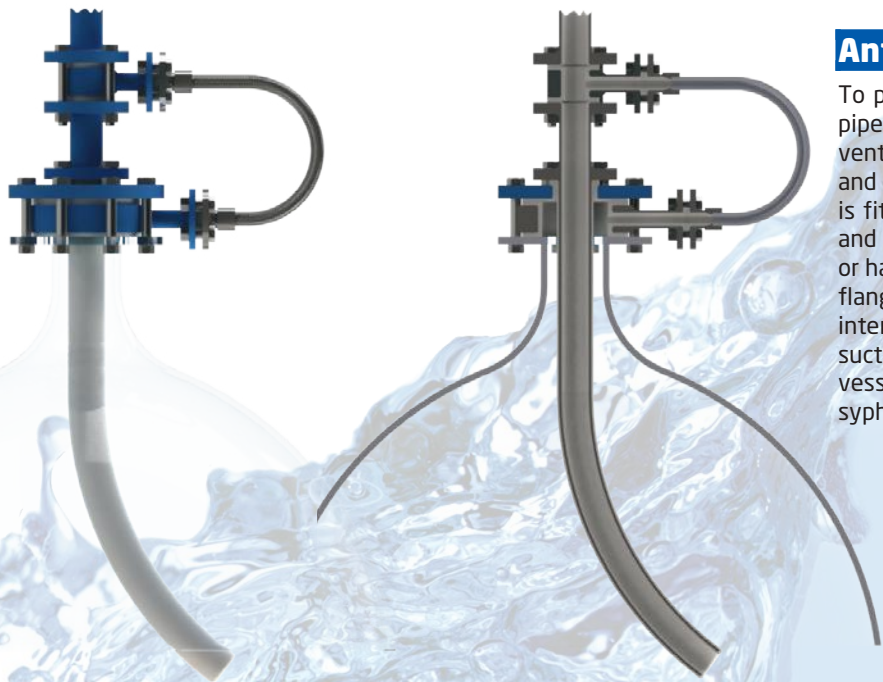
4" or 6" NB), but the curve has to be very gentle (500mm minimum bend radius), and not with a long straight before the start of the curve.

Screwed and pinned construction solid PTFE dip legs are available, enabling the production of a sharp bend or if a spray ball is required.

CRP has stress calculation model for straight dip pipes in agitated vessels.

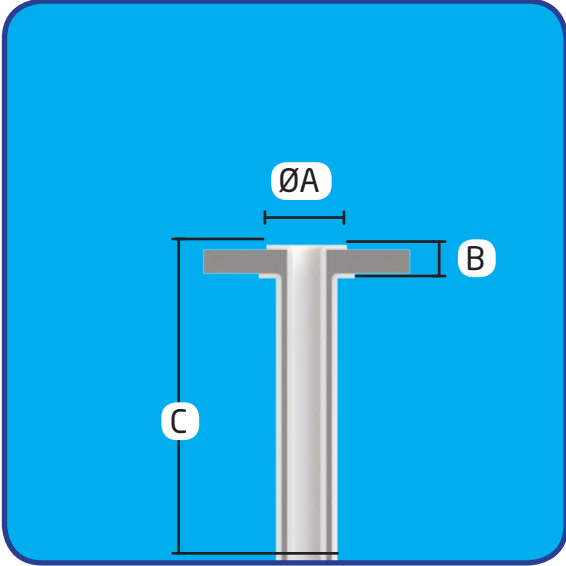
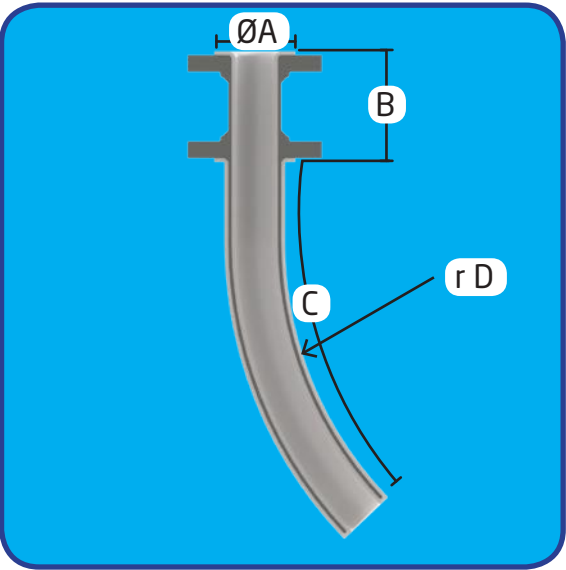
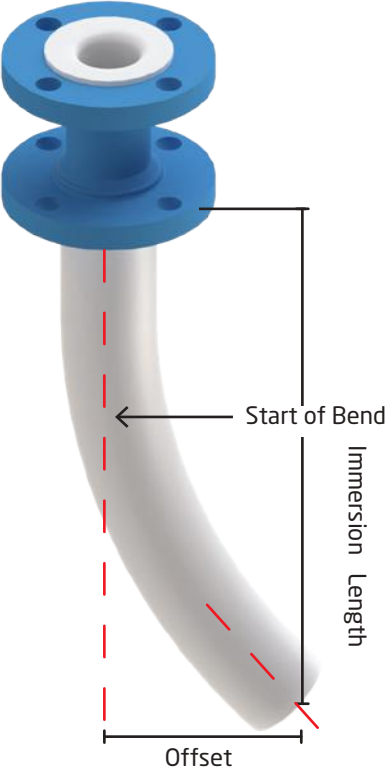
To assist in determining a specification for a particular dip pipe a questionnaire is available to download from our website.

Dip Pipe								Construction Codes	
Nominal Bore		Process Flanges Size	Maximum Vessel Flange Size	Process Flange Raised Face	Face to Face Standard	Maximum Total Length	Maximum Immersion Length	Code	Lining
								Steelwork	
Inches	mm	inch	inch	mm	mm	mm	mm		Construction
¾	20	¾	24	43	150	1000	850	CP	Cast Steel PFA
1	25	1	24	51	150	3000	2850	CT	Cast Steel PTFE
1½	40	1½	24	73	150	3000	2850	FP	Fabricated Steel PFA
2	50	2	24	92	150	3000	2850	FT	Fabricated Steel PTFE
3	80	3	24	127	150	3000	2850		
4	100	4	24	157	150	3000	2650		
6	150	6	24	216	150	2000	1850		



Anti-syphon System

To prevent liquor being drawn up the dip pipe we can supply anti-siphon systems to vent the dip pipe safely within the reactor and create an air break. An instrument tee is fitted on the top of the process flange and connected to another via a PTFE hose or hard piping to another below the vessel flange and having access to the vessel interior. Under any condition inducing suction gases are drawn from within the vessel rather than the contents being syphoned out.



Curved dip pipes have a variety of uses. They can be used to introduce liquor into a vessel directing it to the side of the vessel wall to lessen the gas bubbles created if directed directly onto the liquid level surface reducing the froth that may be created encouraging a gentler introduction of the media into the vessel. They can also be used to position the discharge close to an agitator blade to provide a very effective mixing of the liquid into

the vessel. Where vessels have multiple dip pipes the dip pipe discharges can be positioned to direct flow away from each other to mix effectively with the vessel contents. As we are lining curved dip pipes with straight liners we are not able to produce dip pipes with tight radii, we need a gradual curve so that we do not cause deformations and ripples on the inside

of the bend. Also consideration has to be taken that that the curved dip pipe will actually fit through the nozzle of the vessel. If the vessel nozzle is not much larger diameter than the dip pipe then the curve will prevent this being inserted through, here again a gradual curve helps in these situations. Please consult us to determine what can be achieved.

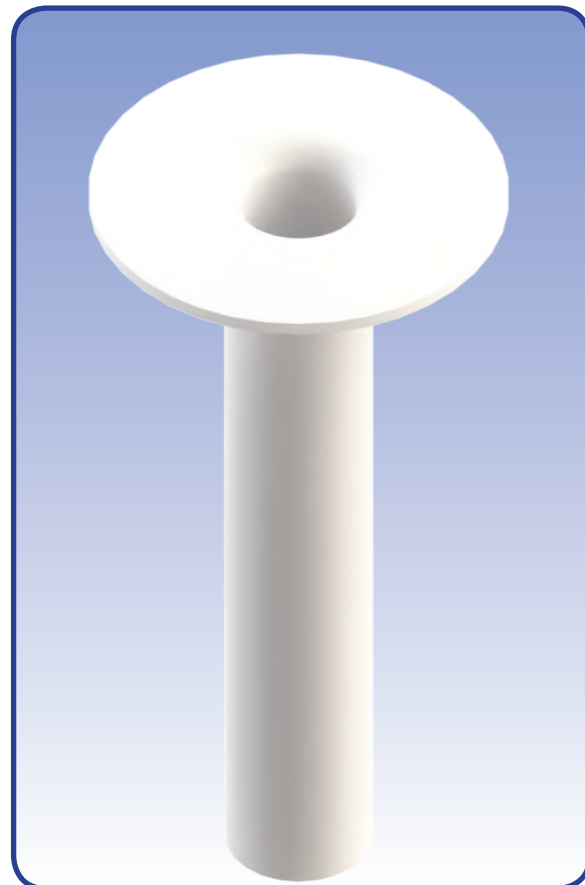
A dip leg is simply a dip pipe without an upstand, this does allow some space saving around a reactor head, If bolting to a reactor vessel flange they typically will have an adaptor flange too as the

connection needs to have a large enough bore to allow the lined dip leg to pass through. Dip legs can also be bolted directly to a pipe discharge straight into a tank or vessel without the need for

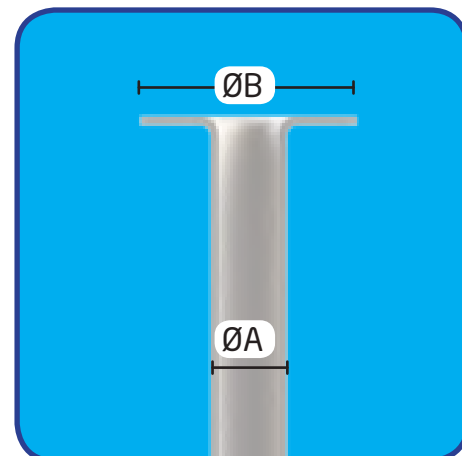
support from a vessel lid etc.

Curved Dip Pipe								
Nominal Bore		Process Flange Size	Maximum Vessel Flange Size	Process Flange Raised Face	Face to Face Standard	Maximum Curve Length	Minimum Bend Radius	Construction
				Ø A	B	C	r D	
Inches	mm	inch	inch	mm	mm	mm	mm	
¾	20	¾	24	43	150	950	500	FT
1	25	1	24	51	150	2900	500	FT
1½	40	1½	24	73	150	2900	500	FT
2	50	2	24	92	150	2900	500	FT
3	80	3	24	127	150	2900	500	FT
4	100	4	24	157	150	2900	500	FT
6	150	6	24	216	150	1900	800	FT

Dip Leg					Construction Codes	
NB		Raised Face Ø A	Face to Face Standard B	Maximum Length C	Code	Lining
					Steelwork	
Inches	mm	mm	mm	mm	Construction	
¾	20	43	17	1000	CP	Cast Steel PFA
1	25	51	20	3000	CT	Cast Steel PTFE
1½	40	73	24	3000	FP	Fabricated Steel PFA
2	50	92	25	3000	FT	Fabricated Steel PTFE
3	80	127	30	3000		
4	100	157	29	3000		
6	150	216	34	2000		



Where there is little need for mechanical strength offered by CRPs lined steel dip pipes, CRP's Entry pipes can be an ideal low cost solution to introduce liquor into a storage vessel etc.. They are manufactured from paste extruded PTFE flared one end to raised face dimensions to connect between suitable mating flanges. They can be supplied in any length up to 6000mm long and generally available in sizes from



1" to 6"NB. Entry pipes are often used to protect the bores of glass lined vessels from mechanical damage, being a sacrificial sleeve. We can supply custom sized liners to ensure correct fit in existing nozzles etc.

Entry Pipe					
NB		Pipe OD	Raised Face	Maximum Length	Material
		Ø A	Ø B		
inches	mm	mm	mm	mm	
½	15	16	35	6000	PTFE
¾	20	21	43	6000	PTFE
1	25	27	51	6000	PTFE
1½	40	41	73	6000	PTFE
2	50	53	92	6000	PTFE
3	80	78	127	6000	PTFE
4	100	102	157	6000	PTFE
6	150	154	216	6000	PTFE
8	200	203	270	3000	PTFE
10	250	254	324	3000	PTFE
12	300	303	381	3000	PTFE
14	350	333	413	3000	PTFE
16	400	381	470	500	PTFE
18	450	429	533	500	PTFE
20	500	478	584	500	PTFE
24	600	575	692	500	PTFE

A Guide For Those New to Lined Piping

Lined piping is a term generally associated with PTFE and PFA piping systems in which a lining is either fitted or moulded into a metal housing. It should not be confused with line pipe – a term used for steel piping to be used in pipelines and one should also be aware that lined pipe can have other plastic materials acting as the lining.

Lined piping comprises an assembly of individual components, generally connected by bolting flanges together in the field. This is because unlike all metal or plastic systems, the technologies and materials involved does not allow it to be site manufactured. This is not universally true as there are some components designed specifically for field fabrication, but these are used for local convenience and it would be unusual to build a plant from these products.

Each individual component comprises an outer housing – usually of carbon or stainless steel. The purpose of this is to provide the mechanical strength element of the piping system and give a means of connection of adjacent components. It is fair to say that these elements in following international design standards created for standalone steel systems are significantly overspecified in terms of pressure, temperature and vacuum capability. There is no disadvantage in this, however, one does not need to focus on aspects of steelwork integrity such as weld porosity which are not relevant in a lined system. It is much more important to consider the lining itself and therefore obtain an understanding of these materials and processes.

Lining

Components are then lined in either paste extruded PTFE or PFA. PTFE is generally used for straight lengths of piping (pipe spools) and PFA for pipe fittings – elbows, tees, etcetera. PFA has all of the performance characteristics of PTFE and some more and is suitable for the more complex fittings components, which have branches or require great dimensional precision. Some fittings are lined in paste extruded PTFE where their geometry is simple, especially when Static-Dissipating materials are selected and commercial considerations enable the use of Static-Dissipating PTFE over Static-Dissipating

PFA.

Finishing

The final element is the external finish, which can be a simple primer/finish coat capable of providing some durability in more benign environments, through to high build multi-coat paint systems for the most corrosive environments in coastal chemical plants.

Configuration

The essential design aspect of lined piping is that the straight spools provide the variable element as it is relatively easy to manufacture these at different lengths, whilst the fittings are manufactured to standard dimensions, which all remain the same within a bore size. This allows interchangeability without complete system redesign and provides the easiest and cheapest way of applying a product that has a complex manufacturing cycle and is unsuited to site running. Changes of direction are most cost-effectively accommodated by having rotating flanges on the pipe spools and fixed flanges on fittings.

Fluoropolymers

Fluoropolymers are ideal for bulk chemical, agro-chemical, fine and speciality chemical, pharmaceutical and biopharmaceutical processing equipment because they have excellent chemical and thermal resistance. Their molecules have continuous non-reactive surfaces and are compatible with virtually all chemicals and solvents. They are far more resistant to chemical attack than conventional chlorinated and hydrocarbon polymers, and have far higher service temperatures.

There are a number of materials in the Fluoropolymer family. PTFE (Polytetrafluoroethylene) is the original Fluoropolymer, discovered by DuPont in 1938. From this original development there have been a number of other materials developed – trying to improve on the difficult processing characteristics of PTFE. These have been more or less successful, having to trade properties of PTFE in order to attain other characteristics. The principal materials

used in the industries that we serve are:

- PTFE
- PFA
- FEP
- PVDF
- ETFE

PTFE

PTFE is not melt-processable and therefore usually needs to be formed into the required shape prior to sintering.

PTFE comprises both carbon and fluorine atoms, as a straight chain molecule, the carbon backbone being protected by a helix of the fluorine atoms wrapped around it. This carbon fluorine bond is one of the strongest chemical bonds and gives the material its properties of corrosion resistance and non-stick.

Key Properties of PTFE

Chemically Inert

PTFE resists the most aggressive organic and inorganic chemicals and solvents over a broad temperature range. This includes:

- Strong mineral acids
- Inorganic bases
- Inorganic oxidising agents
- Salt solutions
- Aldehydes
- Chlorocarbons
- Organic Acids
- Anhydrides
- Aromatics
- Alcohols
- Ketones
- Esters
- Fluorocarbons
- and Others

Electrical Properties

The ability to resist an electrical charge is measured by surface and volume resistivity. In the case of PTFE these figures are colossal. Depending upon how the test work is performed, values in excess of 10¹⁷Ωcm are considered minimum. In the case of equipment lined for the chemical and pharmaceutical industry this property can be a nuisance as PTFE lined equipment may build up electrostatic charges and be unable

to dissipate them. This is considered elsewhere in relation to static-dissipating materials.

Low Friction

PTFE has a very low coefficient of friction and for all calculation purposes it can be considered hydraulically smooth,

Thermal Stability

PTFE retains useful properties (i.e. not more than 15% loss of chemical resistance) at up to 200°C and sometimes beyond depending upon the application. In fact it has the highest retention of its chemical properties of any known plastic like material. (Please be wary of materials performance data stating that PTFE has an upper service limit of 260°C. This is true in a laboratory situation, but in service most material properties such as mechanical strength will have been lost preventing it from performing a useful duty.)

PTFE Paste Extrusion

CRP uses the most expensive grades of PTFE to produce the uniquely manufactured HiPerFlon. These are coagulated dispersions, often referred to as fine powders. These have a very close process control of grain size range and are uniquely capable of being sheared by lubricated paste extrusion into a coherent fibrous matrix with useful structural integrity. Pipe liners for the chemical and pharmaceutical industry are almost universally manufactured from HiPerFlon. The paste extrusion process provides the highest level of surface finish, the

highest resistance to permeation and the closest dimensional control of all of the methods of lining in PTFE. This serves to differentiate what we manufacture from processing technologies using lower quality and priced materials - being ram extrusion, mandrel wrapping and isostatic moulding.

Paste extrusion however is only suitable for making straight lengths of PTFE tubing colloquially known as pipe liners in our industry. It can be subsequently manipulated into bends and other simple forms, but is not capable of lining complex shapes without joints.

PFA

PFA (Perfluoroalkoxy) was developed in order to achieve a true melt-processable fluoropolymer. Its characteristics are such that in service it can be considered as interchangeable with PTFE in terms of its chemical service and temperature and pressure duty. It has the highest permeation resistance of the fluoropolymers, exceeding that even of paste extruded PTFE. It also provides the smoothest and least wettable finish of all of the Fluoropolymers. Unfortunately the trade-off is cost, the material being more expensive than PTFE. CRP uses PFA in the production of most of its lined fittings and the Flowserve range of Atomac and Durco valves are available lined in PFA.

FEP

Standard FEP (Fluorinated Ethylene Propylene) is another melt-processable Fluoropolymer. It does not have the

almost universal chemical resistance of PTFE and PFA and its maximum operating temperature in service is 150°C. CRP uses the material occasionally for the manufacture of "sheet lined products". This is essentially a lining made up of sheet and tube elements of FEP welded together in situ. Sheet lining allows one to line complex articles without the use of expensive moulding tools, to cope with the inevitable tolerance errors of welded fabricated steelwork and with the use of bonded linings to provide a degree of vacuum performance. Where the chemical performance and temperature duty are not an issue, the material provides a less expensive alternative to PFA, however it is not used in lined pipe and fittings.

PVDF

PVDF (Polyvinylidene difluoride) is an engineering fluoropolymer and has a more limited range of chemicals performance and an upper temperature limit of 120°C. It has been replaced in many applications by the improved performance of PTFE resins and is not well supported in the market.

Materials Suppliers

It is worth stating that CRP only use fluoropolymers from well respected global producers. This provides confidence in the raw materials in terms of their standards, both quality and consistency of materials and product traceability.

Pressure

The pressure rating of CRP's Class 150 lined piping system is generally driven by the pressure rating of the flanges used. These pressure ratings are detailed in the US standard ASME B16.5, and specifically Class 150 flanges. Within this standard, the pressure rating of flanges is also dependent upon the material of construction, and the operating temperature. Typically, at ambient temperature, the pressure rating of a carbon steel flange is 19.6 bar(g), with stainless steel flanges having a slightly lower pressure rating, the exact values depending upon the grade used. In all cases the pressure rating of flanges also reduces with increasing temperature. Please refer to the pressure temperature

curves below for more detail.

ASME B16.5 Class 300

In reality many chemical processes are much more benign running at only a few bars of pressure. However, if a higher rated pressure system is required, CRP can offer a Class 300 flanged piping system, although the pressure rating in this case is driven by the joint integrity of the PTFE to PTFE flare faces between the flanges, rather than the pressure rating of the flanges themselves. Please consult CRP for more details.

Exceptions

There are three exceptions to this general rule:

Blanking Spades

Here the pressure rating is limited due to the necessity to keep the spade

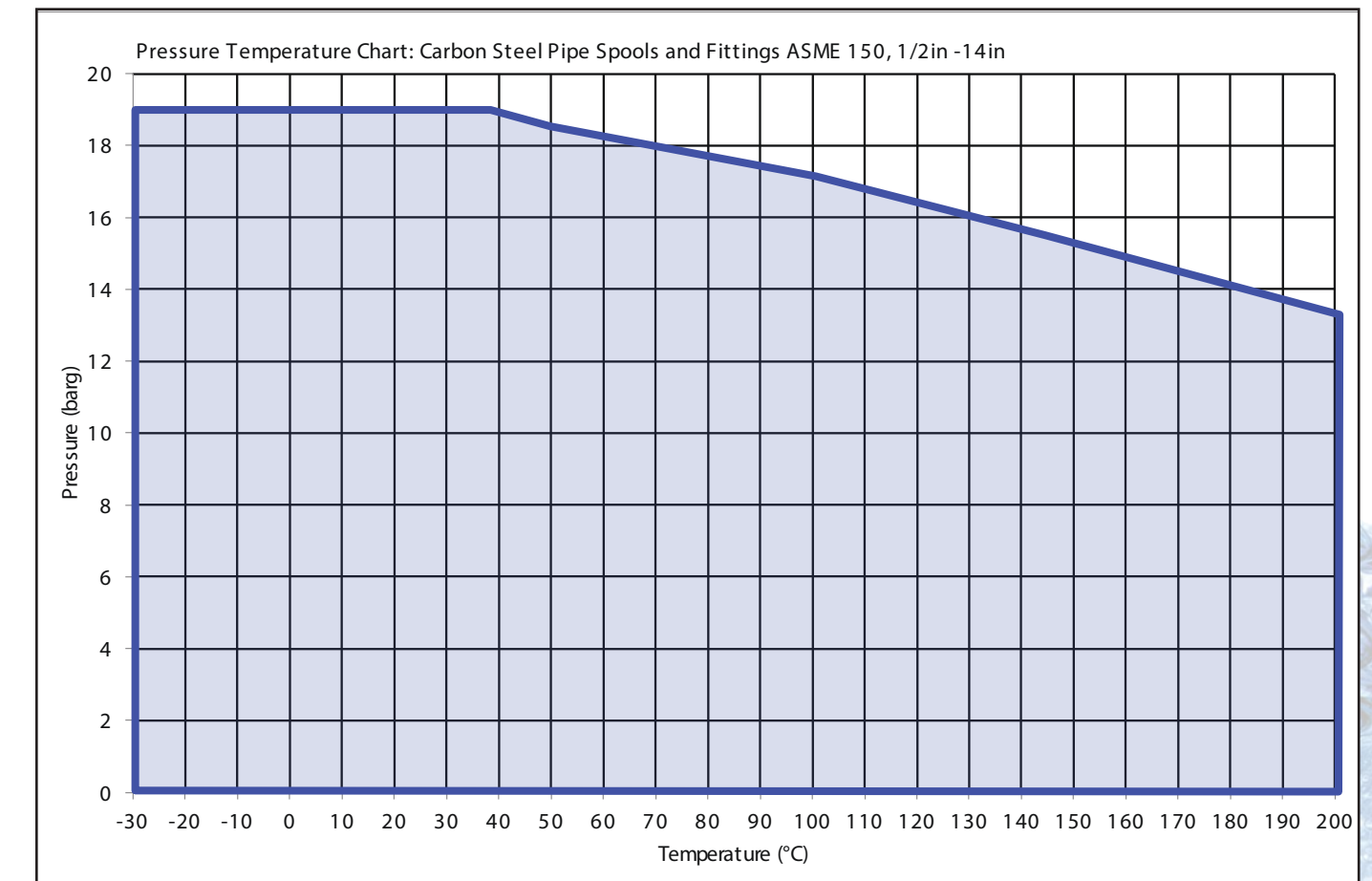
thin enough to be fitted between two flanges. Particularly at larger sizes, this significantly limits the allowable pressure.

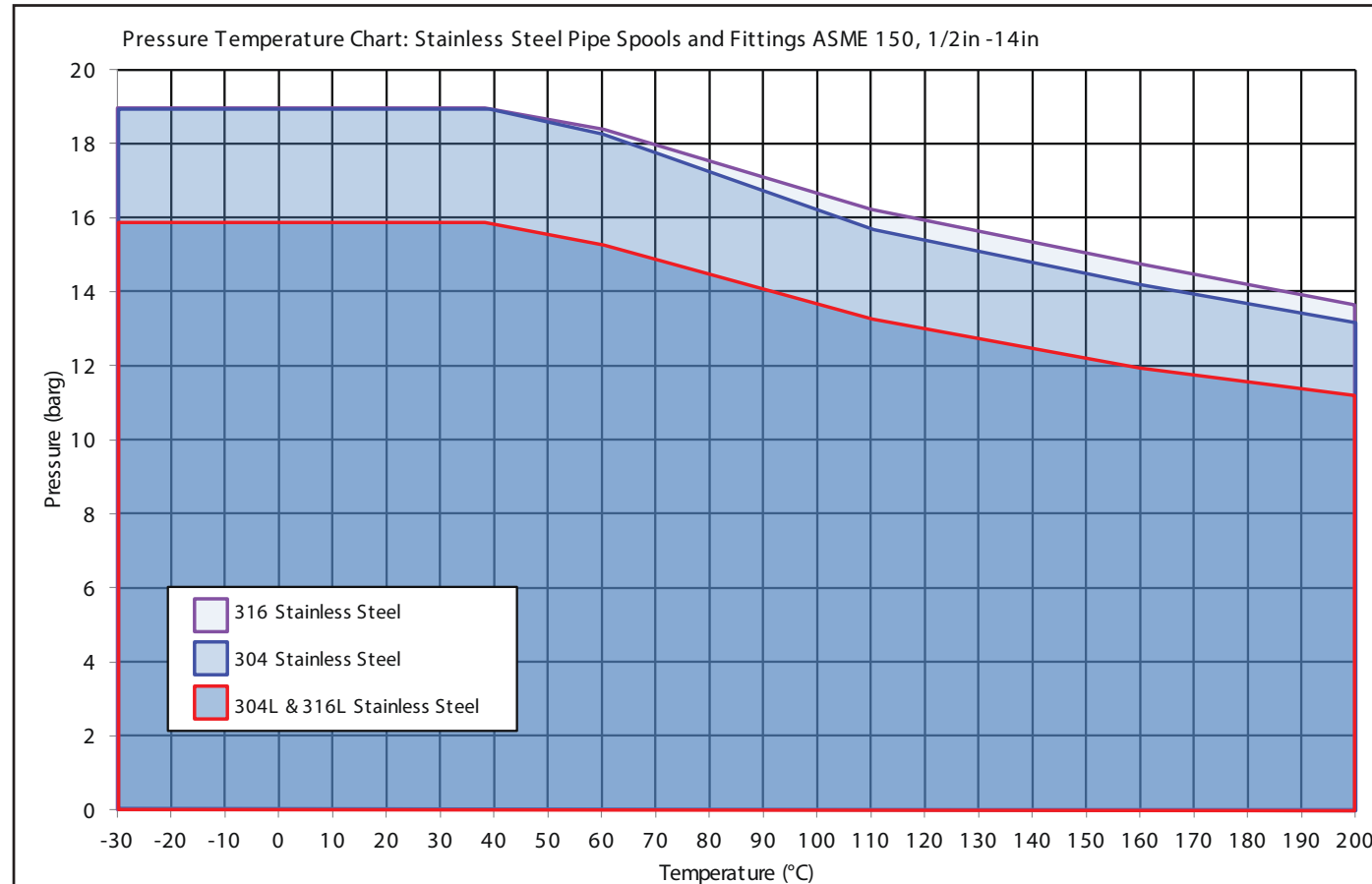
Solid PTFE Sliding Blinds

Here the pressure rating is limited by the fact that the strength of these components comes only from PTFE, there is no steel to provide mechanical strength. Once again, particularly at larger sizes, this imposes significant limits on the pressure rating of these components.

Hose Adapters

In this case the pressure rating is driven by the pressure rating of the hose connection end of the component, which is usually lower than the flange pressure rating.





Temperature

Lower Temperature Limit

For CRP's standard range of carbon steel lined piping, the lower temperature limit is set by the lower operating temperature of the steel housings, -30°C, as detailed in ASME B31.3. PTFE and PFA are both capable of operating down to cryogenic temperatures, and therefore, if operating temperatures below -30°C are required, CRP can offer lined piping systems manufactured using either low temperature carbon steel housings or, more commonly, using stainless steel

housings, which are typically rated to -195°C.

Upper Temperature Limit

This is determined by the mechanical strength of the PTFE/PFA linings used by CRP. While in laboratory conditions, PTFE and PFA retain excellent corrosion resistant properties up to 260°C, as with all polymers, their mechanical properties reduce with increasing temperature, and their thermal expansion rates far exceed those of steel. The consequence of these two factors is that at temperatures over 200°C, the integrity of the joints between individual lined items becomes questionable, as does their vacuum performance.

When specifying a lined piping system,

consideration should also be given to any situations of thermal shock, and the potential for upset conditions (both pressure and temperature).

Vacuum

Vacuum is the most often ignored aspect of lined piping systems and consequently one of the more common causes of failure.

The vacuum performance of a lined piping system is unrelated to the positive pressure rating of the system. Rather it is driven by a combination of: the liner thickness; the degree of interference between the liner and the steel housing; whether the liner is mechanically keyed onto the housing;

and operating temperature. In essence, thicker liners provide more hoop strength to the liner and so resist vacuum better.

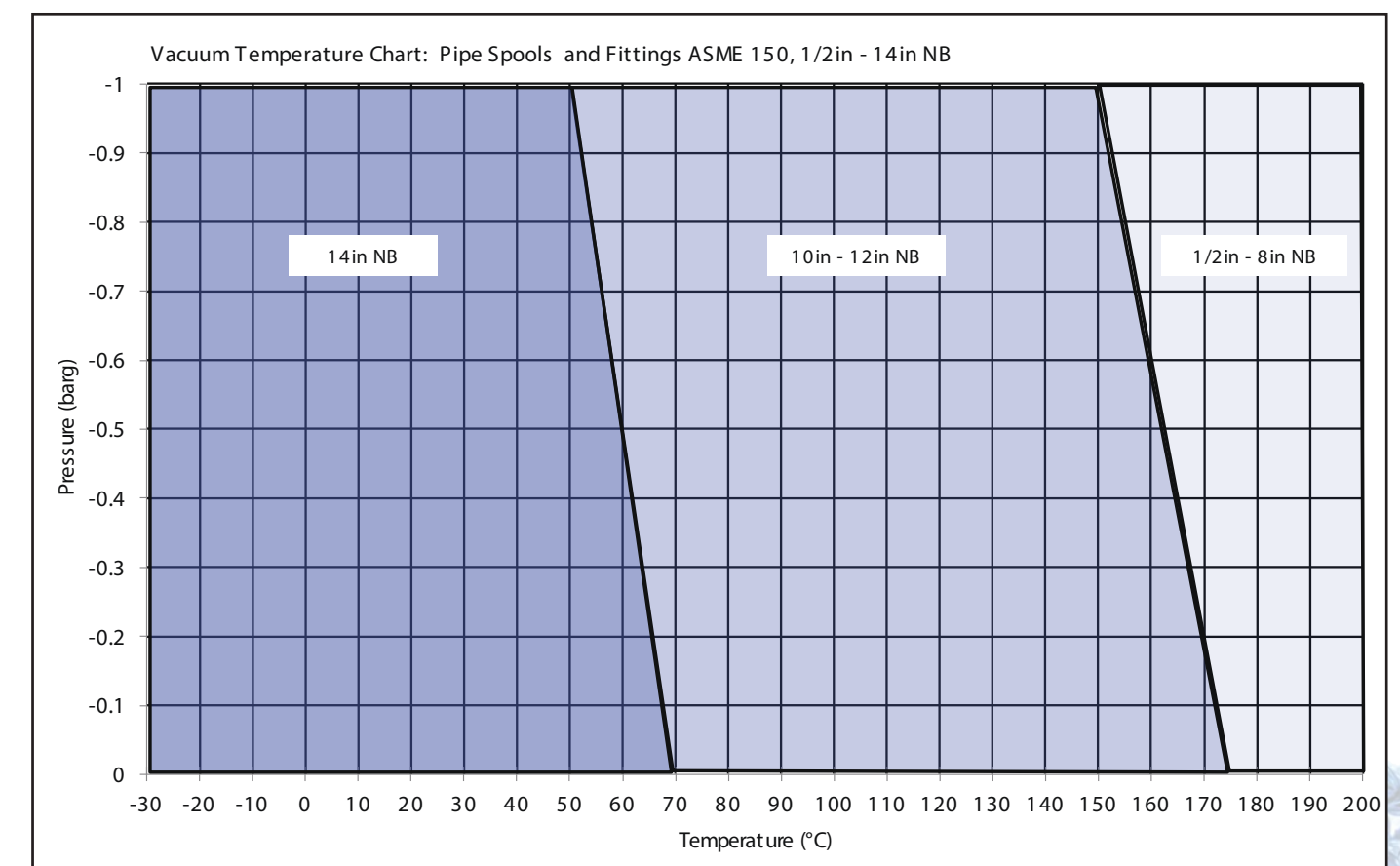
Secondly, liners that are tight in the bore of the housing have a higher vacuum performance than loose liners. This is because, for a tight liner, the steel housing helps prevent the liner from deforming and collapsing under vacuum.

Thirdly, if a liner is mechanically keyed onto the steel housing (only possible for PFA lined components), this provides

additional support for the liner and thus improved vacuum performance.

Fourthly, at higher temperatures, liners have less mechanical strength, and thus a reduced vacuum performance.

By adjusting each of the above factors, CRP's range of lined pipe have the vacuum performance detailed elsewhere in this catalogue.



Materials of Construction																												
Product	Item ↓		Specification ↓	Liner					Carbon Steel					Stainless Steel														
									Fabrication				Cast	Fabrication				Cast										
				Cast/Fabricated	Virgin PTFE	Static-dissipating PTFE	Virgin PTFE	Static-dissipating PTFE	Virgin PFA	Static-dissipating PFA	Pipe	Flange	Stub End	Vent Boss	Vent Extension ⁵	Body	Wrought Fitting	Profile	Casting	Pipe	Flange	Stub End	Vent Boss	Vent Extension ⁵	Body	Wrought Fitting	Profile	Reinforcement
Pipe Spool Van Stone	F	✓	✓	ASTM D4895 Type I	ASTM D4895 Type I + Carbon	ASTM D4894	ASTM D4894 + Carbon	ASTM D3307 Type II	ASTM D3307 Type II + Carbon	API 5L Grade B/ASTM A106 Grade B	ASTM A105	ASTM A516 Grade 60	Free machining Carbon Steel	Free machining Carbon Steel	ASTM A516 Grade 60	ASTM A234 Grade WPB	ASTM A516 Grade 60/ ASTM A105	ASTM A216 Grade WCB	ASTM A312 Grades: 304/304L/316/316L	ASTM A182 Grades: F304/F304L/F316/F316L	ASTM A240 Grades: 304L/316L	ASTM A276 Grades: 304L/316L	ASTM A276 Grades: 304L/316L	ASTM A312 Grades: 304/304L/316/316L	ASTM A403 Grades: 304L/316L	ASTM A403 Grades: 304L/316L	ASTM A240 Grade 304	ASTM A351 Grade CF8/CF8M
Welded Construction Fixed/Rotating Pipe Spool	F	✓	✓							✓	✓	✓	✓	✓					✓	✓	✓	✓	✓					
Welded Construction Fixed/Fixed Pipe Spool	F	✓	✓							✓	✓	✓	✓	✓					✓	✓	✓	✓	✓					
Field Flare	F																											
Spacer Type 1	-			✓	✓																							
Spacer Type 2	-	✓	✓							✓		✓				✓									✓			
Spacer Type 3	-	✓	✓							✓		✓							✓		✓							
90° Elbow	C	✓	✓				✓							✓				✓					✓					✓
90° Elbow	F	✓	✓							✓	✓	✓ ⁴	✓	✓		✓			✓	✓	✓ ⁴	✓	✓	✓		✓		
90° Elbow 3D	F	✓	✓							✓	✓	✓ ⁴	✓	✓		✓			✓	✓	✓ ⁴	✓	✓	✓		✓		
90° Elbow 5D	F	✓	✓							✓	✓	✓ ⁴	✓	✓					✓	✓	✓ ⁴	✓	✓	✓				
45° Elbow	C	✓	✓							✓	✓	✓ ⁴	✓	✓				✓		✓	✓ ⁴	✓	✓	✓				✓
45° Elbow	F	✓	✓							✓	✓	✓ ⁴	✓	✓				✓		✓	✓ ⁴	✓	✓	✓				✓
Equal Tee	C						✓	✓						✓				✓					✓					✓
Equal Tee	F						✓	✓		✓	✓	✓ ⁴	✓						✓	✓	✓ ⁴	✓	✓	✓				✓
Reducing Tee	C						✓	✓		✓	✓	✓ ⁴	✓					✓		✓	✓ ⁴	✓	✓	✓				✓
Reducing Tee	F						✓	✓		✓	✓	✓ ⁴	✓						✓	✓	✓ ⁴	✓	✓	✓				✓
Short Stack Tee	C						✓	✓		✓	✓	✓	✓					✓										
Short Stack Tee	F						✓	✓		✓	✓	✓	✓					✓										
Strainer Tee	C		✓ ¹	✓ ¹			✓	✓		✓	✓	✓		✓				✓			✓	✓	✓					✓
Equal Lateral Tee	C						✓	✓		✓	✓	✓																
Equal Lateral Tee	F						✓	✓		✓	✓	✓		✓					✓	✓			✓					
Reducing Lateral Tee	C						✓	✓		✓	✓	✓		✓					✓	✓			✓					
Reducing Lateral Tee	F						✓	✓		✓	✓	✓		✓					✓	✓			✓					
Instrument Tee	C						✓	✓		✓	✓	✓		✓				✓					✓				✓	
Instrument Tee	F						✓	✓		✓	✓	✓ ⁴	✓	✓					✓	✓	✓ ⁴	✓	✓	✓				
Double Branch Instrument Tee	F						✓	✓		✓	✓	✓ ⁴	✓	✓					✓	✓	✓ ⁴	✓	✓	✓				
Equal Cross	C						✓	✓		✓	✓	✓		✓				✓										
Equal Cross	F						✓	✓		✓	✓	✓ ⁴	✓	✓					✓	✓	✓ ⁴	✓	✓	✓				
Reducing Cross	F						✓	✓		✓	✓	✓ ⁴	✓						✓	✓	✓ ⁴	✓	✓	✓				
Short Stack Cross	F						✓	✓		✓	✓	✓		✓					✓	✓	✓	✓	✓	✓				
Concentric Reducer	C	✓ ²	✓ ²				✓	✓		✓	✓			✓				✓					✓				✓	
Concentric Reducer	F	✓	✓				✓ ³	✓ ³		✓	✓	✓ ⁴	✓	✓		✓			✓	✓	✓ ⁴	✓	✓	✓		✓		
Reducing Flange Taper Bore	F	✓ ²	✓ ²				✓	✓		✓							✓						✓			✓		
Reducing Flange Parallel Bore	F	✓	✓				✓ ³	✓ ³						✓									✓			✓		
Eccentric Reducer	C	✓ ²	✓ ²				✓	✓		✓				✓				✓										
Eccentric Reducer	F	✓	✓				✓ ³	✓ ³		✓	✓	✓ ⁴	✓	✓					✓	✓	✓ ⁴	✓	✓	✓		✓		
Blank Flange	-			✓	✓						✓									✓								
Blanking Spade	-		✓	✓							✓															✓		
Orifice Plate	-			✓	✓		✓ ⁵	✓ ⁵									✓ ⁵									✓ ⁵		
Sliding Blind	-			✓	✓																							
Spectacle Blind	-	✓	✓	✓	✓		✓ ⁵	✓ ⁵									✓									✓		
Toughgask	-			✓																							✓	

1 - Strainer Plate
2 - Certain reductions may be PTFE Lined
3 - Certain reductions may be PFA Lined
4 - For fabricated fittings stub ends are only used with rotating flanges
5 - Optional component

PTFE and PFA Material Properties						
	Units	Virgin PTFE (paste extruded) [ASTM D4895 Type I] (Grades A or B)	Static Dissipating PTFE (paste extruded) [ASTM D4895 Type I] (Grades A or B)	Virgin UHP PTFE (paste extruded) [ASTM D4895 Type I] (Grades A or B)	Virgin PFA [ASTM D3307 Type II]	Static Dissipating PFA
Mechanical						
Minimum Tensile Strength	MPa	20.7	20.7	20.7	26.2	26.2
Minimum Elongation at Break	%	250	250	250	300	300
Hardness	Shore D	55-60	55-60	55-61	55	55
Physical						
Specific Gravity		2.16-2.19	2.16-2.19	2.16-2.19	2,12-2,17	2,12-2,17
Melt Flow Rate when tested to ASTM D3307 at 372°C	g/10 min	n/a	n/a	n/a	2	1.8-2.5
Liner Colour		White	Black	White	Translucent	Black
Water Absorption	%	< 0.01	< 0.01	< 0.02	<0.03	<0.03
FDA Compliant		Yes	Yes	Yes	Yes	No
Thermal						
Thermal Conductivity	W/(m·k)	0.25	0.25	0.25	0.19	0.19
Coefficient of Linear Thermal Expansion						
25°C to 100°C	mm/mm.K	124x10 ⁻⁶	124x10 ⁻⁶	109x10 ⁻⁶		
25°C to 150°C	mm/mm.K	135x10 ⁻⁶	135x10 ⁻⁶	141x10 ⁻⁶		
25°C to 200°C	mm/mm.K	151x10 ⁻⁶	151x10 ⁻⁶	141x10 ⁻⁶		
21°C to 100°C	mm/mm.K				140x10 ⁻⁶	140x10 ⁻⁶
100°C to 150°C	mm/mm.K				180x10 ⁻⁶	180x10 ⁻⁶
150°C to 208°C	mm/mm.K				220x10 ⁻⁶	220x10 ⁻⁶
Flammability		Non Flammable				
Electrical						
Volume Resistivity	Ω.m	>10 ¹⁶	-	10 ¹⁸	10 ¹⁶	0,15-0,25
Surface Resistivity	Ω/£	10 ¹⁷	<10 ⁹	10 ¹⁷	10 ¹⁷	Unavailable

PTFE Liner Dimensions							
Nominal Bore		Liner Type	Outside Diameter ²		Wall Thickness		Weight
Inches	mm		Nominal mm	Tolerance +/-mm	Nominal mm	Tolerance +/-mm	Per metre kg
½ ¹	15	Heavy Duty Virgin & Static Dissipating	25	1.0	2.3	0.2	0.5
¾	20		25	1.0	2.3	0.2	0.5
1	25		29	1.0	3.2	0.2	0.6
1½	40		44	1.0	3.2	0.2	0.9
2	50		55	1.5	3.2	0.2	1.2
3	80		82	1.5	3.2	0.2	1.0
4	100		107	3.0	4.5	0.2	3.5
6	150		159	3.0	5.5	0.2	6.8
8	200		208	3.0	8.5	0.2	13.1
10	250		259	4.0	9.1	0.2	15.9
12	300		319	5.0	10.4	0.4	23.4
14	350		343	5.0	8.3	0.2	21.6
½ ¹	15	UltraHiPerFlon®	25	1.0	2.3	0.2	0.5
¾	20	Superweight Virgin UHP	25	1.0	2.3	0.2	0.5
1	25		29	1.0	4.5	0.2	0.8
1½	40		43	1.0	4.5	0.2	1.3
2	50		54	1.0	4.5	0.2	1.7
3	80		81	1.5	4.8	0.2	2.5
4	100		107	1.5	5.0	0.2	3.5
6	150		159	1.5	6.0	0.2	6.8
8	200	UltraHiPerFlon®	208	3.0	8.5	0.2	13.1
10	250	Heavy Duty UHP	259	4.0	9.1	0.2	15.9
12	300		319	5.0	10.4	0.4	23.4
14	350		343	5.0	8.3	0.2	21.6

1 - 1/2in liners are too small, so a 3/4in size is used.
2 - When supplied as a separate pipe liner, NB when fitted into a steel pipe the liner will take on the id of the pipe.

The nature of PFA mouldings are such that the lining thickness is very dependent upon the internal diameter of the steelwork, whose standards give rise to large tolerances, therefore these are expressed as minimums.

PFA Lining Dimensions			
Nominal Bore		Wall Thickness	
Inches	mm	Nominal mm	Minimum mm
½	15	3.5	1.8
¾	20	3.5	1.8
1	25	3.5	2.4
1½	40	4.0	2.8
2	50	4.3	3.2
3	80	6.0	4.8
4	100	8.2	6.8
6	150	8.6	6.9
8	200	9.5	7.6
10	250	10.2	8.0
12	300	10.1	7.6
14	350	9.8	7.0

Spool & Fitting Bores

Please note that because of the method of manufacture and tolerances on steel materials these are a guide. Please consult if you require a precise dimension for instrument, mixer or other insertion or a calibrated volume.

Spool and Fitting Bores				
Nominal Bore		Nominal Lined Bore Diameters		
		Pipe Spool/PTFE Lined Fitting		Lined Fitting
		Heavy Duty	Superweight	PFA
Inches	mm	mm	mm	mm
½	15	16	16	12
¾	20	16	16	12
1	25	20	18	20
1½	40	34	32	33
2	50	46	44	44
3	80	70	68	66
4	100	93	91	86
6	150	143	142	137
8	200	188	-	186
10	250	247	-	237
12	300	286	-	287
14	350	319	-	317

Virgin PTFE and PFA Resins

CRP only uses virgin Polytetrafluoroethylene (PTFE) and Perfluoroalkoxy (PFA) resins that have the following status relative to food contact regulations.

European Union

Compliance with European Regulation EU No.10/2011 as amended. We can confirm that the raw materials and the subsequent products manufactured have been produced according to a quality management system which complies with the requirements of European Regulation EC No.2023/2006 on good manufacturing practice for materials and articles intended

to come into contact with food.

United States of America

Compliance with U.S. FDA 21 CFR 177.1550 (a)(2) and (b) Perfluorocarbon resins.

Static-Dissipating PTFE Resin

CRP also declares that the high purity furnace black used in the manufacture of static dissipating PTFE products has the following status relative to food contact regulations.

European Union

Compliance with European Regulation EU No.10/2011 as amended. We can confirm that the raw materials and the subsequent products manufactured have been produced according to a quality

management system which complies with the requirements of European Regulation EC No.2023/2006 on good manufacturing practice for materials and articles intended to come into contact with food.

United States of America

Compliance with U.S. FDA 21 CFR 178.3297 Colorants for polymers. We can confirm that the formulated carbon black levels do not exceed 2.5% by weight.

Static-Dissipating PFA

The carbon used in creating the static-dissipating properties of this PFA is not FDA compliant and nor does the amount used fall under the minimum percentage for compliance. At present there is no FDA compliant material available.

Static-Dissipating PTFE Performance

An independent inspection company and a specialist technical consultancy conducted the following tests with results.

Resistance Test

Measure BS2050 A4.5 modified for PTFE

Result- Measured resistance $2 \times 10^6 \Omega$

Resistivity Tests

Surface Resistivity

This is the resistance to leakage of a charge across a square area of surface.

Tested at ambient temperature and 50% relative humidity

Result - Measured value (inside liner) $1.8 \times 10^4 \Omega m$

Volume Resistivity

This is the internal resistance of an insulating material to current

flow. High volume resistivity guarantees that the material acts as an insulator and low volume resistivity demonstrates that the material is a conductor.

Tested at ambient temperature and 50% relative humidity.

Result - Measured value $2.1 \times 10^4 \Omega m$

Classification

The materials are classified as static-dissipative or anti-static and far exceed the minimum requirements. CRP's static dissipating materials exceed the requirements of the specification EDS. PIP.53.04A June 1989.

PTFE & PFA Material Standards

ASTM D4895 Type I: Standard Specification for Polytetrafluoroethylene : PTFE : Resin Produced From Dispersion

This is the most common global raw material specification for PTFE polymers which are produced by the controlled coagulation of dispersions. These PTFE's are called "Coagulated Dispersions, Fine Powders or Paste Polymers" and are much more precisely controlled than the coarse

granular materials. These types of PTFE are almost always mixed with a volatile processing aid and are used to make high quality extrusions. Type I grades are suitable for extruding the thick walled liners suitable for lining steel pipes.

ASTM D4894:Standard Specification for Polytetrafluoroethylene : PTFE: Granular Molding and Ram Extrusion Materials

This is the most common global raw

material specification for PTFE polymers used to make isostatically moulded PTFE lined pipework, ram extruded PTFE items and billets of PTFE which are machined to produce finished components. This is not a preferred material for lined piping components other than those machined

from soild.

ASTM D3307 Type II:Standard Specification for Perfluoroalkoxy :PFA:-Fluorocarbon Resin Molding and Extrusion Materials

This is the most common global raw material specification for the various types of PFA polymers giving full details of the physical and mechanical attributes of the PFA both as supplied by the manufacturer and after processing. The specification also contains details of test methods to be

used for PFA polymers.

Type II

In common with most ASTM Standard Specifications for materials ASTM D3307 is divided into many grades or in this case 13 types each destined for a different application. A type reference determines the mechanical and thermal properties of a particular grade or type. Whilst the mechanical properties are important it is the thermal properties which have the most significance when PFA is used as a corrosion resistant lining material. Corrosion resistance especially resistance to stress corrosion cracking at elevated

temperatures is determined by the molecular weight and structure of the PFA. The best lining materials have high molecular weights and are renowned for their extraordinarily high viscosity even when they are fully melted. It is a measure of the viscosity when melted referred to as melt flow index which is the principal method of determining a 'type' of PFA. The lower the melt flow index the greater the melt viscosity and performance in highly aggressive situations. CRP only uses PFA classified to type II which has the lowest melt flow index of all the PFA grades.

Steelwork Material Standards

API 5L Grade B:Specification for Lined Pipe

Material specification and some dimensional standards and tolerances for steel pipe. This is the most common standard for steel pipe and is readily recognised throughout the Petrochemical industry. This specification is widely used in the Grade B form as the standard pipe material for Lined Pipe and Fittings manufacture. It is now quite common to see steel pipes dual certified to this specification and to ASTM A106 Grade B.

ASTM A106 Grade B:Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

Material specification often seen as a combined specification with API 5L Grade B. Grade B is the most widely used of the three grades steel pipe referred to in ASTM A106. The term grade B determines the chemical composition and mechanical performance of the steel used to make the pipe.

ASTM A105: Carbon Steel Forgings for Piping Applications

Material specification for forgings - in our case flanges.

ASTM A182 Grades: F304/F304L/ F316/F316L/ Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service

Material specification for stainless flanges.

ASTM A216 Grade WCB: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

A material specification covering both

performance and composition. Grade WCB is used by CRP in their investment castings for the majority of their PFA lined fittings.

ASTM A234 Grade WPB: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

Material specification. This standard covers wrought carbon steel fittings which are manufactured to the dimensional specifications of ASME B16.9 used in the fabrication of our flanged pipe fittings.

Grade WPB is the grade usually used for lined pipe and fittings.

ASTM A240 Grades: 304/304L/316/316L: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

Material specification. Stainless steel to this specification is used where plate materials are required in the manufacture of pipe spool stub ends, reducing flanges and bespoke flanges - anywhere plate may be used.

ASTM A276 Grades: 304L/316L: Standard Specification for Stainless Steel Bars and Shapes

A material specification used for machined

components.

ASTM A312 Grades: 304/304L/316/316L: Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

/Specification for Castings, Austenitic, for Pressure-Containing Parts

ASTM A403 Grades:304L/316L/ Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

Material specification for stainless fittings used in fabricating pipe fittings.

ASTM A516 Grade 60: Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

A material specification. Steel to this specification is used where plate materials are required in the manufacture of pipe spool stub ends, reducing flanges and bespoke flanges - anywhere plate may be used. There are four grades specified in the standard with different composition and mechanical properties. Grade 60 is the most widely used for CRP's products.

BS970 Grade 080M40(Free Machining Carbon Steel): Specification for wrought steels for mechanical and allied engineering purposes. General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels

A material specification used for machined components.

Steelwork Dimensional Standards

ASME B36.10 Welded and Seamless Wrought Steel Pipe

Dimensional standard for carbon steel pipe. This covers the outside diameter of pipes, as well as the various standard wall thicknesses, described as the pipe schedules.

ASME B16.9: Factory-Made Wrought Butt Welding Fittings

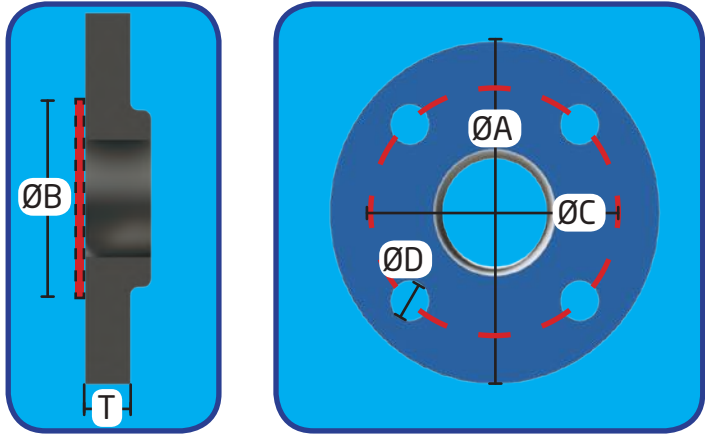
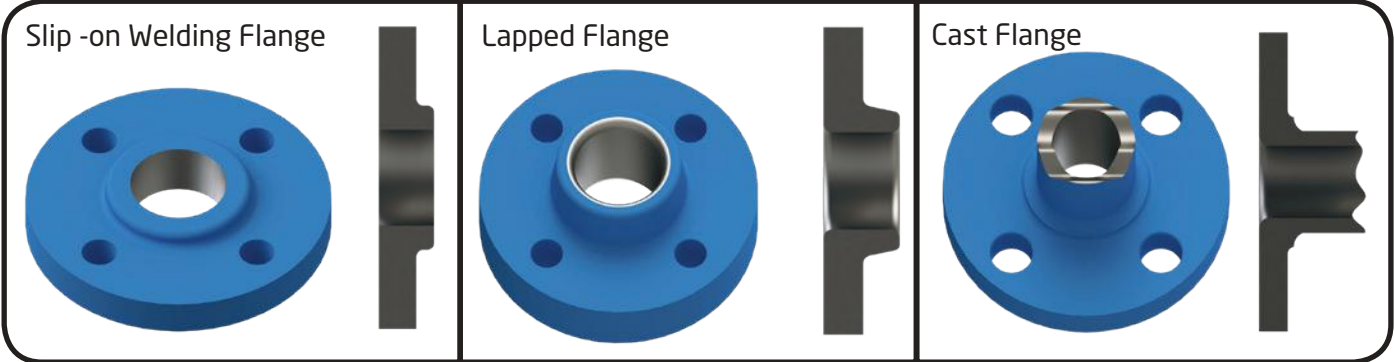
Dimensional standard for the wrought fittings used in the fabrication of our flanged pipe fittings.

Carbon Steel Pipe Dimensions to ASME B36.10					
Nominal Bore		Pipe Schedule ¹	Outside Diameter ²	Wall Thickness ²	Inside Diameter ²
Inches	mm				
½ ³	15	40	26.7	2.9	20.9
¾	20	40	26.7	2.9	20.9
1	25	40	33.4	3.4	26.6
1½	40	40	48.3	3.7	40.9
2	50	40	60.3	3.9	52.5
3	80	40	88.9	5.5	77.9
4	100	40	114.3	6.0	102.3
6	150	40	168.3	7.1	154.1
8	200	30	219.1	7.0	205.1
10	250	30	273.0	7.8	257.4
12	300	30	323.9	8.4	307.1
14	350	30	355.6	9.5	336.6
16	400	Std	406.4	9.5	387.4
18	450	Std	457.2	9.5	438.2
20	500	Std	508.0	9.5	489.0
24	600	Std	609.6	9.5	590.6

1 - All carbon steel spools and fabricated fittings use the same pipe schedule.
2 - All dimensions are nominal.
3 - For 1/2 inch NB lined pipe and fittings 3/4 inch NB pipe is used.

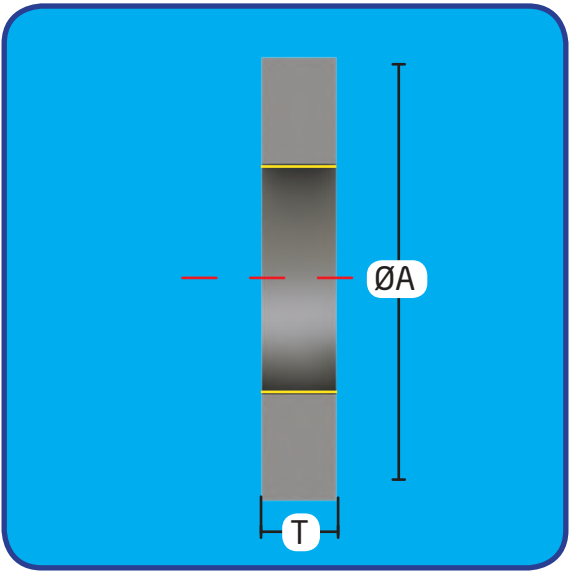
Stainless Steel Pipe Dimensions to ASME B36.19								
Nominal Bore		Outside Diameter ¹	Spools			Fittings		
			Pipe Schedule ²	Wall Thickness ¹	Inside Diameter ¹	Pipe Schedule ²	Wall Thickness ¹	Inside Diameter ¹
Inches	mm	mm		mm	mm		mm	mm
½ ³	15	26.7	10	2.2	22.3	40	2.8	21.1
¾	20	26.7	10	2.2	22.3	40	2.9	20.9
1	25	33.4	10	2.8	27.9	40	3.4	26.6
1½	40	48.3	10	2.8	42.7	40	3.7	40.9
2	50	60.3	10	2.8	54.8	40	3.9	52.5
3	80	88.9	10	3.1	82.8	40	5.5	77.9
4	100	114.3	10	3.1	108.2	40	6.0	102.3
6	150	168.3	10	3.4	161.5	40	7.1	154.1
8	200	219.1	10	3.8	211.6	30	7.0	205.1
10	250	273.0	10	4.2	264.6	30	7.8	257.4
12	300	323.9	10	4.6	314.8	30	8.4	307.1
14	350	355.6	10	4.8	346.0	30	9.5	336.6

1 - All dimensions nominal.
2 - Pipe schedule varies between spools and fabricated fittings as detailed.
3 - For 1/2 inch NB lined pipe and fittings 3/4 inch NB pipe is used.



Steel Flange Dimensions ¹ ASME B16.5 Class 150										
Nominal Bore		Flange	Raised Face ²	Flange Thickness (Min)			Pitch Circle	Bolt Holes	Bolt Hole	UNC Bolt Size
				Slip-on Welding Flange ³	Lapped Flange	Cast Flange				
Inches	mm	Ø A	Ø B	T			Ø C	Qty	Ø D	Metric Equivalent Bolt
		mm	mm	mm			mm		mm	M Size
½	15	90	34.9	9.60	11.2	8.0	60.3	4	15.9	½ M12/M14 ⁴
¾	20	100	42.9	11.20	12.7	8.9	69.9	4	15.9	½ M12/M14 ⁴
1	25	110	50.8	12.70	14.3	9.6	79.4	4	15.9	½ M12/M14 ⁴
1½	40	125	73.0	15.90	17.5	12.7	98.4	4	15.9	½ M12/M14 ⁴
2	50	150	92.1	17.50	19.1	14.3	120.7	4	19.1	⅝ M16
3	80	190	127.0	22.30	23.9	17.5	152.4	4	19.1	⅝ M16
4	100	230	157.2	22.30	23.9	22.3	190.5	8	19.1	⅝ M16
6	150	280	215.9	23.90	25.4	23.9	241.3	8	22.2	¾ M20
8	200	345	269.9	27.00	28.6	27.0	298.5	8	22.2	¾ M20
10	250	405	323.8	28.60	30.2	28.6	362.0	12	25.4	⅞ M24
12	300	485	381.0	30.20	31.8	30.2	431.8	12	25.4	⅞ M24
14	350	535	412.8	33.40	35.0	33.4	476.3	12	28.6	1 M27
16	400	595	469.9	35.00	36.6	35.0	539.8	16	28.6	1 M27
18	450	635	533.4	38.10	39.7	38.1	577.9	16	31.8	1⅜ M30
20	500	700	584.2	41.30	42.9	41.3	635.0	20	31.8	1⅜ M30
24	600	815	692.2	46.10	47.7	46.1	749.3	20	34.9	1¼ M30

1 - All dimensions exclude liner thicknesses.
2 - Steel raised faces are not usually relevant in lined piping as it is the PTFE or PFA raised face that is critical. Steel raised faces may be retained or may be machined from proprietary flanges to suit production methods. Face to face and centreline to face dimensions will take account of this.
3 - Flange thickness excluding raised face.
4 - As standard CRP would assume M12 bolting, but M14 can be accommodated if required.



Stub End Dimensions				
Nominal Bore		Stub End ¹	Stub End Thickness ²	Weight
Inches	mm	ØA mm	T mm	
½	15	44	10	0.1
¾	20	54	12	0.2
1	25	64	12	0.3
1½	40	83	12	0.4
2	50	102	14	0.7
2½	65	121	14	0.8
3	80	133	16	1.2
4	100	171	16	1.9
5	125	186	18	2.1
6	150	216	18	2.6
8	200	270	20	3.9
10	250	324	22	5.4
12	300	381	22	7.1
14	350	413	24	8.7
16	400	470	24	10.8
18	450	533	24	14.4
20	500	584	24	16.4
24	600	692	24	21.5

1 - Diameter is to flange inner bolt circle, up to and including 10 in, after that it is the raised face diameter.
2 - Thickness to EN1092-1., until 14in then it stays at the same thickness.

Cast Fittings Carbon & Stainless Steel Dimensions to ASME B16.5				
Nominal Bore		Outside Diameter ¹	Wall Thickness ¹	Inside Diameter ¹
Inches	mm	mm	mm	mm
1	25	33	4.0	25
1½	40	48	4.8	38
2	50	62	5.6	51
3	80	87	5.6	76
4	100	115	6.4	102
6	150	166	7.1	152
8	200	219	7.9	203
10	250	271	8.7	254
12	300	324	9.5	305
14	350	358	10.3	337

1 - All dimensions nominal.

Key Product Tolerances

Tolerances	
Element	Tolerance
Pipe Length	± 3.2mm
Fixed flange bolt hole alignment	± 1.6mm
Flange perpendicularity (with pipe centreline)	7.8 mm/m of diameter
Flange Dimensions:	In accordance with ASME B 16.5
Fitting Dimensions:	In accordance with ASME B 16.5
PTFE Liner Thickness:	± 0.2mm
1/2" to 10"	
12" to 14"	± 0.4mm
PFA Liner Thickness:	Not possible to define because of fabricated steelwork or casting tolerance, however nominals in catalogue are a good guide.

Design

CRP's products are all manufactured and tested to national and international standards where applicable, with fundamental design qualification having been undertaken via the approval process required to comply with the Pressure Equipment Directive 2014/68/EU. The primary design standards used by CRP are:

ASME B31.3:Process Piping

This contains requirements for piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing plants and terminals. It covers materials and components, design, fabrication, assembly, erection, examination, inspection, and testing of piping. This represents the core of the design part of a lined piping system.

ASME B16.5: Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24

The standard covers pressure-temperature ratings, materials, dimensions, tolerances, marking, testing, and methods of designating openings for pipe flanges and flanged fittings. Key aspects are the design of flanges and the face to face dimensions of flanged fittings. There are a number of pressure classes detailed in the standard.

Class 150

The pressure classification and therefore

dimensional specification that the majority of lined piping is manufactured to is 150 pound (150lb) or in metric terms 10 bar. Therefore this specification is often referred to and is called ASME B16.5 Class 150, or abbreviated to ASME150.

It is possible to manufacture lined piping for Class 300 (300lb), but although this can be achieved dimensionally, it will not achieve the performance levels of Class 300 due to the creep effect on PTFE and PFA. Please note however that the pressure/temperature rating for a Class 150 flange depends on which raw materials you choose to make the flange from. In the case of CRP's ASTM A105 flanges the pressure rating at ambient is 19.6 bar.

ASTM F1545:Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges

This is the latest version of ASTM lined pipe specifications, setting out the materials to be used, methods of fabrication and testing both as type tests and production tests. It covers several plastic materials including PTFE.

It has over the years been used as the bench mark quality standard for the manufacture of PTFE Lined pipe and fittings throughout most of the world with only central Europe preferring the

DIN equivalent.

ASTM F423 is the original lined piping specification which had a little more detail and only referred to PTFE. It is still referred to in some user specifications although withdrawn in 2002. CRP refers to it, in that our product type testing was mainly done against this specification.

ASME Boiler & Pressure Vessel Code Section IX. Welding, Brazing, and Fusing Procedures: Welders: Brazers: and Welding, Brazing and Fusing Operators

The title is self-explanatory and applies to welding activities principally on spools and fittings.

BS EN ISO 9606-1: Qualification testing of welders -- Fusion welding -- Part 1:Steels

This standard applies to the approvals held by CRP's welding operators.

BS EN ISO 15641-1: Specification And Qualification Of Welding Procedures For Metallic Materials - Welding Procedure Test - Part 1:Arc And Gas Welding Of Steels And Arc Welding Of Nickel And Nickel Alloys

This applies to weld procedure qualification.

Welding

Standard

For CRP's range of products with welded construction steel housings, the company employs coded welders (to ASME IX and/or ISO 9606-1) following procedures in compliance with the requirements of the

PED, and either ASME IX or EN15614-1.

Options

If required, welding can be carried out by welding sub-contractors compliant with the requirements of ISO 3834-2.

Welded fabrications can be supplied with

individual weld maps.

Appropriate types and levels of NDT can be offered, including radiography, magnetic particle inspection, dye penetrant, etc.

Product Finishing

CRP's standard paint finish is a two component low VOC, high solids fast curing epoxy primer/finish containing zinc phosphate anti-corrosive pigmentation. The standard colour is RAL 5015 - Blue Semi-Gloss, with a typical application thickness of 60 microns.

This paint system is intended as a primer coat and would not be considered as falling within any of the environmental/durability classifications of ISO 12944 Parts 1 and 2. However as a primer it should provide sufficient durability for site installation and subsequent over

coating. It will perform as a primer coat for the majority of paint systems applied.

CRP can also apply multi-coat wet paint systems in ISO 12944 compliant paint systems based on selecting the corrosive environment and durability requirement. Typically customers require protection for the C4, C5I and C5M environments and Medium or High durability. CRP are able to provide such finishes or apply customer specified paint systems.

Because of the health hazards associated with paints containing free isocyanate CRP are not able to apply these, but can

offer alternatives.

Steel components are abrasive blast cleaned using non-ferrous media to Sa 2½ ISO 8501-1 - "very thorough blast cleaning". A surface profile Medium (G) ISO 8503-1 is achieved.

Product Testing

All virgin PTFE/PFA lined products are subject to an electrostatic spark test at 25kV. All pipe spools and certain fittings are also subject to Hydrotest at 29 bar(g) for three minutes, followed by a relaxation dwell to atmospheric pressure and a repeat.

All spools and fittings lined in static dissipating PTFE/PFA are subject to Hydrotest at 29 bar(g) for three minutes,

followed by a relaxation dwell to atmospheric pressure and a repeat.

Ultrasonic testing is conducted on large diameter PFA lined fittings to determine the liner thickness.

All spools and fittings are visually examined, particularly the flare faces, to ensure that there are no defects that would prevent the item sealing against

adjacent items.

The mechanical properties and the specific gravity of representative samples of PTFE liner, selected from each sinter batch, are tested to confirm that they comply with the PTFE specification detailed elsewhere in this document.

Quality

ISO 9001:2015

CRP is an ISO 9001:2015 approved company. Originally accredited to BS5750 Part 1 in 1992, CRP maintains this accreditation through a process of continuous third party surveillance with, six monthly, annual and triennial audits taking place. All of the company's manufacturing and test procedures fall within this regime.

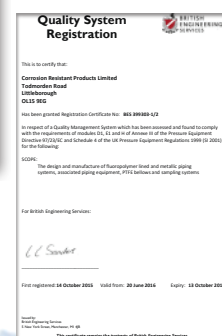
Pressure Equipment Directive

CRP's products are all manufactured and tested to national and international standards where applicable, with fundamental design qualification having been undertaken via the approval process

required to comply with the Pressure Equipment Directive 2014/68/EU.

TSG

CRP has Chinese TSG (Manufacturing License of Special Equipment of The Peoples Republic of China) licence approval from the GuangZhou Special Pressure Equipment Inspection and Research Institute, for many of its products, including its range of PTFE/PFA lined pipe and fittings. This is often referred to as a China Stamp.



Permanent Product Marking

CRP is proud of what we manufacture and wherever possible the product is identified as having been manufactured by us. This is as permanent as practicable - in contrast to much other product on the market which is anonymous. Castings have the CRP logo, together with the web address, our notified body number (CE mark), the product class (ASME 150), the material standard e.g. A216 WCB and the

product size e.g. 40 x 25 (1 1/2" x 1").

Those products subject to PED compliance which are not castings have a high temperature cable tie added with the notified body number and company details.

Some products have a stainless steel data plate riveted containing basic product data, serial numbers and in some cases basic performance limits.

Shipment Product Marking

To enable easy identification of product on delivery - particularly when delivering a mixed collection of product for a project, CRP has developed some simple systems which enable items to be matched to delivery documentation. As standard pipe spools are identified with their nominal bore and length in indelible marker pen. Timber end boards are identified with the customer name, CRP order number, order line item number and which one of the

item it is - in the case of multiple identical items on the same line of the order e.g. 1 of 20.

On consultation with the customer, information such as the isometric drawing number or plant item tag can be added both the item and the delivery paperwork, making it easier to select items.

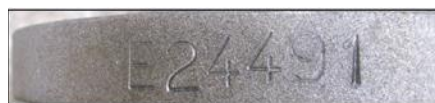
Product Traceability

All CRP manufactured Lined Pipe and Fittings are backwards traceable from the finished component to the manufacturing tests, processes and lining materials.

Pipe Spools

Each spool has one flange stamped with the reference of the liner batch used in its construction. This provides traceability back to the liner manufacture, the tests undertaken and the materials certification

of the polymer.



PFA Moulded Fittings

PFA moulded items likewise are stamped with a mould reference which again provide traceability back to the

manufacturing and test activities and the material certification of the polymers used.



Type 2.2. material certification can be provided as routine. Type 3.1 certification can be provided on request.

Installation

CRP has a comprehensive User Manual which gives extensive guidance on the installation of lined piping systems. Please ensure that those charged with installing the product read this guide and familiarise themselves with the special requirements of lined piping. There is nothing particularly complicated, but there are a few basic rules that must be followed in order to have a successful installation. CRP can also provide comprehensive training

in the installation of lined equipment and our field sales team are trained in providing practical support. Copies of the User Guide are shipped with all product and it is also available to download from the website.



Non-Destructive Testing

Non-destructive testing is also referred to by the acronym NDT or in the USA as non-destructive examination (NDE). It is the process by which materials - usually metals are examined without destroying them. Usually this is for searching for defects. In the case of CRP it would principally be specified for the examination of welds.

CRP Experience

It is worth commenting that in

the history of CRP, no product has ever failed because of a lack of weld integrity. In CRP's product the welds are not in contact with the process fluid and therefore do not need to retain the liquid or gas, they are serving to hold the housing together and to support the lining. As routine, all PFA lined fittings are subject to at least 70 Bar and 370°C as part of the moulding process.

Appropriate Non-Destructive Testing					
Weld Type	Material	Radiography	Ultrasonic	Magnetic Particle Inspection	Liquid (Dye) Penetrant
Butt Weld	Carbon Steel	✓	✓	✓	✓
Butt Weld	Stainless Steel	✓	✓	✗	✓
Fillet Weld	Carbon Steel	✗	✗	✓	✓ Not preferred
Fillet Weld	Stainless Steel	✗	✗	✗	✓

Training

CRP offer customers and their nominated contractor's comprehensive training in three specific areas:

Installation Training

Because of the niche position of PTFE and PFA lined equipment, it is not unusual for installation contractors to be unfamiliar with the installation of lined equipment. This can lead to installation mistakes, expensive rework and a delayed project implementation. Through the provision of some simple training CRP can assist in ensuring a good piping installation that does the equipment justice and gives the client confidence in its application.

Product Training

CRP is keen to help customers choose the correct lined equipment for the job and get the best out of it. With the health, safety and environmental duties that come to bear on many of our customers and the need to keep the general technical level of understanding up of an ever changing workforce, CRP has developed training to assist design, project and plant engineers to understand the world of lined equipment. The objective is to provide a comprehensive overview of PTFE lined piping systems, including an understanding of why such materials are selected and how they are used. This could be to meet training obligations - either for continuous professional development, or

to fulfil health and safety requirements.

Field Flare Training

Field Flare piping is a useful addition to the toolbox of any serious user of lined equipment. It provides a simple self-help system, enabling the local fabrication of spools for emergency use or for the odd small modification or maintenance task. Occasionally because of historic site development or convenience some customers manufacture all of their spool requirements locally and CRP can support such users. Through the provision of training CRP can "approve" nominated staff of the end user or their contractor in the use and installation of field flare spools.

Method

Usually this is provided via a classroom based training session, site based or at CRP's facility; making use of audio-visual presentations and classroom media. The training session would typically last two hours and a class size of around 10 is ideal. The training is provided by our technical, manufacturing and commercial staff as appropriate. Field flare training is usually provided via a practical training session at CRP's factory. This enables the candidates not only to undertake hands on training on the activity of field flaring, but also to understand all of the other issues that surround the use of fluoropolymer lined equipment.

A short multiple choice question paper is set

to both help fix and confirm understanding. As part of the presentation, CRP will put together a small exhibition of products to aid understanding and a question and answer session concludes the training.

Course Materials

We plan to provide course materials for each attendee, which will include notes relating to the presentation and other reference materials for subsequent reference. We will also provide immediately after the visit, certificates confirming the individual's attendance and understanding of the training.

Caveat and Costs

It is important to comment that we are not acting as paid consultants. We are not insured for such a role. However, we believe that we can bring a wealth of both theoretical and practical experience that is not available from other sources, which should give your team and others a good background in working with these materials.

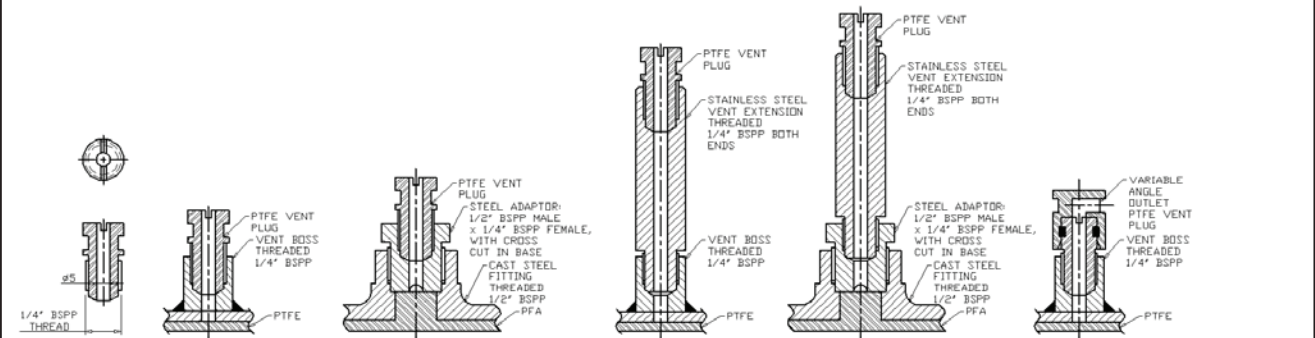
We see the provision of such training as part of the added value that a supply chain relationship with CRP can bring. To this end we offer such training to our supply contract customers and their agents and sub-contractors. Costs are usually on the basis of meeting our expenses.

Performance	Temperature Range		-29°C to +200°C Class 150	
	Pressure Range		Temperature (°C)	Max Pressure (bar g) Class 150
			-29 to +38	19.6
			50	19.2
			100	17.7
			150	15.8
			200	13.8
			Nb. It is acceptable to linearly interpolate to intermediate temperatures.	
	Vacuum Range		1" – 8" NB: Full vacuum at all temperatures. 10" – 12" NB: Full vacuum at temperatures up to 150°C.	
Design Standards	Metalwork		ASME B31.3, ASME B16.5, PER/PED	
	Lined Items		ASTM F1545 – ASME B16.5 Class 150	
Materials	Virgin PTFE Liners	Standards	PTFE to ASTM D4895 Type I, Grade 1, Class A or B Method of manufacture: Fine powder paste extrusion.	
		Mechanical properties	Minimum Tensile Requirements: Longitudinal Tensile Strength at Break: 20.7 MPa (when tested to ASTM D4895) Transverse Tensile Strength at Break: 19.0 MPa (when tested to ASTM D4895) Longitudinal Elongation at Break: 250% (when tested to ASTM D4895) Transverse Elongation at Break: 200% (when tested to ASTM D4895) Specific Gravity: 2.14-2.17 (when tested to ASTM D792)	
		Minimum Wall Thicknesses	NB	Min Wall (mm)
			½"	2.0
			¾"	2.0
	Products lined in PTFE		1"	3.0
			1.1/2"	3.0
			2"	3.0
			3"	3.0
			Nb. All blind flanges are supplied with bonded on, 2mm thick PTFE liner.	
	Notes		• All spools	
			• All type 2 and type 3 spacers	
			• Concentric and eccentric reducers with one size reduction	
			• Some reducing flanges	
			• Elbows with angles other than 90 degrees, and/or with non-standard centreline to face dimensions.	
	Static-Dissipating PTFE Liners	Standards	PTFE to ASTM D4895 Type I, Grade 1, Class A Fluffy Form Speciality Carbon Black meeting the requirements of F1545 for fillers Method of manufacture: Fine powder paste extrusion.	
		Mechanical properties	Minimum Tensile Requirements: Longitudinal Tensile Strength at Break: 20.7 MPa (when tested to ASTM D4895) Transverse Tensile Strength at Break: 19.0 MPa (when tested to ASTM D4895) Longitudinal Elongation at Break: 250% (when tested to ASTM D4895) Transverse Elongation at Break: 200% (when tested to ASTM D4895) Specific Gravity: 2.14-2.17 (when tested to ASTM D792) Resistance: < 1 MΩ thereby meeting the requirements of DIN 2874 Section 3.7 and EDS.PIP.53.04.A Section 16.3.2	

Materials	Static Dissipating PTFE Liners	Minimum Wall Thicknesses	NB	Min Wall (mm)	NB	Min Wall (mm)
			½"	2.0	4"	4.5
			¾"	2.0	6"	6.0
			1"	3.0	8"	8.0
			1.1/2"	3.0	10"	9.0
	Products lined in PTFE		2"	3.0	12"	9.5
			3"	3.0	14"	8.3
			Nb. All blind flanges are supplied with bonded on, 2mm thick PTFE liner.			
			• All spools			
			• All type 2 and type 3 spacers			
Virgin PFA Linings	Standards		PFA to ASTM D3307 type II Note PFA is the preferred lining material for fittings, with paste extruded PTFE liners also acceptable.			
		Mechanical properties	Minimum Tensile Requirements: Tensile Strength at Break: 26.2 MPa (when tested to ASTM D3307 or ISO 12086) Elongation at Break: 300% (when tested to ASTM D3307 or ISO 12086) Minimum Melting Temperature: 300°C (when tested to ASTM D4591) Specific Gravity: 2.12-2.17 (when tested to ASTM D792) Melt Flow Rate: 1-3g/10mins (when tested to ASTM D3307 or ISO 12086)			
		Minimum Wall Thicknesses	NB	Min Wall (mm)	NB	Min Wall (mm)
			1"	3	6"	5
			1.1/2"	3	8"	6.5
	Products lined in PFA		2"	3	10"	7.5
			3"	3	12"	8.5
			4"	4	14"	8.5
			• Class 150 90 degree elbows with standard centreline to face dimensions			
			• Equal and reducing tees			
Static Dissipating PFA Linings	Standards		Not applicable, not covered by ASTM D3307			
		Mechanical properties	Minimum Tensile Requirements: Tensile Strength at Break: 26.2 MPa (when tested to ASTM D3307 or ISO 12086) Elongation at Break: 300% (when tested to ASTM D3307 or ISO 12086) Typical Melting Temperature: 284°C (when tested to ASTM D4591) Specific Gravity: 2.12-2.17 (when tested to ASTM D792) Melt Flow Rate: 1-3g/10mins (when tested to ASTM D3307 or ISO 12086) Volume Resistivity: 0.10 Ωm (when tested to ISO 3915)			
			• Linings shall show no evidence of pinholes, porosity or cracks.			
			• The gasket-sealing surface of the linings shall be free of surface defects that could impair sealing effectiveness.			
			• Scratches, dents, nicks or tool marks on the sealing surface shall be not deeper than 0.15 mm. Any radial defect shall be cause for rejection.			
	Notes		• Additives and colourants in liners are not permitted.			
			• Linings on flange/collar faces shall be uniform thickness, and not less than 80% of the wall thickness in the bore, unless otherwise agreed.			
			• Spool liners to be a sliding or interference fit.			
			• Linings shall show no evidence of pinholes, porosity or cracks.			
			• Any bulges or other obvious indication of poor contact with the housing shall be cause for rejection.			

Dimensions	Fittings	External Sizes	90 degree elbows, 45 degree elbows, equal tees, reducing tees, concentric reducers, eccentric reducers: Face to face and centreline to face dimensions as per ASME B16.5 Class 150 Instrument tees: <table><tr><td>Branch NB</td><td colspan="2">Body Face to face (mm)</td></tr><tr><td></td><td>Class 150</td><td>Class 300</td></tr><tr><td>1"</td><td>51</td><td>76</td></tr><tr><td>1.1/2"</td><td>76</td><td>76</td></tr><tr><td>2"</td><td>89</td><td>89</td></tr><tr><td>3"</td><td>150</td><td>N/A</td></tr></table> Nb. Centreline to face is the same as for an equivalent reducing tee. Not all combinations of body and branch size are possible for instrument tees						Branch NB	Body Face to face (mm)			Class 150	Class 300	1"	51	76	1.1/2"	76	76	2"	89	89	3"	150	N/A																						
		Branch NB	Body Face to face (mm)																																													
			Class 150	Class 300																																												
		1"	51	76																																												
	1.1/2"	76	76																																													
	2"	89	89																																													
	3"	150	N/A																																													
	Flange Arrangements	Standard is all fixed off centres. Rotating flanges and on centres flanges can be supplied if required. If rotating flanges are used, collar thicknesses will be the same as for spools, unless dictated by component geometry.																																														
	Pipe & Flange Specs	Pipe: ½" – 6" NB: Sch.40; 8" – 14": Sch.30 Flanges: ASME B16.5 Class 150 Casting wall thicknesses: As per ASME B16.5 Class 150																																														
	Spacers	General	Spacers are a non-preferred item. The use of site closing spools is a better way of making site adjustments.																																													
Type 1		These are solid Virgin PTFE thick walled rings. For all nominal bore sizes the minimum thickness is 1mm and the maximum thickness is 25mm. They can be supplied with a small taper angle if required. These spacers should not be used for pressures greater than Class 150.																																														
Types 2 & 3		Type 2 (thick walled steel hollow bar), and type 3 (pipe with welded on stub ends) spacers are both permissible. Materials: Steelwork and liners and are the same as for spools. Liner thicknesses: These are the same as for spools of the same nominal bore. The outside diameter of all spacers is to be inner bolt circle diameter. Lengths: <table><tr><td>NB</td><td>Min (mm)</td><td>Max (mm)</td><td>NB</td><td>Min (mm)</td><td>Max (mm)</td></tr><tr><td>½"</td><td>26</td><td>60</td><td>4"</td><td>26</td><td>150</td></tr><tr><td>¾"</td><td>26</td><td>60</td><td>6"</td><td>26</td><td>150</td></tr><tr><td>1"</td><td>26</td><td>100</td><td>8"</td><td>26</td><td>200</td></tr><tr><td>1.1/2"</td><td>26</td><td>100</td><td>10"</td><td>26</td><td>200</td></tr><tr><td>2"</td><td>26</td><td>150</td><td>12"</td><td>26</td><td>200</td></tr><tr><td>3"</td><td>26</td><td>150</td><td>14"</td><td>26</td><td>200</td></tr></table>						NB	Min (mm)	Max (mm)	NB	Min (mm)	Max (mm)	½"	26	60	4"	26	150	¾"	26	60	6"	26	150	1"	26	100	8"	26	200	1.1/2"	26	100	10"	26	200	2"	26	150	12"	26	200	3"	26	150	14"	26
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Venting	PTFE Lined Items	5mm vent hole Vent hole locations: Spools: ≤ 500mm length 1 vent hole centrally 501mm - 6000mm length 2 vent holes 150mm from each flange on same axis. Fittings: 1 vent hole centrally, or as cast. Permeant Service Venting: Vent Boss Description (see Fig 2 below): Vent bosses shall be carbon steel, set on and welded using a full penetration weld. The welding boss shall be threaded BSP parallel. There shall be a minimum of 10mm of full threads. A 5mm vent hole in the pipe shall be drilled and deburred post welding to ensure the welding process does not obscure the vent hole. Vent boss locations: Spools: ≤ 500mm length One vent boss centrally 501mm - 6000mm length 2 vent bosses 150mm from each flange on same axis. Fittings* One vent boss centrally, or as cast on. * Excludes reducing flanges, instrument tees and type 2 spacers where no vent boss is required - the body is tapped and the vent plug fitted directly into it. Vent Plugs: Vent plugs shall be made from Virgin PTFE, and the design shall be as shown in Fig 2 below. Every spool and fitting shall be supplied with a vent plug fitted into every vent boss/vent hole.																																														
		PFA Lined Items	No specific venting required, with the injection boss acting as a vent. Permeant Service Venting: Vent Boss Description (see fig 3 below): The injection boss on the fitting shall be used for the venting system. The injection boss will be drilled and tapped ½" BSP parallel. The tapping drill hole will extend 2 – 3mm beyond the end of the threads. A flat bottomed drill will be used. A ½" BSP parallel x ¼" BSP parallel reducing bush will be fitted to the injection boss.																																													

Dimensions	Venting	PFA Lined Items	Vent Plugs: Vent plugs shall be made from Virgin PTFE, and the design shall be as shown in Fig 1 below. Every fitting shall be supplied with a vent plug fitted into the reducing bush in the injection boss.
		Vent Extensions – All items	If vent extensions are required for insulated lines, there shall be a threaded ¼” BSPP half coupling welded over the vent hole and a carbon steel taper threaded pipe fitted over this to create a 70mm tall assembly. For PFA lined fittings a threaded steel reducer is fitted to the injection bosses to take the extension pipe. Permeant Service Venting: The permeant service vent boss is fitted either directly to pipe spools or as part of a reducer in PFA fittings and a 5mm hole extension piece fitted (see Figs 4 & 5 below)
		Notes	Each pipe and fitting including reducing flanges, instrument tees, lined spacers etc. shall be provided with a venting system that will release any gas which, during service, may permeate through the lining and will also indicate any leakage due to failure of the lining. Variable angle outlet PTFE vent plugs (see Fig 6 below) can be retro-fitted to vent plugs if required.
Earthing			Earth continuity shall be achieved by the use of star washers on two of the joint bolts and a CRP spikey washer behind all rotating flanges.
In Process Testing		PTFE Liners	Visual Outside Diameter Wall thickness (4 positions) Acceptable sintering profile Longitudinal Tensile Strength Transverse Tensile Strength Longitudinal Elongation at Break Transverse Elongation at Break SG determination of PTFE
Finished Product Testing		Class 150 flanged spools & fittings	Hydrostatic Test: Raise pressure to 29 bar g, hold for 3 minutes, and reduce pressure. Repeat cycle. Electrostatic Test: 25kV all over surface of lining.
			Hydrostatic Test: Any evidence of leakage shall be cause for rejection. Electrostatic Test: Any audible or visible spark through the lining shall be cause for rejection. The electrostatic test shall be carried out after the hydrostatic test.
Paint Finish			As standard all items will be supplied painted with CRP standard two component low VOC, high solids fast curing epoxy primer/finish containing zinc phosphate anti-corrosive pigmentation: Intergard 345, RAL 5015, blue semi-gloss. Typical thickness 60 microns. Other paint colours and systems are available by agreement.
Packing PFA lined items		PTFE lined items	Timber end boards bolted to all flange faces.
			Push fit plastic end caps to all flange faces.
Certification			Standard certificate of conformity provides details of materials used and details of Electrostatic Test and Hydrostatic Test. All material test certificates if requested at time of order.
Identification Fittings		Spools	NB, size, length, supplier order number, line item number and customer name to be marked on end boards.
			Supplier order number and line item number to be marked on end caps.
Traceability			All products should be reverse traceable from component through the manufacturing process to original polymer certification. This is provided on fittings via a unique number stamped upon the component flange and on pipe spools via the PTFE run reference stamped upon the component flange. All records relating to the manufacture and test of these items shall be available for scrutiny.
Quality Systems			Certificate 020-QMS-001 for ISO9001:2015 for the development and manufacture of fluoropolymer lined and metallic piping systems, associated pipeline equipment and swampling systems. The stocking and supply of third party valve and actuation products and associated pipeline equipment. Sub-contract fluoropolymer moulding and lining services.

Quality Systems	PED compliant, suitable for Group 1 Gases. Registration BES 399303-1/2 in respect of a Quality Management System which has been assessed and found to comply with the requirements of modules D1, E1 and H of Annex III of the Pressure Equipment Directive 97/23/EC and Schedule 4 of the UK Pressure Equipment Regulations 1999 (SI 2001) for the design and manufacture of fluoropolymer lined and metallic piping systems, associated piping equipment, PTFE bellows and sampling systems.
Qualification Tests	ASTM F1545 BS EN 61340-2-3 third party testing determining that static-dissipating lined pipe and fittings manufactured by CRP have been proven as static-dissipative.
Diagram of permeant venting arrangements	
	
Fig 1	PTFE Vent Plug
Fig 2	Vent Boss & PTFE Vent Plug for PTFE Lined Items
Fig 3	Vent Boss, Threaded Adaptor & PTFE Vent Plug for PFA Lined Items
Fig 4	Vent Boss, Stainless Steel Vent Extension & PTFE Vent Plug for PTFE Lined Items (Insulated Lines)
Fig 5	Vent Boss, Threaded Adaptor, Stainless Steel Vent Extension & PTFE Vent Plug for PFA Lined Items (Insulated Lined)
Fig 6	Optional Variable Angle Outlet PTFE Vent Plug





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Lined Piping Systems Iss.1

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