

# RESISTOFLEX®

# NGC

PRODUCT SOLUTIONS™

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**brands you trust.**



Design Manual 2019

Plastic Lined Pipe and Fittings

**CRANE**®

Crane ChemPharma & Energy

[www.cranecpe.com](http://www.cranecpe.com)

## CRANE® Co. And Resistoflex®



### ABOUT CRANE CO.

Crane Co. is a diversified manufacturer of highly engineered industrial products with a substantial presence in a number of focused niche markets. With approximately 12,000 employees working together in five business segments across 25 countries, Crane generated 2018 net sales of \$3.34 billion.

#### Financial Strength

Crane has a strong financial position, giving it the capacity to continue strategic acquisitions.

#### Global Reach

Worldwide operations in over 120 locations grow Economic Value Added (EVA) with top people and products, customer focus, and a common Crane Business System throughout the Company.

#### Leadership

Our businesses have leading market shares in focused niche markets and seek to produce high returns and excess cash flow.



### ABOUT RESISTOFLEX

Resistoflex®, a CRANE ChemPharma & Energy business within the Fluid Handling Unit of CRANE Co. is the largest plastic-lined piping products supplier in the world, with manufacturing and sales locations in North America, Europe, and Asia. Our corrosion-resistant plastic lined pipe, fittings, and TEFLON® lined hoses are used in corrosive fluid services as an economical alternative to expensive alloys.

Resistoflex manufactures corrosion-lined pipe, fittings, and expansion joints. Resistoflex manufactures liners in-house, from raw plastic resin for complete liner quality control. Some other manufacturers source their liners from 3rd party suppliers due to lack of capital and/or know-how.

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## Terminology and Standards

### **LINER MATERIALS**

PTFE	Polytetrafluoroethylene
PFA	Perfluoroalkoxy
PVDF	Polyvinylidene Fluoride, manufactured by Arkema under the name Kynar® and Kynar Flex®
PP	Polypropylene
ETFE	Ethylenetetrafluoroethylene

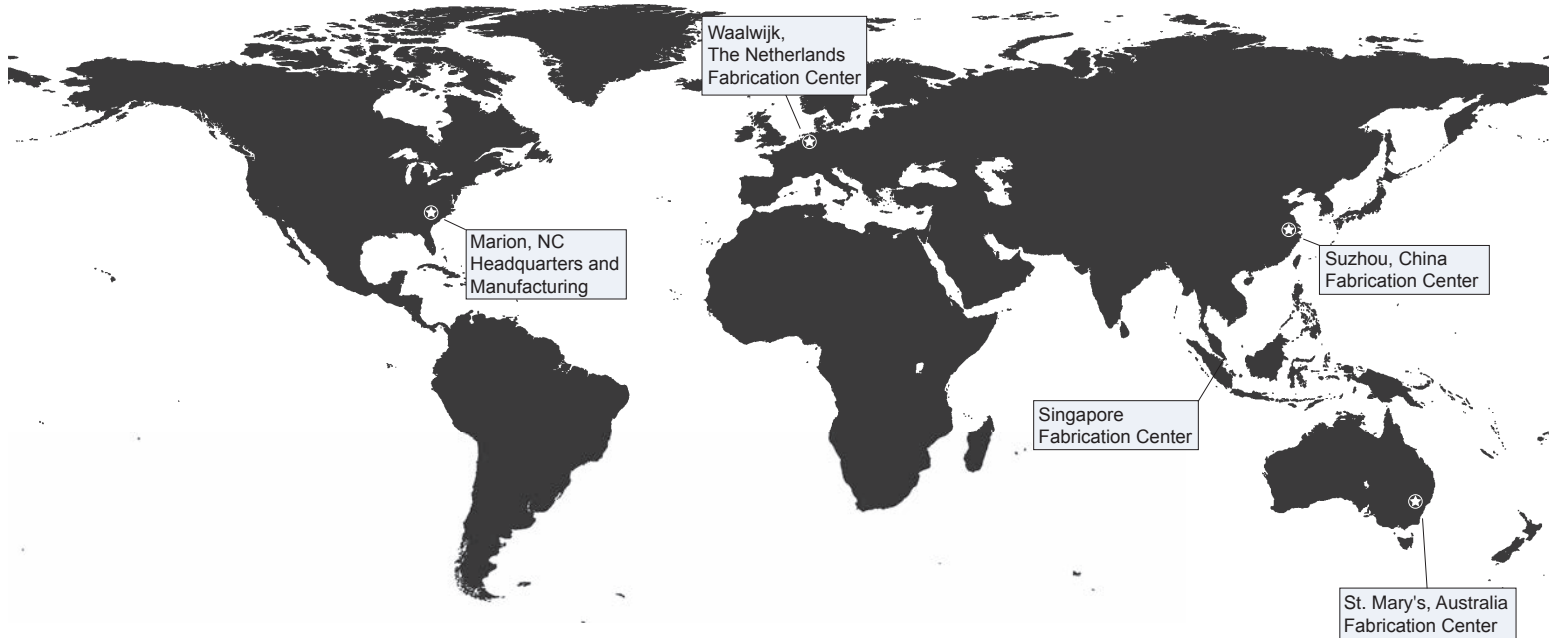
### **ASTM F1545-15a TABLE 3 STANDARD LINER COLOR**

PTFE	White (natural color - no pigment added; also available as electrically conductive black)
PFA	Natural - off white
PVDF	Black (available unpigmented for high-purity applications)
PP	Orange (available unpigmented for high-purity applications)
ETFE	Natural - shiny, milky white

### **INDUSTRY ASSOCIATIONS & STANDARDS**

ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASTM F1545-15a	Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges  Resistoflex fully complies with ASTM F1545-15a, including qualification testing on representative pipe/fittings. This qualification testing includes high/low temperature aging, steam/cold water temperature cycling, and vacuum testing. Qualification test reports are available on request, per the requirements of ASTM F1545-15a. All finished lined piping components are electrostatically tested at 30 KV. Hydrostatic testing is available on request.
A53	ASTM standard specification for carbon steel pipe.
A105	ASTM standard specification for forged carbon steel used for flanges
A106	ASTM standard specification for Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A182	ASTM standard specification for forged stainless steel used for flanges
A216	ASTM standard specification for carbon steel castings for fittings
A234	ASTM standard specification for wrought carbon steel weld fittings
A312	ASTM standard specification for stainless steel pipe
A395	ASTM standard specification for ferritic ductile iron castings for flanges and fittings.
A403	ASTM standard specification for wrought stainless steel weld fittings
A513	ASTM standard specification for electric-resistance-welded carbon and alloy steel mechanical tubing
A587	ASTM standard specification for electric-resistance-welded low-carbon steel pipe for use as process lines in chemical industries.

## Global Support



Crane Resistoflex main offices and manufacturing location is in Marion, NC, and we have a well-established network of distributors and ChemPharma & Energy sales offices throughout the world. This extensive network offers our customers local, knowledgeable, and personalized service, regardless of location. Resistoflex customers can rely on support from authorized distributors and ChemPharma & Energy sales offices in the Americas, Europe, Asia, Australia, and the Middle East.

Resistoflex supplies plastic-lined piping to projects all over the world. For day-to-day customer needs outside the U.S, Resistoflex maintains Fabrication Centers located in The Netherlands, Singapore, China and Australia. These fabrication centers stock plastic liners that have been manufactured in Marion, NC, and perform the metal fabrication and lining procedures to serve their local markets in a timely fashion.

Our distributors are not just order takers. Many of them share over 50 years of partnership with Resistoflex, and all are experienced in the technology of fluid handling and how plastic lined pipe can be used to solve fluid handling problems safely and economically. All of our distributors are dedicated to providing unmatched customer service. Additional involvement with, and experience in related products results in a team of professionals able to assist in any specialized project.

To find a local distributor or ChemPharma & Energy sales office, visit [www.cranecpe.com](http://www.cranecpe.com) or contact our Customer Service Center at (828) 724-4000.

## The Thermalok® Process

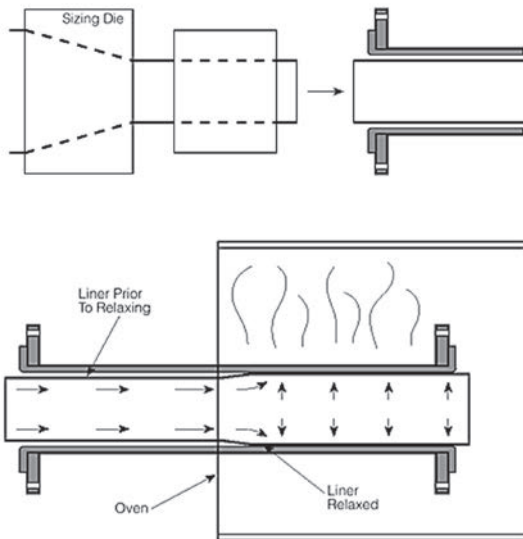
Resistoflex Thermalok steel pipe and liner act as a monolithic unit, even during extreme thermocycling. Combining dissimilar materials with very different coefficients of thermal expansion, our precision Thermalok Process locks the plastic liner into the pipe housing, making it full vacuum rated through the liner's temperature range. We developed and patented the Thermalok process for lining steel pipe in the 1950's, and have been the world leader in the manufacture of plastic-lined piping products ever since.

The Thermalok Process:

- Incoming lots of resin are analyzed in our Quality Assurance laboratory for conformance to established raw material specifications as required by ASTM F1545-15.
- The liner is formed under controlled conditions to a size somewhat larger than the I.D. of the steel housing into which it will be installed. It is then thoroughly inspected for conformance to design specifications. Next, the liner is subjected to a battery of quality tests designed to ensure liner integrity.
- The liner is then drawn through a sizing die at carefully controlled draw rates which results in a calculated reduction in the outside diameter.
- A programmed heating cycle relaxes the liner inside the steel housing, resulting in a snug liner fit. Design allowances are incorporated in this procedure to eliminate undesirable stresses in the finished product.
- Both liner ends of the pipe spool are then hot flared. Temperature, time and pressure are carefully monitored.
- The finished pipe is then tested in accordance with ASTM F1545-15 standards.

This unique Thermalok process provides lined pipe with dimensional stability under vacuum, pressure, and thermal cycling conditions, which prevents liner buckling and cracked flares within operational limits.

Drawing and Sizing



### Thermalok Field Flare Pipe

Thermalok Field Flare (FF) pipe is Flange x Plain End or Plain End x Plain End pipe with movable liner for distributor or end-user fabrication<sup>1</sup> with the following features:

- Resistoflex manufactures Field Flare pipe utilizing the the same Thermalok Process as factory-finished pipe, but the process is modified to result in a movable liner.
- The liner can be removed from the pipe, allowing the fabricator a wide variety of flange options, including the Resistoflex field flare flange, all types of weld flanges, and lap joint flanges.
- Resistoflex Field Flare pipe has the same performance characteristics of the factory-finished pipe, including full vacuum capability.
- Available in PTFE, PP, and PVDF, in the same sizes as factory-finished spools.
- Resistoflex Field Flare pipe has passed all ASTM F1545-15 Qualification Testing
- Housings are available in CS or SS.

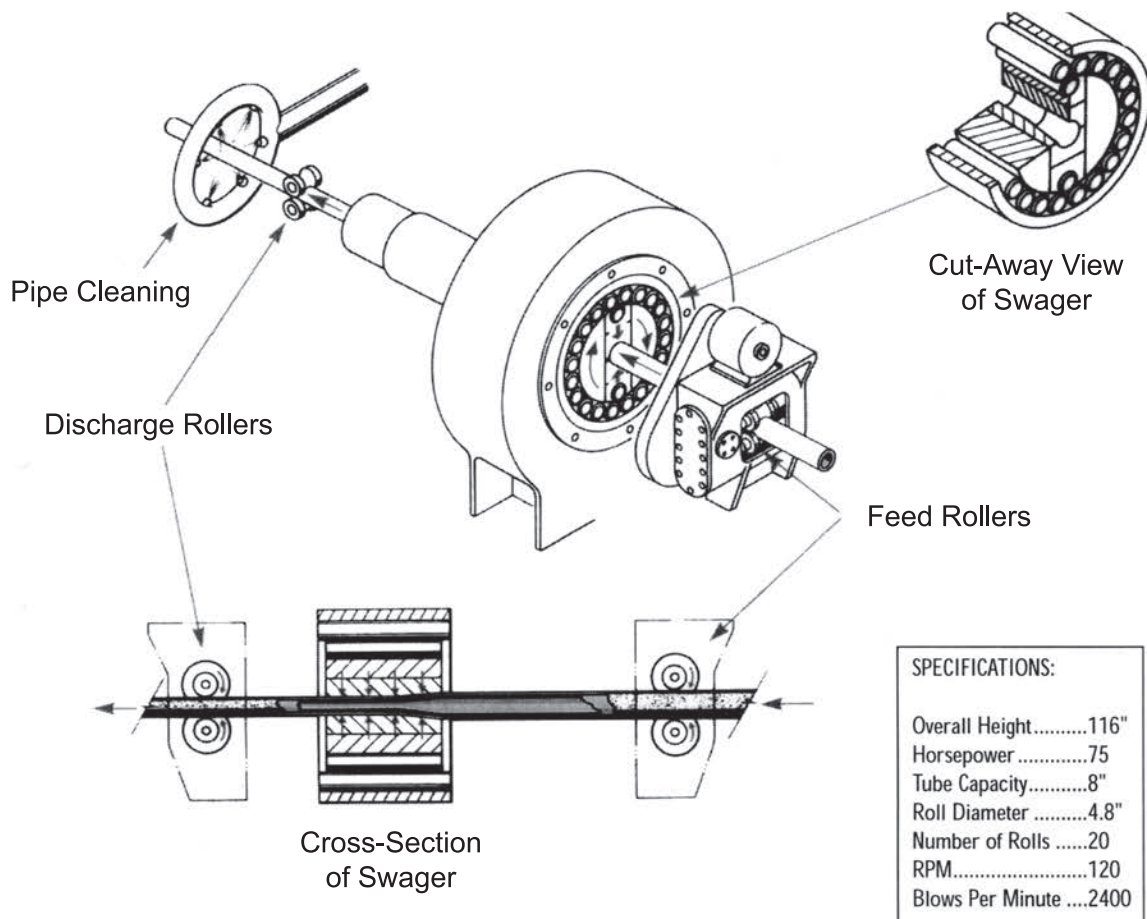
<sup>1</sup> - Special fabrication tooling and training required.

## The Swaging Process

The process of swaging, as performed on the Abbey Etna Rotary Swager, consists of hammering metal to reduce its diameter without cutting or grinding.

We start with ASTM A513 tube that has a slightly larger OD than ASME B36.10 pipe, insert the pre-molded liner into the tube, and feed both into the swager. The swager reduces the tube OD to the equivalent of ASME B36.10 pipe, while in the process fully locking the tube down on to the liner.

The result is a lined pipe that acts as a monolithic unit throughout the temperature range, and passes all ASTM F1545-15 qualification tests.



## Standard Specifications for 1/2" (DN 15) - 12" (DN 300) Pipe and Fittings

Pipe and fittings manufactured by Resistoflex are in full compliance with: ASTM F1545-15a, Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges as follows

- Resistoflex purchases approved ASTM designations of resin used to manufacture liner
- Resistoflex uses approved ASTM designations of materials of construction of flanged housings
- Resistoflex meets or exceeds minimum dimensional requirements
- Resistoflex meets qualification testing requirements, including steam/cold water, temperature aging, and vacuum testing
- Resistoflex performs proof-testing on 100% of finished goods using approved procedures

Resistoflex products also meet the following specifications/requirements:

<b>Liners:</b>	PTFE — Polytetrafluoroethylene, ASTM D4894 and D4895 PFA — Perfluoroalkoxy, ASTM D3307 PVDF — Polyvinylidene Fluoride, ASTM D3222 and D5575 PP — Polypropylene, ASTM D4101								
<b>Pipe:</b>	<p><u>Thermalok (Carbon Steel):</u> NPS 1/2 (DN 15) through NPS 4 (DN 100), Sch. 40 Carbon Steel per ASTM A53 ERW, Grade B Type E or A587 ERW NPS 6 (DN 150) - NPS 8 (DN 200), Sch. 40 Carbon Steel per ASTM A53 ERW, Grade B Type E NPS 10 (DN 250), Sch. 30 Carbon Steel per ASTM A53 ERW, Grade B Type E NPS 12 (DN 300), Sch. 20 Carbon Steel per ASTM A53 ERW, Grade B Type E</p> <p>Note: ASTM A106 Gr. B available on request</p> <p><u>Thermalok (Stainless Steel) 304LSS or 316LSS:</u> NPS 1 (DN 25) through NPS 8 (DN 200), Sch. 40 Stainless Steel per ASTM A312 ERW NPS 10 (DN 250), Sch. 30 Stainless Steel per ASTM A312 ERW NPS 12 (DN 300), Sch. 20 Stainless Steel per ASTM A312 ERW</p> <p><u>Swaged:</u> NPS 1 (DN 25) - NPS 4 (DN 100) , Sch. 40 Carbon Steel per ASTM A513 ERW</p>								
<b>Flanges:</b>	<p>Lap-joint, NPS 1 (DN 25) - NPS 12 (DN 300) , Ductile Iron ASTM A395, dimensions per ASME B16.42 Class 150 Lap-joint, NPS 1/2 (DN 15) - NPS 12 (DN 300), Carbon Steel, ASTM A105, dimensions per ASME B16.5 Class 150 or Class 300 Lap-joint, NPS 1/2 (DN 15) - NPS 12 (DN 300) , Stainless Steel, ASTM A182, dimensions per ASME B16.5 Class 150 or Class 300 Threaded*, NPS 1 (DN 25) - NPS 4 (DN 100), Carbon Steel ASTM A105, dimensions per ASME B16.5 Class 150 or Class 300</p> <p>Note: Standard flange configuration for Thermalok pipe spools and most PTFE-lined fittings is rotating lap joint. * Swaged pipe is a "flared lap" conforming to ASME B31.3 Para. 306.4 Flared Laps. Slip-on or weld neck flanges are available.</p>								
<b>Fittings:</b>	<p>Fabricated Carbon Steel: Components per ASTM A587, ASTM A53 and/or ASTM A234 WPB Fabricated Stainless Steel: Components per ASTM A312 and/or ASTM A403 Cast Fittings: Ductile Iron Casting (60-40-18) per ASTM A395 or Cast Steel per ASTM A216 Gr. WCB Fittings Flange Material: Ductile Iron Casting (60-40-18) per ASTM A395, or Cast Steel per ASTM A216 Gr. WCB, or Forged Carbon Steel per ASTM A105, or Forged Stainless Steel per ASTM A182.</p>								
<b>Fabrication:</b>	<p>Pipe and Fittings Tolerances per ASTM F1545-15a:</p> <table border="1"> <thead> <tr> <th>Dimension</th> <th>Tolerance, in.</th> </tr> </thead> <tbody> <tr> <td>Length and Centerline Dimensions</td> <td>± 1/8" (3.2 mm)</td> </tr> <tr> <td>Fixed Flange Bolt Hole Alignment</td> <td>± 1/16" (1.6 mm)</td> </tr> <tr> <td>Flange Perpendicularity (with Pipe Centerline)</td> <td>3/32 in/ft (7.8 mm/m) of nominal pipe diameter</td> </tr> </tbody> </table>	Dimension	Tolerance, in.	Length and Centerline Dimensions	± 1/8" (3.2 mm)	Fixed Flange Bolt Hole Alignment	± 1/16" (1.6 mm)	Flange Perpendicularity (with Pipe Centerline)	3/32 in/ft (7.8 mm/m) of nominal pipe diameter
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Flange Perpendicularity (with Pipe Centerline)	3/32 in/ft (7.8 mm/m) of nominal pipe diameter								

See page 65 for standard specifications for 14" (DN 350) - 48" (DN 1200) pipe and fittings.



## ASTM F1545-15a Compliance

### ASTM F1545-15a is the Governing Standard for Plastic-Lined Pipe and Fittings

Full compliance to ASTM F1545-15a requires passing the following qualification tests at design stage:

- **Temperature Aging (Hot)** - (3) 3-hour cycles at rated maximum allowable liner temperature, followed by electrostatic liner inspection
- **Temperature Aging (Cold)** - 48 hours at minimum allowable liner temperature, followed by electrostatic liner inspection.
- **Steam-Cold Water Cycling** - Fill pipe/fitting with steam until metal reaches 350 F (PTFE), drain steam, fill with ambient temperature water until metal temperature cools to 120 F. Repeat 100 cycles.
- **Vacuum Testing** - Full vacuum at desired temperature for 48 hours.

Any changes to manufacturing or design of lined pipe and fittings which affect the fit between the liner and the housing (either pipe or fitting) will require the affected items to be re-tested. Any change in resin formulation also triggers the retest, which applies to lined pipe manufacturers that purchase pre-made liners from multiple vendors.

Resistoflex manufacturers 100% of its liners from raw resin. Manufacturers that purchase liners on the open market should not be automatically presumed to meet ASTM F1545-15a. Buyers can and should request manufacturers to submit qualification test reports for review. ASTM F1545-15a requires that manufacturers perform the tests and keep the qualification test reports on file.

### Is Compliance with ASME B31.3 Process Piping Code Important to You?

ASTM F1545-15a is a "listed component standard" in ASME B31.3 Table A326.1. A manufacturer that does not fully comply with ASTM F1545-15a, including all qualification test requirements, does not comply with ASME B31.3

**Resistoflex meets all requirements of ASTM F1545-15a, including all qualification test requirements. Resistoflex can provide ASTM F1545-15a Qualification Test Reports on request.**

### Resistoflex Also Performs the Following Tests to Ensure Superior Quality:

Stringent testing of the plastic liners before installation into the housings:

- **Dimensional Checks** - OD and wall thickness must be within tolerance
- **Mechanical Testing** - Tensile strength and elongation must meet the requirements of ASTM F1545-15a Table 4
- **Roll Testing of Liners** - 100% of PTFE liners are "roll tested" to reveal any latent cracks.
- **Light Candelung of Liners** - 100% of PTFE liners are illuminated with high-intensity light to reveal any contamination embedded within the liner wall.
- **Differential Scanning Calorimetry** - Thermal analysis of PTFE liners to ensure proper sintering profile.

Rigorous quality testing of all finished lined products:

- **Dimensional Checks** - Pipe and fitting lengths and plastic flare OD
- **30 kV Electrostatic Test** - Test for liner integrity is Resistoflex default test on most items.
- **450 psig Hydrostatic Test** - Test for liner integrity for 10" and larger PTFE-lined pipe and fittings, and 6" - 12" thermoplastic fittings. 100% hydrostatic test is available on request.

### ASTM F1545-15a Test Certification is Available on Request


ASTM F1545-15a Compliance Statement

This is to certify that Resistoflex piping products are in full compliance with all ASTM F1545-15a requirements. This includes the four design qualification tests specified in Section 6, comprised of the following:

- Elevated Temperature Vacuum Test
- Low Temperature Aging Test
- High Temperature Cycling Test
- Steam/Cold Water Cycling Test

Section 6 also requires test documentation be kept on file. Resistoflex test reports are available for customer viewing upon request.

Respectfully submitted,



David Yanik  
Resistoflex Engineering Manager

Contact your Authorized Resistoflex Distributor or the factory to request the Resistoflex Code Compliance brochure, which includes the complete ASTM F1545-15a standard.

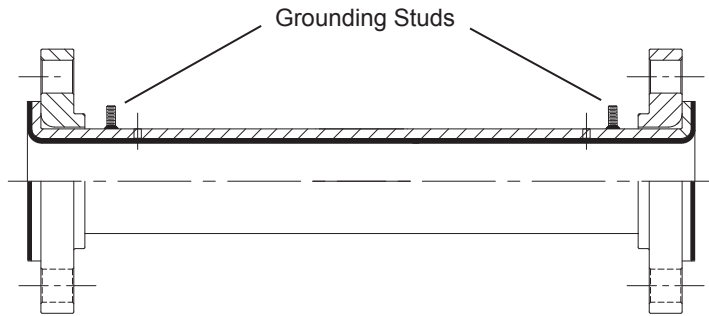
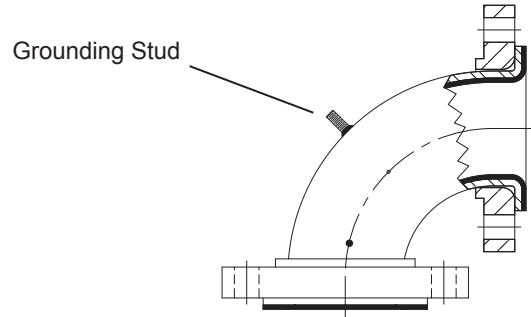
# Grounding - External and Internal

## External Grounding

Pipe and fittings can be specified with threaded grounding studs, or other connection method, as part of a grounding/continuity strategy for plastic-lined pipe and fittings.

The design and installation of "jumper" cables and connectors to each pipe and fitting and grounding points is the scope of the end user or design engineer.

Pipe and fittings can also be provided with an electrically-conductive paint .



## Internal Grounding

Non-conductive fluids can generate a static charge when flowing through a standard PTFE-lined piping system due to the fact that PTFE is electrically insulating. Under certain conditions, conductive and semi-conductive fluids can also generate a static charge. Without dissipative methods, the static charge can build to a level high enough to exceed the dielectric strength of the PTFE liner. This can cause an electrostatic discharge that can arc through the liner, causing liner damage (pinholes) and loss of containment.

Steps can be taken to reduce this condition by limiting fluid velocity in PTFE lined piping as follows:

Liquid Conductivity	Recommended Flow Velocity For PTFE lined piping
1,000 - 10,000 pS/m	less than 9.9 f/s (3 m/s)
50 - 1,000 pS/m	less than 6.6 f/s (2 m/s)
less than 50 pS/m	less than 3.3 f/s (1 m/s)

These values may not be practical, however, due to productivity demands. Where higher flows are necessary, pinholes can be avoided by the prevention of charge accumulation.

The end user can install metal grounding rings or paddles at flange connections to route static charge to grounding points. The paddle material must be compatible with the service fluid. The number and frequency of paddles is determined by the design engineer or a third-party engineer specializing in electrostatic hazard mitigation.

PTFE liner can also be specified as "Anti-Static" or conductive, which is made by adding a small amount of carbon black to the PTFE resin during the liner manufacturing process. The anti-static PTFE has a surface resistivity of  $10^4$  to  $10^8$  Ohm. The static charge will dissipate through the liner to the metal housing, rather than accumulating on the surface of the liner.

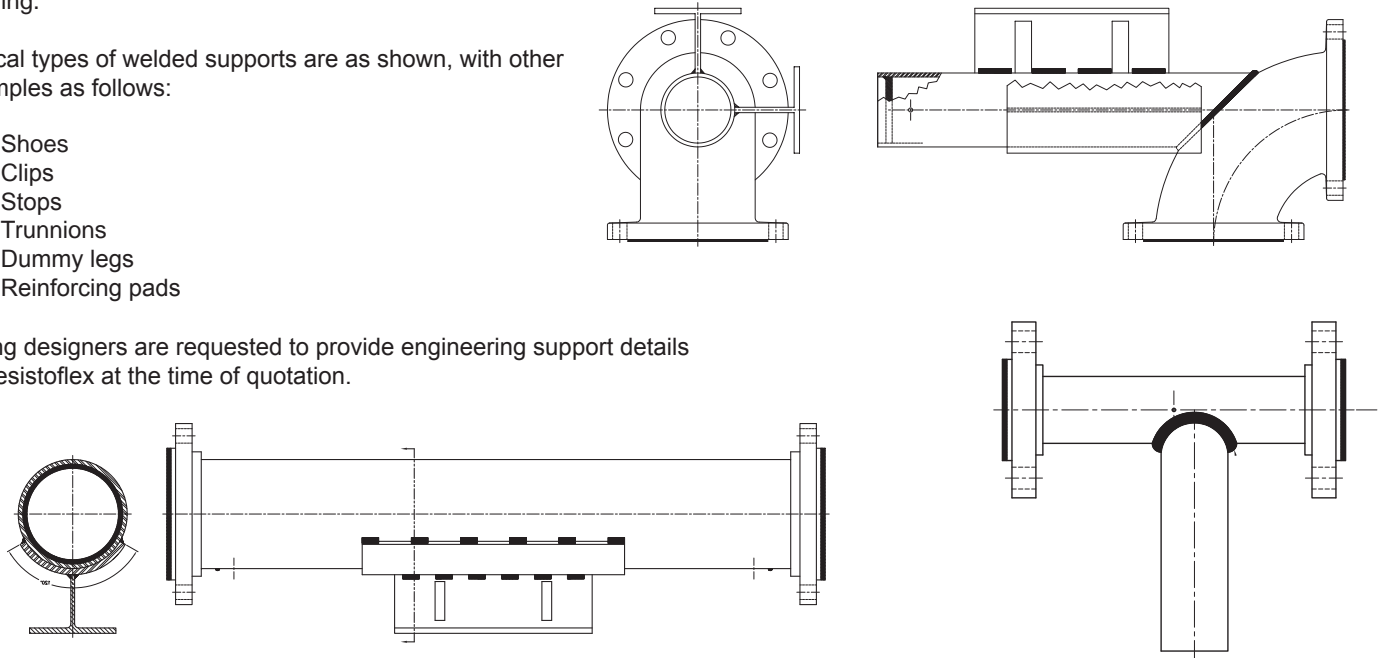
## Welded Supports

Welded attachments cannot be applied to lined pipe at the site, or liner damage will result. Resistoflex can provide shop-welded supports that are attached to the pipe or fitting prior to lining.

Typical types of welded supports are as shown, with other examples as follows:

- Shoes
- Clips
- Stops
- Trunnions
- Dummy legs
- Reinforcing pads

Piping designers are requested to provide engineering support details to Resistoflex at the time of quotation.



## Engineering Support Services

### Bill of Material Take-Off for Quotes

Resistoflex can generate a bill of material from customer isometric drawings or orthographic drawings at no charge. Bills of materials from orthographic drawings will be marked as "budgetary". Drawings can be submitted in PDF or \*.dwg format.

### Resistoflex Isometric Drawing Service

We can develop isometric drawings from customer orthographic drawings, or from hand-sketches of field measurements. This is a fee-based service.

### Installation Training Certification

Plastic-lined pipe and fittings are installed like other flanged piping systems, with emphasis placed on using calibrated torque wrenches and following the manufacturer's torque requirements. For installers that are unfamiliar with plastic-lined pipe installation, or would like a refresher course, we offer on-site installation training and certification.

### Field Fabrication Training Certification

Resistoflex offers three styles of lined pipe - Thermalok, Swaged, and CONQUEST®, all of which can be field-fabricated at site using tooling and procedures provided by Resistoflex. We strongly recommend that operators be trained and certified before beginning field fabrication.

For more information regarding Engineering Support Services, contact your Resistoflex Distributor or the factory.

## Standard and Custom Coatings

### Standard Coating

All pipe and fittings are coated with International Coatings Intergard 345, which is a high-solids amine-cured epoxy primer containing zinc phosphate anti-corrosive pigmentation. Color is gray.

Surface preparation is SSPC-SP10 Near-White Blast Cleaning.

### Optional High Performance Coatings

After collecting input from major end-users, paint manufacturers, and distributors, we have developed four premium paint options with reduced standard pricing. This standardized offering meets 90% of the past special painting requirements. These four options enable improved pricing and shorter lead times by using paints that are designed with high performance and ease of application.

The four High-Performance paints are:

International Coatings Interzinc 52:	Zinc-Rich Epoxy.
International Coatings Intergard 345:	Amine-Cured Epoxy.
International Coatings Interthane 990:	Acrylic-Polyester Polyurethane.
Carboline Thermaline 450:	High-Temperature, Corrosion-Resistant Glass Flake-Filled Amine-Cured Epoxy Novolac.

These paints are offered in the following 2 & 3 coat combinations.

Paint System Number	Application	Paint System Description	Paint	DFT mils (µm)	Supplier
1	Above Ground, <250 F, Not Insulated	Primer: Organic Zinc-Rich Epoxy per SSPC Paint 20 Topcoat: Amine-Cured Epoxy	Interzinc 52 Intergard 345	2 - 3 (50 - 75) 4 - 6 (100 - 150)	International Coatings
2	Above Ground, <250 F, Not Insulated UV Resistance	Primer: Organic Zinc-Rich Epoxy per SSPC Paint 20 Topcoat: Acrylic Polyurethane	Interzinc 52 Interthane 990	2 - 3 (50 - 75) 2 - 3 (50 - 75)	International Coatings
3	Above Ground, <250 F, Not Insulated UV Resistance	Primer: Organic Zinc-Rich Epoxy per SSPC Paint 20 Intermediate coat: Amine-Cured Epoxy Topcoat: Acrylic Polyurethane	Interzinc 52 Intergard 345 Interthane 990	2 - 3 (50 - 75) 4 - 6 (100 - 150) 2 - 3 (50 - 75)	International Coatings
4	Insulated Pipe, Temps to 450 F, corrosive mist or splash	Primer: Glass Flake-Filled Amine-Cured Novolac Epoxy Topcoat: Glass Flake-Filled Amine-Cured Novolac Epoxy	Thermaline 450	4 - 5 (100 - 125) 4 - 5 (100 - 125)	Carboline

Note: Other customer-specified coatings are available on request, including inorganic zinc silicates, epoxy phenolics, siloxanes, and electrically-conductive polyamine-cured epoxies. Upon review of the data sheets of the requested paints, however, Resistoflex reserves the right to decline quoting customer-specified coatings based on VOC content, manufacturing incompatibility, or other factors.

Note: All paint systems have a poor resistance to handling and transit damage. This fact should be considered when evaluating shop painting versus painting at site. If shop painting is selected, touch-up will be required after job-site receipt. Touch-up costs are for Buyer's account.

# 1/2" (DN 15) - 12" (DN 300) Flange and Pipe Dimensional Data

ASME B16.5 Flange Dimensions										
Class 150						Class 300				
Size NPS (DN)	Outside Diameter in. (mm)	Thickness in. (mm)	No. and Diameter of Bolt Holes	Bolt Circle Diameter in. (mm)		Outside Diameter in. (mm)	Thickness in. (mm)	No. and Diameter of Bolt Holes	Bolt Circle Diameter in. (mm)	
1/2 (15)	3 1/2 (89)	7/16 (11)	(4) 5/8	2 3/8 (60)		3 3/4 (95)	9/16 (14)	(4) 5/8	2 5/8 (67)	
3/4 (20)	3 7/8 (98)	1/2 (13)	(4) 5/8	2 3/4 (70)		4 5/8 (117)	5/8 (16)	(4) 3/4	3 1/4 (83)	
1 (25)	4 1/4 (108)	9/16 (14)	(4) 5/8	3 1/8 (79)		4 7/8 (124)	11/16 (17)	(4) 3/4	3 1/2 (89)	
1 1/2 (40)	5 (127)	11/16 (17)	(4) 5/8	3 7/8 (98)		6 1/8 (156)	13/16 (21)	(4) 7/8	4 1/2 (114)	
2 (50)	6 (152)	3/4 (19)	(4) 3/4	4 3/4 (121)		6 1/2 (165)	7/8 (22)	(8) 3/4	5 (127)	
3 (80)	7 1/2 (191)	15/16 (24)	(4) 3/4	6 (152)		8 1/4 (210)	1 1/8 (29)	(8) 7/8	6 5/8 (168)	
4 (100)	9 (229)	15/16 (24)	(8) 3/4	7 1/2 (191)		10 (254)	1 1/4 (32)	(8) 7/8	7 7/8 (200)	
6 (150)	11 (279)	1 (25)	(8) 7/8	9 1/2 (241)		12 1/2 (318)	1 7/16 (37)	(12) 7/8	10 5/8 (270)	
8 (200)	13 1/2 (343)	1 1/8 (29)	(8) 7/8	11 3/4 (298)		15 (381)	1 5/8 (41)	(12) 1	13 (330)	
10 (250)	16 (406)	1 3/16 (30)	(12) 1	14 1/4 (362)		17 1/2 (445)	1 7/8 (48)	(16) 1 1/8	15 1/4 (387)	
12 (300)	19 (483)	1 1/4 (32)	(12) 1	17 (432)		20 1/2 (521)	2 (51)	(16) 1 1/4	17 3/4 (451)	

Flange data for 14" (DN 350) - 48" (DN1200) sizes is on page 66

ASME B36.10 Pipe Dimensions						
Size NPS (DN)	Outside Diameter in. (mm)	Wall Thickness in. (mm)				
		Sch. 40	Sch. 30	Sch. 20		
1/2 (15)	0.840 (21)	0.109 (2.8)	-- --	-- --		
3/4 (20)	1.050 (27)	0.113 (2.9)	-- --	-- --		
1 (25)	1.315 (33)	0.133 (3.4)	-- --	-- --		
1 1/2 (40)	1.900 (48)	0.145 (3.7)	-- --	-- --		
2 (50)	2.375 (60)	0.154 (3.9)	-- --	-- --		
3 (80)	3.500 (89)	0.216 (5.5)	-- --	-- --		
4 (100)	4.500 (114)	0.237 (6)	-- --	-- --		
6 (150)	6.625 (168)	0.280 (7.1)	-- --	-- --		
8 (200)	8.625 (219)	0.322 (8.2)	-- --	-- --		
10 (250)	10.750 (273)	-- --	0.307 (7.8)	-- --		
12 (300)	12.750 (324)	-- --	-- --	0.250 (6.4)		

Pipe data for 14" (DN 350) - 48" (DN1200) sizes is on page 66

## Pressure Ratings and Liner Data

The pressure/temperature ratings of Resistoflex Plastic-Lined Piping Products conform to ASME B16.5 Class 150 per the appropriate flange metallurgy. See Figure 1. The pressure/temperature ratings for lined piping with ASME B16.5 Class 300 flanges are lower than the true Class 300 ratings due to the plastic raised face gasket sealing surface on lined pipe and fittings.

Standard 1" - 12" PTFE-lined pipe and fittings are rated for full vacuum at 450 F (230 C) continuous. There are a few fittings that are not rated for full vacuum to 450 F - the vacuum ratings of all 1" - 12" PTFE-lined fittings are indicated on the product pages in this design manual. PP and PVDF-lined pipe and fittings are rated for full vacuum to 225 F (107 C) and 275 F (135 C), respectively.

14" - 18" PTFE-lined pipe and fittings have limited vacuum resistance. Please consult Resistoflex for specific capabilities. 20" - 24" PTFE-lined pipe and fittings are not rated for vacuum service.

Figure 1: Pressure ratings for Resistoflex 1" - 24" pipe and fittings

Temperature °F (°C)	Pressure Class and Flange Material			
	Class 150 Ductile Iron psig (barg)	Class 150 Carbon Steel psig (barg)	Class 150 Stainless Steel Type 304L/316L psig (barg)	Class 300 Carbon Steel psig (barg)
0 (-18)	250 (17.2)	285 (19.7)	230 (15.9)	485 (33.4)
50 (10)	250 (17.2)	285 (19.7)	230 (15.9)	485 (33.4)
100 (38)	250 (17.2)	285 (19.7)	230 (15.9)	485 (33.4)
150 (65)	242 (16.7)	275 (19.1)	212 (14.6)	485 (33.4)
200 (93)	235 (16.2)	260 (17.9)	195 (13.4)	475 (32.8)
250 (121)	225 (15.5)	245 (16.9)	185 (12.8)	460 (31.7)
300 (149)	215 (14.8)	230 (15.9)	175 (12.1)	450 (31.1)
350 (177)	207 (14.3)	215 (14.8)	167 (11.5)	440 (30.3)
400 (204)	200 (13.8)	200 (13.8)	160 (11.1)	425 (29.3)
450 (232)	185 (12.8)	185 (12.8)	155 (10.7)	405 (27.9)

## Plastic-Liner Data

Liner Characteristics	PTFE	PFA	PP	PVDF (homopolymer)	PVDF (copolymer)	ETFE
Service Temperature Range, °F <sup>1</sup>	-20°F to 450°F	0°F to 450°F	0°F to 225°F	0°F to 275°F	-20°F to 275°F	-20°F to 300°F
Liner Color	White	Natural	Orange <sup>2</sup>	Black <sup>2</sup>	Black <sup>3</sup>	Natural
Color of Liner Identification Band	White with Black Lettering	Brown w/ White Lettering	Orange w/ Black Lettering	Black w/ White Lettering	Black w/ White Lettering	Gray w/ White Lettering
Coefficient of Thermal Expansion of Pipe Liner Prior to Lining, in./in./°F	5.5 x 10 <sup>-5</sup>	7.8 x 10 <sup>-5</sup>	4.8 x 10 <sup>-5</sup>	6.6 x 10 <sup>-5</sup>	7.8 x 10 <sup>-5</sup>	7.4 x 10 <sup>-5</sup>
Thermal Conductivity ("K" Factor) of Liner, BTU-in./hr.-sq. ft.-°F	1.7	1.3	0.8	0.9	1.18	1.65
Tensile Strength of Liner at Yield, psi	3,000 - 4,000	3,800 - 4,500	4,000 - 4,500	5,000 - 6,000	4,500 - 5,500	6700
Elongation of Liner at Yield, %	250 - 350	300 - 350	10 - 13	8 - 10	10 - 20	150 - 300
Compressive Strength of Liner at Yield, psi	1,700	3,500	5,500 - 8,000	10,000 - 16,000	5000 - 8500	2,500
Specific Gravity of Liner	2.14 - 2.19	2.12 - 2.17	0.90 - 0.92	1.75 - 1.78	1.76 - 1.78	1.70 - 1.72

PTFE = polytetrafluoroethylene  
PFA = perfluoroalkoxy

PP = polypropylene  
PVDF = polyvinylidene fluoride

ETFE = ethylene tetrafluoroethylene

<sup>1</sup> Max. allowable temperature depends on the specific contact chemicals.

<sup>2</sup> Available unpigmented as a special option.

## Thermalok and Swaged Pipe Dimensions

Thermalok Pipe											
Size NPS (DN)	Liner Thickness, in. (mm)						Max. Length ft. (mtr.)	Weight			
	PTFE/ATL*		PP		PVDF			(2) Flanges, lbs.	Per Foot, lbs.	(2) Flanges, kg	Per Meter, kg
	Inch	mm	Inch	mm	Inch	mm					
1/2 (15)	0.054	1.4	N/A				20 (6)	1.2	1	0.5	1.4
3/4 (20)	0.062	1.6	N/A				20 (6)	2	1.4	0.9	2
1 (25)	0.130	3.3	0.135	3.5	0.138	3.5	20 (6)	5.4	1.9	2.5	2.8
1 1/2 (40)	0.150	3.8	0.160	4.1	0.162	4.1	20 (6)	6.4	3.1	2.9	4.6
2 (50)	0.155	3.9	0.175	4.5	0.162	4.1	20 (6)	10.4	4.1	4.7	6.1
3 (80)	0.155	3.9	0.175	4.5	0.162	4.1	20 (6)	16.8	8.3	7.6	12.3
4 (100)	0.160	4.1	0.210	5.4	0.195	5	20 (6)	27	11.8	12.3	17.5
6 (150)	0.255	6.5	0.220	5.6	0.220	5.6	20 (6)	39.8	20.6	18.1	30.6
8 (200)	0.310	7.9	0.220	5.6	0.220	5.6	20 (6)	61	32.1	27.7	47.8
10 (250)	0.350	8.9	0.320	8.2	0.223	5.7	PTFE - 15 (4.5) PP/PVDF - 20 (6)	89	39	40.5	58
12 (300)	0.450	11.4	0.380	9.7	N/A		PTFE - 15 (4.5) PP/PVDF - 20 (6)	130	59	59.1	87.8

\*ATL is available in 1" - 12", only.

Thermalok standard flange style is rotating both ends. Fixed flange available on request, at additional charge.

1" - 12" PP and 1" - 10" PVDF lined Thermalok are full-vacuum rated to maximum liner operating temperature

PTFE-lined Thermalok is rated to full-vacuum at 450 F (230 C) in 1" - 12" sizes.

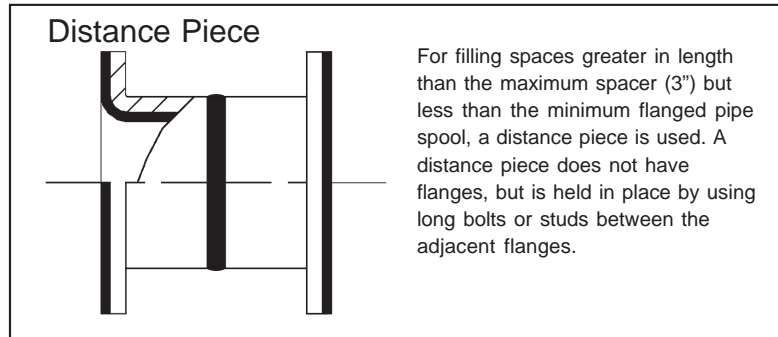
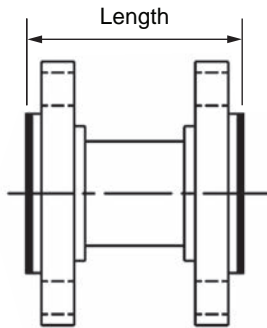
Swaged Pipe										
Size NPS (DN)	Liner Thickness, in. (mm)		Max. Length, ft. (mtr)			Weight				
	PTFE	PP/PVDF	PTFE	PP	PVDF	(2) Flanges, lbs.	Per Foot, lbs.	(2) Flanges, kg	Per Meter, kg	
1 (25)	0.130 (3.3)	0.150 (3.9)	20 (6)	20 (6)	20 (6)	5.4	1.9	2.5	3	
1 1/2 (40)	0.130 (3.3)	0.160 (4.1)	40 (12.2)	40 (12.2)	40 (12.2)	6.4	3.1	2.9	4.6	
2 (50)	0.130 (3.3)	0.172 (4.4)	40 (12.2)	40 (12.2)	40 (12.2)	10.4	4.1	4.7	6.2	
3 (80)	0.130 (3.3)	0.175 (4.5)	40 (12.2)	40 (12.2)	40 (12.2)	16.8	8.3	7.6	12.5	
4 (100)	0.160 (4.1)	0.207 (5.3)	40 (12.2)	40 (12.2)	40 (12.2)	27.1	11.8	12.2	17.7	

Swaged pipe is only available in ASTM A513 ERW carbon steel.

Swaged standard flange is fixed x rotating. Rotating both ends available on request, at additional charge.

Swaged pipe is full-vacuum rated to maximum liner operating temperature

# Minimum Flanged Pipe Spool Lengths



Thermalok Minimum Pipe Spool Lengths (Fixed x Rotating Flanges)										
Size NPS (DN)	No Options				With Vent Couplings or Grounding Studs				Class 150 Field Flare *	
	Class 150		Class 300		Class 150		Class 300			
	Inch	mm	Inch	mm	inch	mm	inch	mm		
1/2 (15)	2 5/8	67	3 3/8	86	3 7/8	98	4 5/8	117	N/A	
3/4 (20)	2 5/8	67	3 3/8	86	3 7/8	98	4 5/8	117	N/A	
1 (25)	2 5/8	67	3 3/8	86	3 7/8	98	4 5/8	117	5 1/2 (139.7)	
1 1/2 (40)	3 1/8	79	3 3/4	95	4 3/8	111	5	127	7 (177.8)	
2 (50)	3 3/8	86	4	102	4 5/8	117	5 1/4	133	8 (203.2)	
3 (80)	3 3/4	95	4 3/4	121	5	127	6	152	10 5/8 (269.9)	
4 (100)	4 1/4	108	5 3/8	137	5 1/2	140	6 5/8	168	11 (279.4)	
6 (150)	4 7/8	124	5 7/8	149	6 1/8	156	7 1/4	181	16 1/2 (419.1)	
8 (200)	5 1/4	133	6 5/8	168	6 1/2	165	7 7/8	200	16 1/2 (419.1)	
10 (250)	5 7/8	149	8 3/8	213	7 1/8	181	9 5/8	244	Consult Factory	
12 (300)	6 1/4	156	8 5/8	219	7 3/8	187	9 7/8	251	Consult Factory	

1/2" and 3/4" consult factory

Minimum lengths are with fixed x rotating flanges. Shorter lengths available with fixed x fixed flanges.

\* When using a pipe end forming machine such as a Conrac by PHI, a division of Tulip Corporation. Min. length assumes no welding of stubends.

Swaged Minimum Pipe Spool Lengths											
Size NPS (DN)	Standard				Special *				Field **		
	Class 150		Class 300		Class 150		Class 300				
	Inch	mm	Inch	mm	inch	mm	inch	mm	inch	mm	
1 (25)	4	102	4	102	2 1/2	64	2 1/2	64	7	178	
1 1/2 (40)	4	102	4	102	2 3/4	70	2 3/4	70	7	178	
2 (50)	4 1/2	114	4 1/2	114	3 1/8	79	3 1/8	79	7	178	
3 (80)	5	127	5	127	3 1/2	89	3 1/2	89	8	203	
4 (100)	5 1/2	140	5 1/2	140	3 3/4	95	3 3/4	95	8	203	

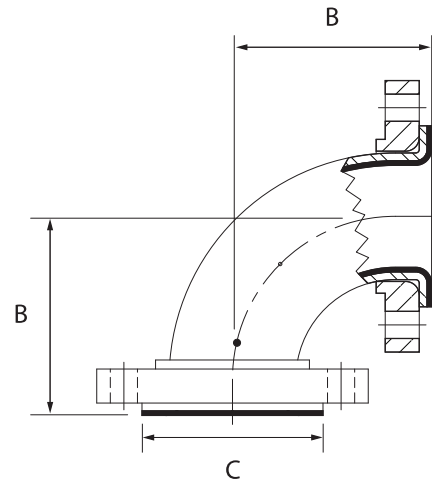
\* Available only as fixed flanged spools

\*\* Capability of field threaders, such as Wheeler Rex, or equal



# 90 Degree Elbows, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions				Available Construction					Weight	
		B		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	Cast DI A395	Cast Steel A216 WCB	ATL	lbs.	kg
		Inch	mm	Inch	mm							
1/2	15	3 1/2	89	1 3/4	35		●				3	1.5
3/4	20	3 1/2	89	1 11/16	43		●				5	2.1
1	25	3 1/2	89	2	51	●	●		●	●	6	2.7
1 1/2	40	4	102	2 7/8	73	●	●		●	●	9	4
2	50	4 1/2	114	3 5/8	92	●	●		●	●	14	6.4
3	80	5 1/2	140	5	127	●	●		●	●	26	12
4	100	6 1/2	165	6 3/16	157	●	●		●	●	42	19
6	150	8	203	8 1/2	216	●	●	●	●	●	79	36
8	200	9	229	10 5/8	270	●	●	●	●	●	125	57
10	250	11	279	12 3/4	324	●	●	●	●	●	180	82
12	300	12	305	15	381	●	●	●	●	●	244	111

Note: Cast steel elbows are more economical than fabricated steel in 6" - 10" sizes.  
 Vacuum Rating: 1" - 12" is Full Vacuum Rated to 450 F (232 C)

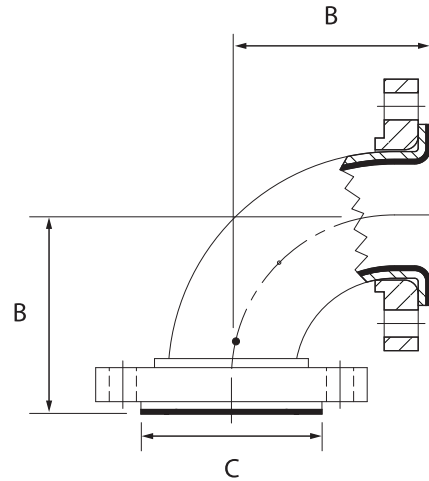
Also available in stainless steel and other alloys  
 Weights are approximate

See page 68 for for 14" (DN 350) - 48" (DN 1200) 90 degree elbow dimensional information.

# 90 Degree Elbows, PTFE-Lined

CS = Carbon Steel  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

Note: 1" - 6" sizes can be made to Class 150 center-face dimensions  
 Consult factory for Class 300 flanged fittings in 10" and larger sizes  
 Also available in stainless steel and other alloys  
 Weights are approximate

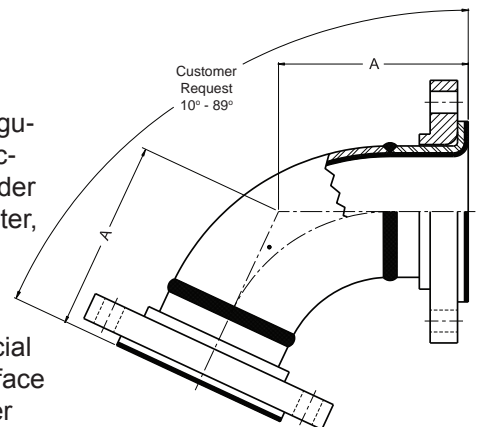


ASME B16.5 Class 300 Flanged									
Size (NPS)	Size (DN)	Dimensions				Available Construction		Weight	
		B		C		FAB with CS Flanges (Fixed or Rotating)	ATL	lbs.	kg
		Inch	mm	Inch	mm				
1/2	15	3 1/2	89	1 3/4	35	•		5	2
3/4	20	3 1/2	89	1 11/16	43	•		8	4
1	25	4	102	2	51	•	•	8	4
1 1/2	40	4 1/2	114	2 7/8	73	•	•	14	6
2	50	5	127	3 5/8	92	•	•	18	8
3	80	6	152	5	127	•	•	35	16
4	100	7	178	6 3/16	157	•	•	62	28
6	150	8 1/2	216	8 1/2	216	•	•	115	52
8	200	10	254	10 5/8	270	•	•	187	85

## Fabricated Special Angle Elbows Lined with PTFE, ETFE, or PVDF

Resistoflex can provide special angle elbows in various sizes and many configurations, in carbon steel or stainless steel. These are custom fabrications to accommodate non-standard applications that may occur in piping design. To order these elbows, please submit a sketch and/or description including pipe diameter, bend angle, and desired centerline-face dimension ("A" in diagram at right). Special angle elbows are not rated for vacuum service.

As a guide, when centerline-face dimensions are not known or provided, special angle elbows with less than 45 degree bend angle have the same centerline-face as a standard 45 degree elbow. Special angle elbows with bend angle greater than 45 degrees have the same centerline-face as a standard 90 degree elbow.

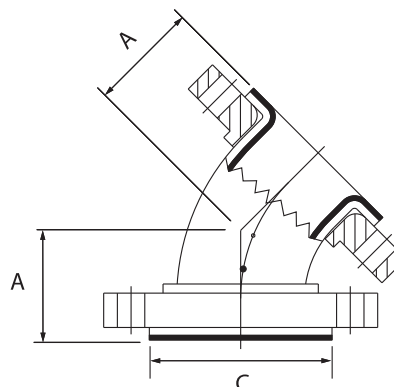


## 45 Degree Elbows, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

Vacuum Rating: 1" - 12" is Full Vacuum Rated to 450 F (232 C)

Also available in stainless steel and other alloys  
 Weights are approximate



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions				Available Construction					Weight	
		A		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	Cast DI A395	Cast Steel A216 WCB	ATL	lbs.	kg
		Inch	mm	Inch	mm							
1/2	15	1 3/4	45	1 3/4	35		•				4.6	2.1
3/4	20	1 3/4	45	1 11/16	43		•				5	2.3
1	25	1 3/4	45	2	51	•	•	•	•	•	5.3	2.4
1 1/2	40	2 1/4	57	2 7/8	73	•	•	•		•	8	3.6
2	50	2 1/2	64	3 5/8	92	•	•		•	•	12.1	5.5
3	80	3	76	5	127	•	•			•	21.5	9.8
4	100	4	102	6 3/16	157	•	•		•	•	39.5	18.0
6	150	5	127	8 1/2	216	•	•	•		•	57.5	26.1
8	200	5 1/2	140	10 5/8	270	•	•	•		•	98.6	44.8
10	250	6 1/2	165	12 3/4	324	•	•	•		•	100	45.5
12	300	7 1/2	190	15	381	•	•	•		•	160	72.7

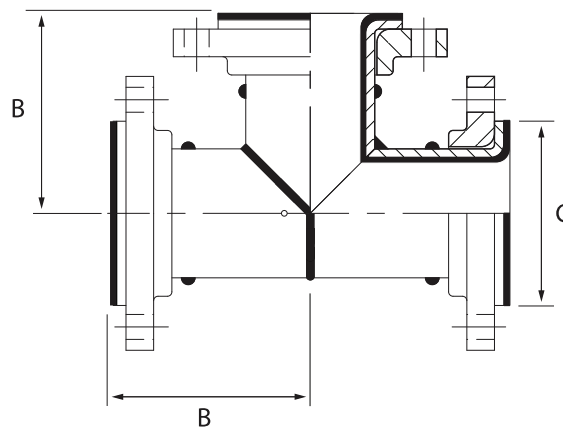
  

ASME B16.5 Class 300 Flanged												
Size (NPS)	Size (DN)	Dimensions				Available Construction					Weight	
		A		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	Cast DI A395	Cast Steel A216 WCB	ATL	lbs.	kg
		Inch	mm	Inch	mm							
1	25	2 1/4	57	2	51		•			•	7	3.2
1 1/2	40	2 3/4	70	2 7/8	73		•			•	9.5	4.3
2	50	3	76	3 5/8	92		•			•	13.5	6.1
3	80	3 1/2	89	5	127		•			•	28	12.7
4	100	4 1/2	114.3	6 3/16	157		•			•	53	24.1
6	150	5 1/2	140	8 1/2	216		•			•	94	42.7
8	200	6	152	10 5/8	270		•			•	143	65.0

See page 69 for for 14" (DN 350) - 48" (DN 1200) 45 degree elbow dimensional information.

## Equal Tees, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner



ASME B16.5 Class 150 Flanged										
Size (NPS)	Size (DN)	Dimensions				Available Construction			Weight	
		B		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL	lbs.	kg
		Inch	mm	Inch	mm					
1/2*	15	3 1/2	89	1 3/4	35		●		5.5	2.5
3/4*	20	3 1/2	89	1 11/16	43		●		7	3.2
1	25	3 1/2	89	2	51	●	●	●	10	4.5
1 1/2	40	4	102	2 7/8	73	●	●	●	14	6.4
2	50	4 1/2	114	3 5/8	92	●	●	●	19.5	8.9
3	80	5 1/2	140	5	127	●	●	●	40	18.2
4	100	6 1/2	165	6 3/16	157	●	●	●	67	30.5
6	150	8	203	8 1/2	216	●	●	●	120	54.5
8	200	9	229	10 5/8	270	●	●	●	180	81.8
10	250	11	279	12 3/4	324	●	●	●	219	99.5
12	300	12	305	15	381	●	●	●	318	144.5

\* PFA-lined

Vacuum Rating = Full at 450 F (232 C)

Also available in stainless steel and other alloys

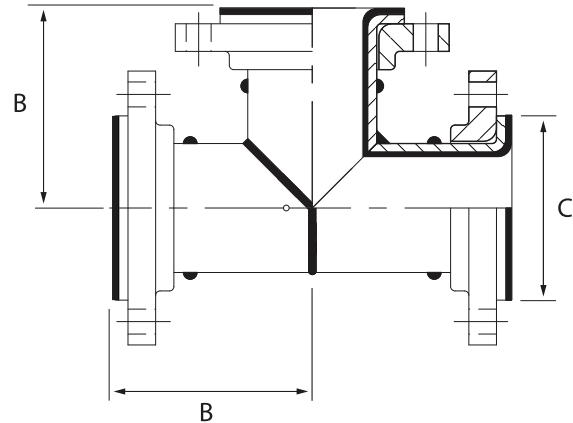
Weights are approximate

Note: Tees are available with shortened branch or run dimensions. Please consult factory with custom requirements.

See page 70 for 14" (DN 350) - 48" (DN 1200) equal tee dimensional information.

## Equal Tees, PTFE-Lined

CS = Carbon Steel  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner



ASME B16.5 Class 300 Flanged									
Size (NPS)	Size (DN)	Dimensions				Available Construction		Weight	
		B		C		FAB with CS Flanges (Fixed or Rotating)	ATL	lbs.	kg
		Inch	mm	Inch	mm				
1/2	15	3 1/2	89	1 3/4	35	●		5	2
3/4	20	3 1/2	89	1 11/16	43	●		8	4
1	25	4	102	2	51	●	●	8	4
1 1/2	40	4 1/2	114	2 7/8	73	●	●	14	6
2	50	5	127	3 5/8	92	●	●	18	8
3	80	6	152	5	127	●	●	35	16
4	100	7	178	6 3/16	157	●	●	62	28
6	150	8 1/2	216	8 1/2	216	●	●	115	52
8	200	10	254	10 5/8	270	●	●	187	85

Note: 1" - 6" sizes can be made to Class 150 center-face dimensions  
 Vacuum Rating = Full at 450 F (232 C)  
 Consult factory for Class 300 flanged fittings in 10" and larger sizes  
 Also available in stainless steel and other alloys  
 Weights are approximate

## Reducing Tees, PTFE-Lined

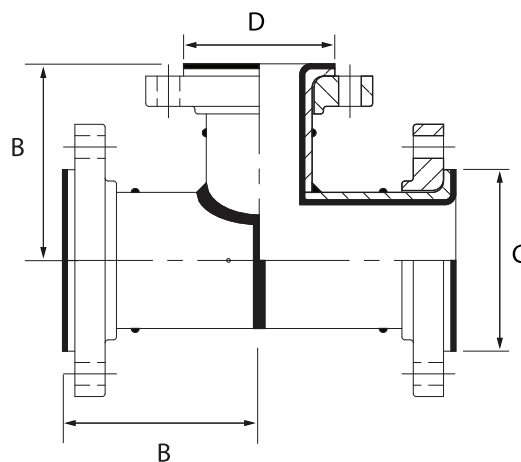
CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

Vacuum Rating: 1" - 12" is Full Vacuum Rated to 450 F (232 C)

Also available in stainless steel and other alloys

Weights are approximate

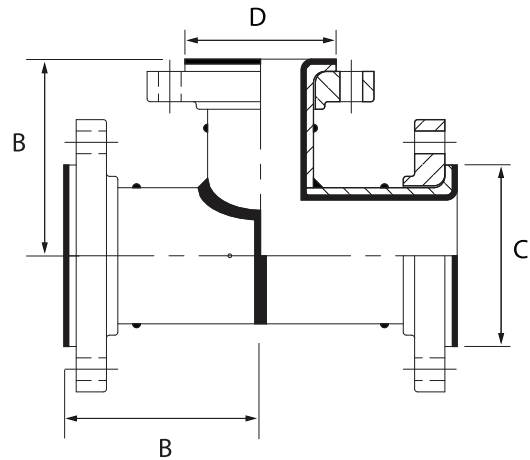
\* PFA-Lined



ASME B16.5 Class 150 Flanged												
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction			Weight	
		B		C		D		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL		
		Inch	mm	Inch	mm	Inch	mm				lbs.	kg
1 (25)	1/2 (15)*	3 1/2	89	2	51	1 3/4	35		Fixed		8	3.6
	3/4 (20)*					1 11/16	43		Fixed		9	4.1
1 1/2 (40)	1/2 (15)*	4	102	2 7/8	73	1 3/4	35		Fixed		9	4.1
	3/4 (20)*					1 11/16	43		Fixed		10	4.5
	1 (25)					2	51	•	•	•	12.2	5.5
2 (50)	1 (25)	4 1/2	114	3 5/8	92	2	51	•	•	•	16.2	7.4
	1 1/2 (40)					2 7/8	73	•	•	•	17.6	8.0
3 (80)	1 (25)	5 1/2	140	5	127	2	51	•	•	•	31	14.1
	1 1/2 (40)					2 7/8	73	•	•	•	32.2	14.6
	2 (50)					3 5/8	92	•	•	•	34	15.5
4 (100)	1 (25)	6 1/2	165	6 3/16	157	2	51	•	•	•	45.5	20.7
	1 1/2 (40)					2 7/8	73	•	•	•	56.2	25.5
	2 (50)					3 5/8	92	•	•	•	57	25.9
	3 (80)					5	127	•	•	•	57.7	26.2

See page 71 - 74 for 14" (DN 350) - 48" (DN 1200) reducing tee dimensional information.

# Reducing Tees, PTFE-Lined



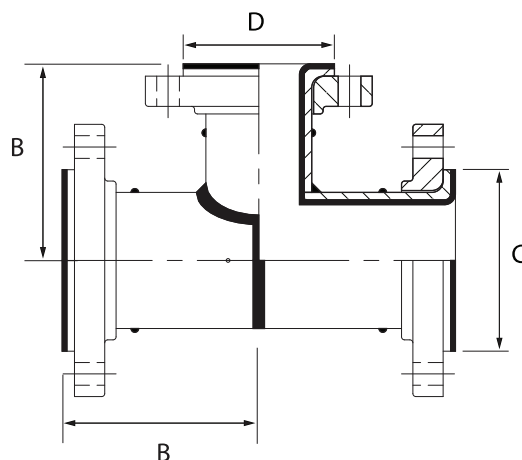
- CS = Carbon Steel
- DI = Ductile Iron
- FAB = Fabricated Steel
- ATL = Advanced Technology Liner

ASME B16.5 Class 150 Flanged												
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction			Weight	
		B		C		D		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL		
		Inch	mm	Inch	mm	Inch	mm				lbs.	kg
6 (150)	2 (50)	8	203	8 1/2	216	3 5/8	92	•	•	•	90.8	41.3
	5					127	•	•	•	80	36.4	
	6 3/16					157	•	•	•	105.6	48.0	
8 (200)	3 (80)	9	229	10 5/8	270	5	127	•	•	•	162	73.6
	6 3/16					157	•	•	•	165.5	75.2	
	8 1/2					216	•	•	•	170.3	77.4	
10 (250)	6 (150)	11	279	12 3/4	324	8 1/2	216	•	•	•	250	113.6
	10 5/8					270	•	•	•	260	118.2	
12 (300)	4 (100)	12	305	15	381	6 3/16	157	•	•	•	260	118.2
	8 1/2					216	•	•	•	270	122.7	
	10 5/8					270	•	•	•	280	127.3	
	12 3/4					324	•	•	•	290	131.8	

VVacuum Rating = Full at 450 F (232 C)  
 Also available in stainless steel and other alloys  
 Weights are approximate

## Reducing Tees, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner



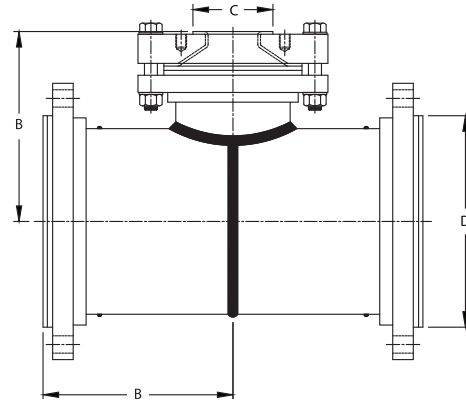
ASME B16.5 Class 300 Flanged												
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction			Weight	
		B		C		D		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL		
		Inch	mm	Inch	mm	Inch	mm				lbs.	kg
1.5 (40)	1 (25)	4	102	2 7/8	73	2	51	•	•	•	18.5	8.4
2 (50)	1 (25)	4 1/2	114	3 5/8	92	2	51	•	•	•	21.1	9.6
	1.5 (40)					2 7/8	73	•	•	•	24.3	11
3 (150)	1 (25)	5 1/2	140	5	127	2	51	•	•	•	41.3	18.8
	1.5 (40)					2 7/8	73	•	•	•	44.3	20.1
	2 (50)					3 5/8	92	•	•	•	45.4	20.6
4 (100)	1.5 (40)	6 1/2	165	6 3/16	157	2 7/8	73	•	•	•	78.5	35.7
	2 (50)					3 5/8	92	•	•	•	78.6	35.7
	3 (80)					5	127	•	•	•	82	37.3
6 (150)	2 (50)	8	203	8 1/2	216	3 5/8	92	•	•	•	128.8	58.5
	3 (80)					5	127	•	•	•	120.7	54.9
	4 (100)					6 3/16	157	•	•	•	151.4	68.8
8 (200)	3 (80)	9	229	10 5/8	270	5	127	•	•	•	222.7	101.2
	4 (100)					6 3/16	157	•	•	•	231.3	105.1
	6 (150)					8 1/2	216	•	•	•	244.3	111

Vacuum Rating = Full at 450 F (232 C)  
 Also available in stainless steel and other alloys  
 Weights are approximate



## Fabricated Two-Piece Reducing Tees, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

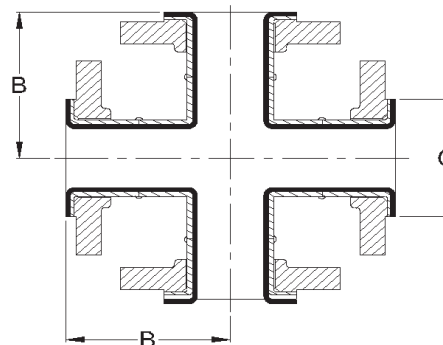


ASME B16.5 Class 150 Flanged										
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction		
		B		C		D		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL
		Inch	mm	Inch	mm	Inch	mm			
6 (150)	1 (25)	8	203	8 1/2	216	2	51	•	•	•
	2 7/8					73	•	•	•	
8 (200)	1 (25)	9	229	10 5/8	270	2	51	•	•	•
	2 7/8					73	•	•	•	
	3 5/8					92	•	•	•	
10 (250)	1 (25)	11	279	12 3/4	324	2	51	•	•	•
	2 7/8					73	•	•	•	
	3 5/8					92	•	•	•	
	5					127	•	•	•	
	6 3/16					157	•	•	•	
12 (300)	1 (25)	12	305	15	381	2	51	•	•	•
	2 7/8					73	•	•	•	
	3 5/8					92	•	•	•	
	5					127	•	•	•	

Construction is a reducing tee with a shortened stack and a reducing filler flange bolted together  
 Vacuum Rating = Full at 450 F (232 C)  
 Also available in stainless steel and other alloys  
 Consult factory for weights

## Crosses, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner



ASME B16.5 Class 150 Flanged										
Size (NPS)	Size (DN)	Dimensions				Available Construction			Weight	
		B		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL	lbs.	kg
		Inch	mm	Inch	mm					
1/2*	15	3 1/2	89	1 3/4	35		●		7	3.2
3/4*	20	3 1/2	89	1 11/16	43		●		8.8	4
1	25	3 1/2	89	2	51	●	●	●	12	5.5
1 1/2	40	4	102	2 7/8	73	●	●	●	19	8.6
2	50	4 1/2	114	3 5/8	92	●	●	●	28.5	13
3	80	5 1/2	140	5	127	●	●	●	51	23.2
4	100	6 1/2	165	6 3/16	157	●	●	●	86	39.1
6	150	8	203	8 1/2	216	●	●	●	145	65.9
8	200	9	229	10 5/8	270	●	●	●	218	99.1
10**	250	11	279	12 3/4	324		●		352	160
12**	300	12	305	15	381		●		468.6	213

\* PFA-lined

\*\*Multi-Piece Construction - See Page 18

Vacuum Rating: 1" - 8" is Full Vacuum Rated to 450 F (232 C)

10" - 12" = Consult Factory

Also available in stainless steel and other alloys

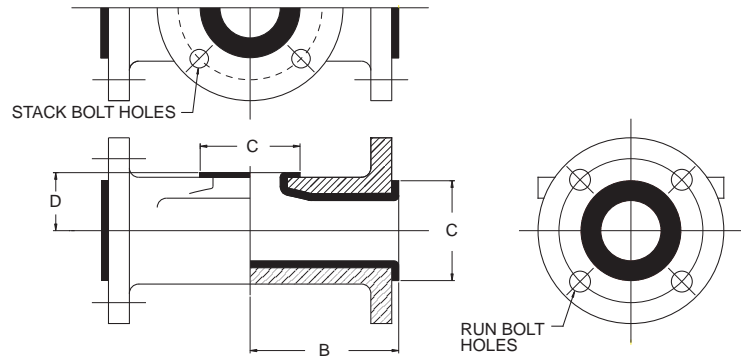
Weights are approximate

Consult factory for availability and dimensions of crosses with Class 300 flanges

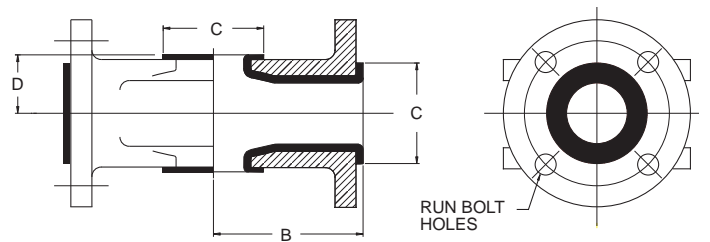
# DI Short Stack Tees and Crosses, PFA and PTFE-Lined

Construction is cast DI with fixed flanges.  
 ATL is not available in this fitting.  
 FV = Full Vacuum

\* All bolt holes are tapped  
 \*\* The 4 holes closest to centerline are tapped.  
 The other bolt holes are bored smooth.



**Tee**



**Cross**

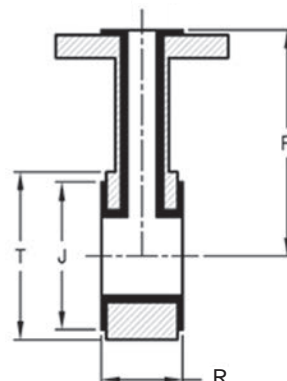
ASME B16.5 Class 150 Flanged															
Size (NPS)	Size (DN)	Dimensions						Flange Drilling		Vacuum Rating (in. Hg at °F)		Weight			
		B		C		D		Run Bolt Holes	Stack Bolt Holes	Tee	Cross	Tee		Cross	
		Inch	mm	Inch	mm	Inch	mm					lbs.	kg	lbs.	kg
1	25	3 1/2	89	2	51	1 3/16	30	1/2 - 13	1/2 - 13*	FV/450	FV/300	9	4.1	11	5
1 1/2	40	4	102	2 7/8	73	1 15/32	37	1/2 - 13	1/2 - 13*	FV/450	FV/250	11.5	5.2	15	6.8
2	50	4 1/2	114	3 5/8	92	1 1/16	27	3/4	5/8 - 11*	FV/450	FV/250	19.5	8.9	21	9.5
3	80	5 1/2	140	5	127	2 3/16	56	3/4	5/8 - 11*	FV/350	FV/200	33	15	37	16.8
4	100	6 1/2	165	6 3/16	157	2 11/16	68	3/4	5/8 - 11**	FV/210	25/200	54	24.5	60	27.3
6	150	8	203	8 1/2	216	3 1/16	78	7/8	3/4 - 10**	11/210	No Vacuum	85	38.6	99	45
8	200	9	229	10 5/8	270	4 15/16	125	7/8	3/4 - 10**			150	68.2	163	74.1
10	250	11	279	12 3/4	324	6	152	1	7/8 - 9**			245	111.4	270	122.7
12	300	12	305	15	381	7 1/32	179	1	7/8 - 9**			280	127.3	310	140.9

1" - 4" are PFA-lined  
 6" - 12" are PTFE-lined

# 1" (DN 25) Branch Instrument Tees

## Cast Bodies, PTFE-Lined

Instrument tees are rated for full vacuum to 450 °F  
 A395 Cast Ductile Iron available in 1" - 8", only.  
 A216 WCB Cast Steel and 395 Cast Ductile Iron have the same weight,  
 J and T dimensions, and ATL availability.  
 Weights are approximate



### ASME B16.5 Class 150 Flanged - A216 WCB Cast Steel and A395 Cast Ductile Iron

Size (NPS)	Size (DN)	Dimensions									Weight	
		P				J		T		ATL		
		A216 WCB Cast Steel		A395 Cast Ductile Iron								
		Inch	mm	Inch	mm	Inch	mm	Inch	mm		lbs.	kg
1 x 1	25 x 25	3 1/2	89	3 1/2	89	2	51	2 5/8	67	●	3.7	1.7
1 1/2 x 1	40 x 25	4	102	4	102	2 7/8	73	3 3/8	86	●	5.1	2.3
2 x 1	50 x 25	4 1/2	114	5 9/16	141	3 5/8	92	4 1/8	105	●	6.6	3
3 x 1	80 x 25	5 1/2	140	6 5/16	160	5	127	5 3/8	137	●	9.2	4.2
4 x 1	100 x 25	6 1/2	165	7 1/16	179	6 3/16	157	6 3/4	171	●	13.3	6
6 x 1	150 x 25	8	203	8 1/16	205	8 1/2	216	8 3/4	222	●	17.4	7.9
8 x 1	200 x 25	9	229	9 5/16	237	10 5/8	270	11	279	●	23.6	10.7
10 x 1	250 x 25	11	279	N/A		12 3/4	324	13 3/8	340	●	38.1	17.3
12 x 1	300 x 25	12	305			15	381	16 1/8	410	●	50.8	23.1

### ASME B16.5 Class 300 Flanged

Size (NPS)	Size (DN)	Dimensions							Weight	
		P		J		T		ATL		
		Inch	mm	Inch	mm	Inch	mm			lbs.
1 x 1	25 x 25	4	102	2	51	2 7/8	73	●	4.6	2.1
1 1/2 x 1	40 x 25	4 1/2	114	2 7/8	73	3 3/4	95	●	6	2.7
2 x 1	50 x 25	5	127	3 5/8	92	4 3/8	111	●	7.5	3.4
3 x 1	80 x 25	6	152	5	127	5 7/8	149	●	10.1	4.6
4 x 1	100 x 25	7	178	6 3/16	157	7 1/8	181	●	14.2	6.5
6 x 1	150 x 25	8 1/2	216	8 1/2	216	9 7/8	251	●	18.3	8.3
8 x 1	200 x 25	10	254	10 5/8	270	12 1/8	308	●	24.5	11.1

# 1" (DN 25) Branch Instrument Tees

## Fabricated Bodies, PTFE-Lined

### Notes for Class 150 Flanged Instrument Tees

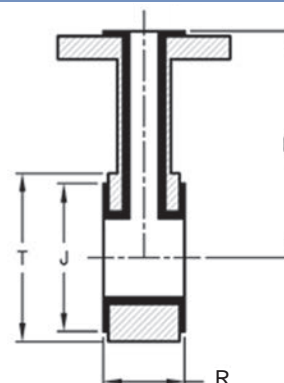
1" - 12" instrument tees are rated for full vacuum to 450 °F.  
Consult factory or vacuum rating of 14" - 24" instrument tees.

### Notes for Class 300 Flanged Instrument Tees

1" - 8" instrument tees are rated for full vacuum to 450 °F.

Also available in stainless steel and other alloys  
Weights are approximate

Note: 1" - 8" Instrument tees can be supplied with  
two branches, 180 degrees apart, on request.

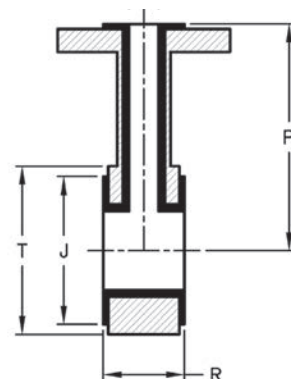


ASME B16.5 Class 150 Flanged														
Size (NPS)	Size (DN)	Dimensions											Weight	
		P				R		J		T		ATL		
		With Rotating Branch Flange		With Fixed Branch Flange										
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	lbs.
1 x 1	25 x 25	3 1/2	89	3 1/2	89	2	51	2	51	2 5/8	67	●	3.7	1.7
1 1/2 x 1	40 x 25	4	102	4	102	2	51	2 7/8	73	3 3/8	86	●	5.1	2.3
2 x 1	50 x 25	4 1/2	114	5 9/16	141	2	51	3 5/8	92	4 1/8	105	●	6.6	3
3 x 1	80 x 25	5 1/2	140	6 5/16	160	2	51	5	127	5 3/8	137	●	9.2	4.2
4 x 1	100 x 25	6 1/2	165	7 1/16	179	2	51	6 3/16	157	6 3/4	171	●	13.3	6
6 x 1	150 x 25	8	203	8 1/16	205	2	51	8 1/2	216	8 3/4	222	●	17.4	7.9
8 x 1	200 x 25	9	229	9 5/16	237	2	51	10 5/8	270	11	279	●	23.6	10.7
10 x 1	250 x 25	11	279	10 3/8	264	2	51	12 3/4	324	13 3/8	340	●	38.1	17.3
12 x 1	300 x 25	12	305	11 7/8	302	2	51	15	381	16 1/8	410	●	50.8	23.1

ASME B16.5 Class 300 Flanged														
Size (NPS)	Size (DN)	Dimensions											Weight	
		P				R		J		T		ATL		
		With Rotating Branch Flange		With Fixed Branch Flange										
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	lbs.
1 x 1	25 x 25	4	102	4	102	2	51	2	51	2 7/8	73	●	4.6	2.1
1 1/2 x 1	40 x 25	4 1/2	114	4 1/2	114	2	51	2 7/8	73	3 3/4	95	●	6	2.7
2 x 1	50 x 25	5	127	5 9/16	141	2	51	3 5/8	92	4 3/8	111	●	7.5	3.4
3 x 1	80 x 25	6	152	6 5/16	160	2	51	5	127	5 7/8	149	●	10.1	4.6
4 x 1	100 x 25	7	178	7 1/16	179	2	51	6 3/16	157	7 1/8	181	●	14.2	6.5
6 x 1	150 x 25	8 1/2	216	8 1/16	205	2	51	8 1/2	216	9 7/8	251	●	18.3	8.3
8 x 1	200 x 25	10	254	9 5/16	235	2	51	10 5/8	270	12 1/8	308	●	24.5	11.1

# 1 1/2" (DN 40) Branch Instrument Tees Fabricated Bodies, PTFE-Lined



**Notes for Class 150 Flanged Instrument Tees**

1" - 12" instrument tees are rated for full vacuum to 450 °F.

**Notes for Class 300 Flanged Instrument Tees**

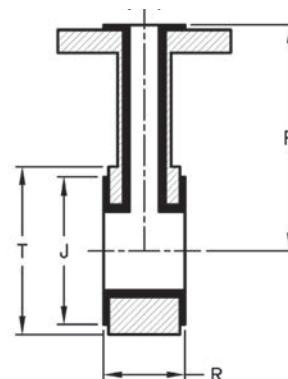
1" - 8" instrument tees are rated for full vacuum to 450 °F.  
1" flanged is fixed.

Also available in stainless steel and other alloys  
Weights are approximate

ASME B16.5 Class 150 Flanged																
Size (NPS)	Size (DN)	Dimensions													Weight	
		With Rotating Branch Flange				With Fixed Branch Flange				J		T		ATL		
		P		R		P		R								
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	lbs.
1 1/2 x 1 1/2	40 x 40	4	102	4	102	4	102	3	76	2 7/8	73	3 3/8	86	●	8.3	3.8
2 x 1 1/2	50 x 40	4 1/2	114	4	102	5 9/16	141	3	76	3 5/8	92	4 1/8	105	●	10.8	4.9
3 x 1 1/2	80 x 40	5 1/2	140	4	102	6 5/16	160	3	76	5	127	5 3/8	137	●	15	6.8
4 x 1 1/2	100 x 40	6 1/2	165	4	102	7 1/16	179	3	76	6 3/16	157	6 3/4	171	●	21.7	9.9
6 x 1 1/2	150 x 40	8	203	4	102	8 1/16	205	3	76	8 1/2	216	8 3/4	222	●	28.1	12.8
8 x 1 1/2	200 x 40	9	229	4	102	9 5/16	237	3	76	10 5/8	270	11	279	●	38.1	17.3
10 x 1 1/2	250 x 40	11	279	4	102	10 3/8	264	3	76	12 3/4	324	13 3/8	340	●	52.6	23.9
12 x 1 1/2	300 x 40	12	305	4	102	11 7/8	302	3	76	15	381	16 1/8	410	●	65.2	29.6

ASME B16.5 Class 150 Flanged																
Size (NPS)	Size (DN)	Dimensions													Weight	
		With Rotating Branch Flange				With Fixed Branch Flange				J		T		ATL		
		P		R		P		R								
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	lbs.
1 1/2 x 1 1/2	40 x 40	4	102	4	102	4 1/2	114	3	76	2 7/8	73	3 3/8	86	●	8.3	3.8
2 x 1 1/2	50 x 40	4 1/2	114	4	102	5 9/16	141	3	76	3 5/8	92	4 1/8	105	●	10.8	4.9
3 x 1 1/2	80 x 40	5 1/2	140	4	102	6 5/16	160	3	76	5	127	5 3/8	137	●	15	6.8
4 x 1 1/2	100 x 40	6 1/2	165	4	102	7 1/16	179	3	76	6 3/16	157	6 3/4	171	●	21.7	9.9
6 x 1 1/2	150 x 40	8	203	4	102	8 1/16	205	3	76	8 1/2	216	8 3/4	222	●	28.1	12.8
8 x 1 1/2	200 x 40	9	229	4	102	9 5/16	235	3	76	10 5/8	270	11	279	●	38.1	17.3

## 2" (DN 50) Branch Instrument Tees Fabricated Bodies, PTFE-Lined



1" - 12" instrument tees with fixed flange are rated for full vacuum to 450 °F.  
 1" - 8" instrument tees with rotating flange are rated for full vacuum to 450 °F.  
 10" - 12" instrument tees with rotating flange are non-vacuum rated.  
 Also available in stainless steel and other alloys  
 Weights are approximate

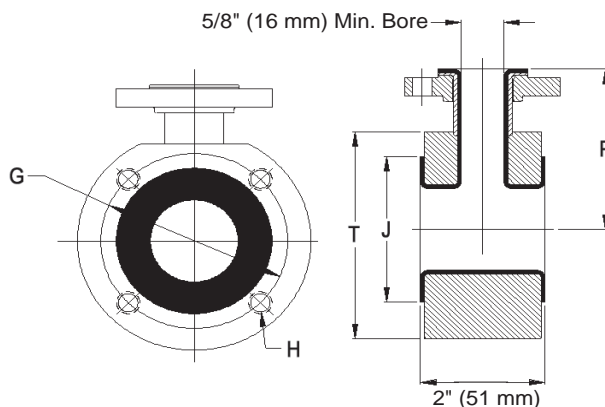
ASME B16.5 Class 150 Flanged														
Size (NPS)	Size (DN)	Dimensions											Weight	
		P				R		J		T		ATL		
		With Rotating Branch Flange		With Fixed Branch Flange										
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm		lbs.	kg
2 x 2	50 x 50	4 1/2	114	5 9/16	141	4	102	3 5/8	92	4 1/8	105	●	7	3.2
3 x 2	80 x 50	5 1/2	140	6 5/16	160	4	102	5	127	5 3/8	137	●	24	10.9
4 x 2	100 x 50	6 1/2	165	7 1/16	179	4	102	6 3/16	157	6 3/4	171	●	33	15
6 x 2	150 x 50	8	203	8 1/16	205	4	102	8 1/2	216	8 3/4	222	●	43	19.5
8 x 2	200 x 50	9	229	9 5/16	237	4	102	10 5/8	270	11	279	●	62	28.2
10 x 2	250 x 50	11	279	10 3/8	264	4	102	12 3/4	324	13 3/8	340	●	79	35.9
12 x 2	300 x 50	12	305	11 7/8	302	4	102	15	381	16 1/8	410	●	108	49.1
14 x 2	350 x 50	N/A		14 3/4	375	4 3/4	120	16 1/4	412	17 1/4	438		162	73.7
16 x 2	400 x 50			15 3/8	390	4 3/4	120	18 1/2	470	19 7/8	505		184	83.7
18 x 2	450 x 50			17 3/4	450	4 3/4	120	21	534	21 1/4	540		206	93.7
20 x 2	500 x 50			19 5/8	500	4 3/4	120	23	585	23 1/2	597		222	100.7
24 x 2	600 x 50			20	510	4 3/4	120	27 1/4	692	27 3/4	705		237	107.7

Consult factory for availability of Class 300 flanged instrument tees with 2" branch.

# 1" (DN 25) Branch Lug Body Instrument Tees

## PTFE, PP, and PVDF-Lined

1" - 12" instrument tees are rated for full vacuum to 450 °F.  
 10" - 12" sizes are non-vacuum rated.  
 Also available in stainless steel and other alloys  
 Weights are approximate



ASME B16.5 Class 150 Flanged														
Size (NPS)	Size (DN)	Dimensions										Weight		
		P		J		T		G		H Holes No. and Size	Liner Availability		lbs.	kg
		Inch	mm	Inch	mm	Inch	mm	Inch	mm		PTFE/ATL	PP/PVDF		
1 x 1	25 x 25	3 1/2	89	2	51	4 1/4	108	3 1/8	79	(4) 1/2 - 13	●	●	6	2.7
1 1/2 x 1	40 x 25	4	102	2 7/8	73	5	127	3 7/8	98	(4) 1/2 - 13	●	●	8	3.6
2 x 1	50 x 25	4 1/2	114	3 5/8	92	6	152	4 3/4	121	(4) 5/8 - 11	●	●	10	4.5
3 x 1	80 x 25	5 1/2	140	5	127	7 1/2	191	6	152	(4) 5/8 - 11	●	●	12	5.5
4 x 1	100 x 25	6 1/2	165	6 3/16	157	9	229	7 1/2	191	(8) 5/8 - 11	●	●	18	8.2
6 x 1	150 x 25	8	203	8 1/2	216	11	279	9 1/2	241	(8) 3/4 - 10	●	●	22	10
8 x 1	200 x 25	9	229	10 5/8	270	13 1/2	343	11 3/4	298	(8) 3/4 - 10	●	●	30	13.6
10 x 1	250 x 25	11	279	12 3/4	324	16	406	14 1/4	362	(12) 7/8 - 9	●		55	25
12 x 1	300 x 25	12	305	15	381	19	483	17	432	(12) 7/8 - 9	●		69	31.4

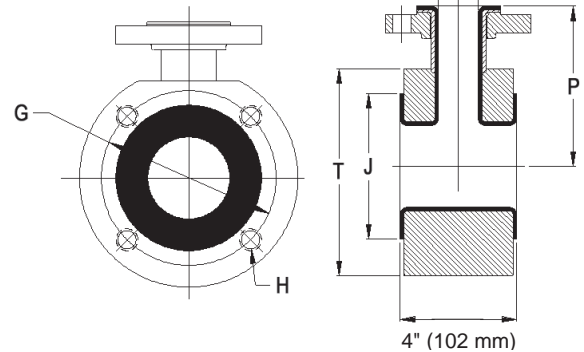
Consult factory for availability of Class 300 lug body instrument tees.



# 1 1/2" (DN 40) and 2" (DN 50) Branch Lug Body Instrument Tees

## PTFE, PP, and PVDF-Lined

1 1/2" Branch = 1 1/8" (29 mm) Min. Bore  
 2" Branch = 1 5/8" (41 mm) Min. Bore



1" - 12" instrument tees are rated for full vacuum to 450 °F.  
 10" - 12" sizes are non-vacuum rated.  
 Also available in stainless steel  
 Weights are approximate

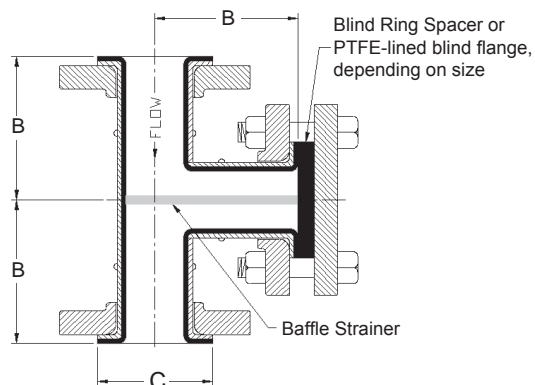
ASME B16.5 Class 150 Flanged, 1 1/2" Branch															
Size (NPS)	Size (DN)	Dimensions										Liner Availability		Weight	
		P		J		T		G		H Holes No. and Size					
		Inch	mm	Inch	mm	Inch	mm	Inch	mm		PTFE/ATL	PP/PVDF	lbs.	kg	
1 1/2 x 1 1/2	40 x 40	4	102	2 7/8	73	5	127	3 7/8	98	(4) 1/2 - 13	●	●	12	5.5	
2 x 1 1/2	50 x 40	4 1/2	114	3 5/8	92	6	152	4 3/4	121	(4) 5/8 - 11	●	●	16	7.3	
3 x 1 1/2	80 x 40	5 1/2	140	5	127	7 1/2	191	6	152	(4) 5/8 - 11	●	●	27	12.3	
4 x 1 1/2	100 x 40	6 1/2	165	6 3/16	157	9	229	7 1/2	191	(8) 5/8 - 11	●	●	41	18.6	
6 x 1 1/2	150 x 40	8	203	8 1/2	216	11	279	9 1/2	241	(8) 3/4 - 10	●	●	52	23.6	
8 x 1 1/2	200 x 40	9	229	10 5/8	270	13 1/2	343	11 3/4	298	(8) 3/4 - 10	●	●	60	27.3	
10 x 1 1/2	400 x 40	11	279	12 3/4	324	16	406	14 1/4	362	(12) 7/8 - 9	●		77	35	
12 x 1 1/2	300 x 40	12	305	15	381	19	483	17	432	(12) 7/8 - 9	●		104	47.3	

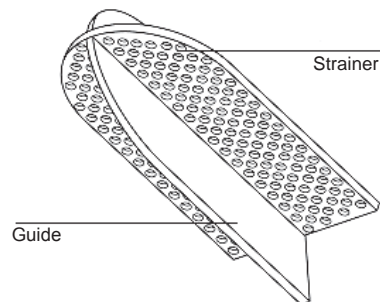
ASME B16.5 Class 150 Flanged, 2" Branch															
Size (NPS)	Size (DN)	Dimensions										Liner Availability		Weight	
		P		J		T		G		H Holes No. and Size					
		Inch	mm	Inch	mm	Inch	mm	Inch	mm		PTFE/ATL	PP/PVDF	lbs.	kg	
2 x 2	50 x 50	4 1/2	114	3 5/8	92	6	152	4 3/4	121	(4) 5/8 - 11	●	●	18	8.2	
3 x 2	80 x 50	5 1/2	140	5	127	7 1/2	191	6	152	(4) 5/8 - 11	●	●	29	13.2	
4 x 2	100 x 50	6 1/2	165	6 3/16	157	9	229	7 1/2	191	(8) 5/8 - 11	●	●	43	19.5	
6 x 2	150 x 50	8	203	8 1/2	216	11	279	9 1/2	241	(8) 3/4 - 10	●	●	54	24.5	
8 x 2	200 x 50	9	229	10 5/8	270	13 1/2	343	11 3/4	298	(8) 3/4 - 10	●	●	62	28.2	
10 x 2	500 x 50	11	279	12 3/4	324	16	406	14 1/4	362	(12) 7/8 - 9	●		79	35.9	
12 x 2	300 x 50	12	305	15	381	19	483	17	432	(12) 7/8 - 9	●		106	48.2	

Consult factory for availability of Class 300 lug body instrument tees.

## Baffle Strainer Tees - PTFE, PFA, PP, and PVDF-Lined



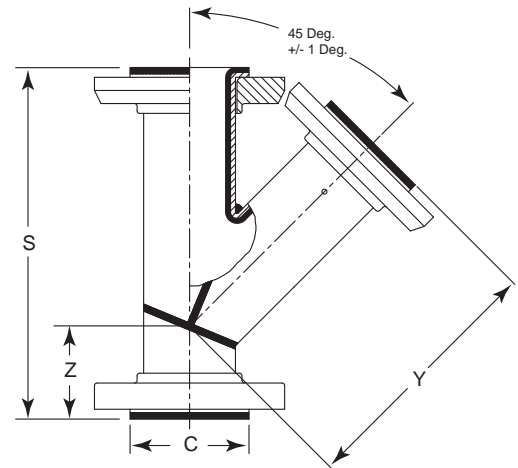
Baffle strainer and blind ring spacer are same material as liner.  
 All sizes and liners are rated for full vacuum at liner maximum operating temperature.  
 Also available in stainless steel and other alloys  
 Consult factory for weights



ASME B16.5 Class 150 Flanged										
Size (NPS)	Size (DN)	Dimensions				Available Construction				
		B		C		PTFE	ATL	PP	PVDF	PFA
		Inch	mm	Inch	mm					
1	25	3 1/2	89	2	51	•	•	•	•	•
1 1/2	40	4	102	2 7/8	73	•	•	•	•	•
2	50	4 1/2	114	3 5/8	92	•	•	•	•	•
3	80	5 1/2	140	5	127	•	•	•	•	•
4	100	6 1/2	165	6 3/16	157	•	•	•	•	•
6	150	8	203	8 1/2	216	•	•	•	•	•
8	200	9	229	10 5/8	270	•	•	•	•	
10	250	11	279	12 3/4	324	•	•	•		
12	300	12	305	15	381	•	•	•		

# 45° Laterals, PTFE-Lined

- CS = Carbon Steel
- DI = Ductile Iron
- FAB = Fabricated Steel
- ATL = Advanced Technology Liner



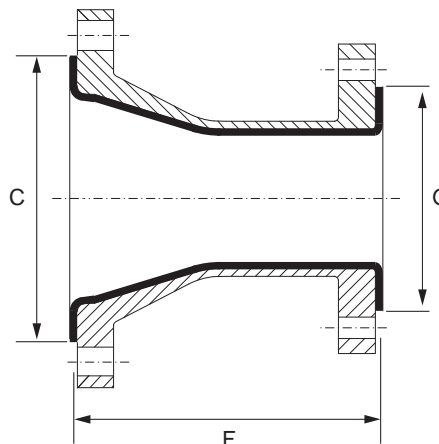
ASME B16.5 Class 150 Flanged														
Size (NPS)	Size (DN)	Dimensions								Available Construction			Weight	
		Y		Z		S		C		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	ATL	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm	Inch	mm					
1	25	5 3/4	146	1 3/4	44	7 1/2	191	2	51	●	●	●	11.4	5.2
1 1/2	40	7	178	2	51	9	229	2 7/8	73	●	●	●	17.7	8
2	50	8	203	2 1/2	64	10 1/2	267	3 5/8	92	●	●	●	25	11.4
3	80	10	254	3	76	13	330	5	127	●	●	●	52.8	24
4	100	12	305	3	76	15	381	6 3/16	157	●	●	●	96.8	44
6	150	14 1/2	368	3 1/2	89	18	457	8 1/2	216	●	●	●	145	65.9
8	200	17 1/2	445	4 1/2	114	22	559	10 5/8	270	●	●	●	219	99.5

Laterals are rated full vacuum to 450 °F.  
 Also available in stainless steel and other alloys  
 Weights are approximate

## Concentric Reducers, PTFE-Lined

CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

Vacuum Rating: 1" - 12" is Full Vacuum Rated to 450 F (232 C)  
 Also available in stainless steel and other alloys  
 Available with Class 300 flanges with same F, C, G dimensions  
 Weights are approximate



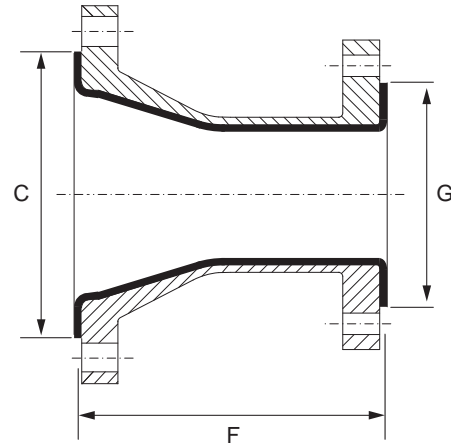
ASME B16.5 Class 150 Flanged														
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction					Weight	
		F		C		G		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	Cast DI A395	Cast Steel A216 WCB	ATL	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm							
1 (25)	1/2 (15)	4 1/2	114	2	51	1 3/4	35		•	•		•	6.5	3
	3/4 (20)					1 11/16	43		•		•	6.8	3.1	
1 1/2 (40)	1/2 (15)	4 1/2	114	2 7/8	73	1 3/4	35		•			•	7.7	3.5
	3/4 (20)					1 11/16	43		•		•	8	3.6	
	1 (25)					2	51	•	•	•	•	8.3	3.8	
2 (50)	1 (25)	5	127	3 5/8	92	2	51	•	•	•		•	9	4.1
	1 1/2 (40)					2 7/8	73	•	•	•	•	11	5	
3 (80)	1 (25)	6	152	5	127	2	51		•	•		•	14	6.4
	1 1/2 (40)					2 7/8	73		•	•	•	15	6.8	
	2 (50)					3 5/8	92	•	•	•	•	17	7.7	
4 (100)	1 (25)	7	178	6 3/16	157	2	51	•	•	•		•	20.4	9.3
	1 1/2 (40)					2 7/8	73	•	•	•	•	22.3	10.1	
	2 (50)					3 5/8	92	•	•	•	•	24.6	11.2	
	3 (80)					5	127	•	•	•	•	29	13.2	

See page 75 - 78 for 14" (DN 350) - 48" (DN 1200) concentric reducer dimensional information.

# Concentric Reducers, PTFE-Lined

- CS = Carbon Steel
- DI = Ductile Iron
- FAB = Fabricated Steel
- ATL = Advanced Technology Liner

Vacuum Rating: 1" - 12" is Full Vacuum Rated to 450 F (232 C)  
 Also available in stainless steel  
 Available with Class 300 flanges with same F, C, G dimensions  
 Weights are approximate



ASME B16.5 Class 150 Flanged														
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction					Weight	
		F		C		G		FAB with DI Rotating Flanges	FAB with CS Flanges (Fixed or Rotating)	Cast DI A395	Cast Steel A216 WCB	ATL	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm							
6 (150)	2 (50)	9	229	8 1/2	216	3 5/8	92		•	•		•	40.3	18.3
	3 (80)					5	127		•	•		•	44.5	20.2
	4 (100)					6 3/16	157		•	•		•	51.5	23.4
8 (200)	4 (100)	11	279	10 5/8	270	6 3/16	157		•	•	•	•	75.4	34.3
	6 (150)					8 1/2	216		•	•	•	•	84	38.2
10 (250)	6 (150)	12	305	12 3/4	324	8 1/2	216		•	•		•	116	52.7
	8 (200)					10 5/8	270		•	•		•	132	60
12 (300)	6 (150)	14	356	15	381	8 1/2	216		•			•	144	65.5
	8 (200)					10 5/8	270		•			•	170	77.3
	10 (250)					12 3/4	324		•			•	190	86.4

## Eccentric Reducers, PTFE-Lined

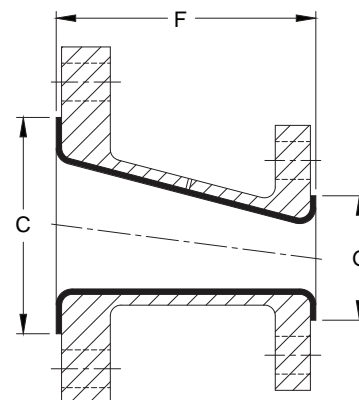
CS = Carbon Steel  
 DI = Ductile Iron  
 FAB = Fabricated Steel  
 ATL = Advanced Technology Liner

Vacuum Rating: 1" - 8 is Full Vacuum Rated to 450 F (232 C)  
 10" - 12" = Consult Factory

Also available in stainless steel and other alloys  
 Available with Class 300 flanges with same F, C, D dimensions  
 Weights are approximate

Centerline offset is found by the following formula:

$$(\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$$

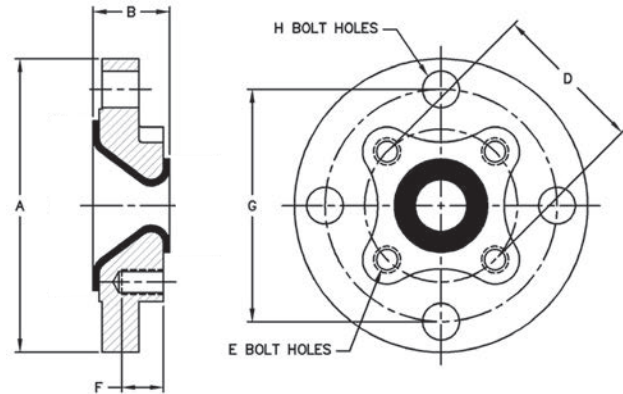


ASME B16.5 Class 150 Flanged													
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions						Available Construction				Weight	
		F		C		G		FAB with CS Fixed Flanges	Cast Steel A216 WCB	Cast DI A395	ATL	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm						
1 (25)	1/2 (15)	4 1/2	114	2	51	1 3/4	35	•			•	6.5	3
	1 11/16					43	•			•	6.8	3.1	
1 1/2 (40)	1 (25)	4 1/2	114	2 7/8	73	2	51	•	•		•	8.3	3.8
2 (50)	1 (25)	5	127	3 5/8	92	2	51	•	•		•	9	4.1
	2 7/8					73	•	•		•	11	5	
3 (80)	1 1/2 (40)	6	152	5	127	2 7/8	73	•	•	•	•	15	6.8
	3 5/8					92	•	•	•	•	17	7.7	
4 (100)	1 1/2 (40)	7	178	6 3/16	157	2 7/8	73	•	•		•	22.3	10.1
	3 5/8					92	•	•	•	•	24.6	11.2	
	5					127	•	•	•	•	29	13.2	
6 (150)	3 (80)	9	229	8 1/2	216	5	127	•	•	•	•	44.5	20.2
	6 3/16					157	•	•	•	•	51.5	23.4	
8 (200)	4 (100)	11	279	10 5/8	270	6 3/16	157	•	•	•	•	75.4	34.3
	8 1/2					216	•	•	•	•	84	38.2	
10 (250)	6 (150)	12	305	12 3/4	324	8 1/2	216	•				116	52.7
	10 5/8					270	•				132	60	
12 (300)	6 (150)	14	356	15	381	8 1/2	216	•				144	65.5
	10 5/8					270	•				170	77.3	
	12 3/4					324	•				190	86.4	

See page 75 - 78 for 14" (DN 350) - 48" (DN 1200) eccentric reducer dimensional information.

# Ductile Iron Reducing Filler Flanges, PTFE-Lined

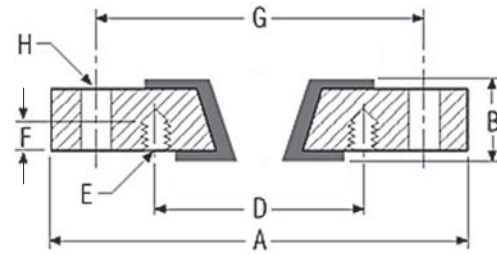
All sizes available lined with ATL  
 All sizes rated for Full Vacuum to 450 F (232 C)  
 Consult factory for weights  
 Dimension "A" = ASME Class 150 Flange OD



ASME B16.5 Class 150 Flanged										
Major Size NPS (DN)	Minor Size NPS (DN)	Thickness, B inch (mm)	H - Bolt Holes			E - Bolt Holes				Bolt Hole Rotation
			No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)	
1 (25)	1/2 (15)	1 5/8 (41)	4	5/8	3 1/8 (79)	4	1/2-13	2 3/8 (67)	7/8 (22)	45°
	3/4 (20)						2 3/4 (70)			
1 1/2 (40)	1 (25)	1 9/16 (40)	4	5/8	3 7/8 (98)	4	1/2-13	3 1/8 (79)	7/8 (22)	45°
2 (50)	1 (25)	1 9/16 (40)	4	3/4	4 3/4 (121)	4	1/2-13	3 1/8 (79)	7/8 (22)	45°
	1 1/2 (40)						3 7/8 (98)			
2 1/2 (65)	2 (50)	1 9/16 (40)	4	3/4	5 1/2 (140)	4	5/8-11	4 3/4 (121)	7/8 (22)	45°
3 (80)	1 (25)	1 5/8 (41)	4	3/4	6 (152)	4	1/2-13	3 1/8 (79)	3/4 (19)	45°
	1 1/2 (40)							3 7/8 (98)		
	2 (50)	1 3/4 (44)					7/8 (22)			
	2 1/2 (65)	1 5/8 (41)								
4 (100)	1 (25)	1 7/8 (48)	8	3/4	7 1/2 (191)	4	1/2-13	3 1/8 (79)	11/16 (17)	0°
	1 1/2 (40)	1 5/8 (41)								
	2 (50)	2 (51)					7/8 (22)			
	3 (80)	1 3/4 (44)								
5 (125)	4 (100)	1 5/8 (41)	8	7/8	8 1/2 (216)	8	5/8-11	7 1/2 (191)	1 (25)	22.5°
	1 1/2 (40)	1 7/8 (48)	8	7/8	9 1/2 (241)	4	1/2-13	3 7/8 (98)	11/16 (17)	0°
							5/8-11	4 3/4 (121)	3/4 (19)	
	3 (80)	1 3/4 (44)						7 1/2 (191)	6 (152)	
							4 (100)		2 1/8 (54)	
5 (125)	11 3/4 (44)	8				3/4-10		8 1/2 (216)		1 (25)
8 (200)	4 (100)	2 (51)	8	7/8	11 3/4 (298)	8	5/8-11	7 1/2 (191)	7/8 (22)	22.5°
	6 (150)						3/4-10	9 1/2 (241)	1 1/8 (29)	0°
10 (250)	4 (100)	2 7/16 (62)	12	1	14 1/4 (362)	8	5/8-11	7 1/2 (191)	7/8 (22)	0°
	6 (150)						3/4-10	9 1/2 (241)	1 (25)	
	8 (200)							11 3/4 (298)		

# Carbon Steel Reducing Filler Flanges, PTFE-Lined

All sizes available lined with ATL  
 1" - 8" rated for Full Vacuum to 450 F (232 C)  
 10" - 12" are not vacuum rated  
 Consult factory for weights  
 Dimension "A" = ASME Class 150 Flange OD  
 Also available in stainless steel and other alloys  
 Straight-through bore available in PTFE and PFA-lined



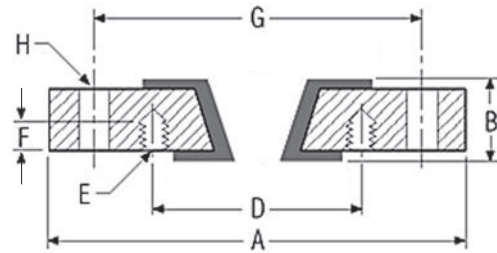
ASME B16.5 Class 150 Flanged										
Major Size NPS (DN)	Minor Size NPS (DN)	Thickness, B inch (mm)	H - Bolt Holes*			E - Bolt Holes				Bolt Hole Rotation
			No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)	
1 (25)	1/2 (15)	1 1/2 (38)	4	1/2-13	3 1/8 (79)	4	1/2-13	2 3/8 (67)	11/16 (17)	45°
	3/4 (20)							2 3/4 (70)		
1 1/2 (40)	1 (25)	1 1/2 (38)	4	1/2-13	3 7/8 (98)	4	1/2-13	3 1/8 (79)	9/16 (14)	45°
2 (50)	1 (25)	1 1/2 (38)	4	5/8-11	4 3/4 (121)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)							3 7/8 (98)	5/8 (16)	45°
3 (80)	1 (25)	1 1/2 (38)	4	5/8-11	6 (152)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)							3 7/8 (98)	5/8 (16)	
	2 (50)							4 3/4 (121)	3/4 (19)	45°
4 (100)	1 (25)	2 (51)	8	3/4	7 1/2 (191)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)							3 7/8 (98)	5/8 (16)	
	2 (50)	3/4 (19)		5/8-11				4 3/4 (121)	3/4 (19)	
	3 (80)							6 (152)		
6 (150)	1 1/2 (40)	2 (51)	8	7/8	9 1/2 (241)	4	1/2-13	3 7/8 (98)	9/16 (14)	0°
	2 (50)							3/4-10	4 3/4 (121)	
	3 (80)			5/8-11					6 (152)	
	4 (100)	1 1/2 (38)						7 1/2 (191)		
8 (200)	3 (80)	2	8	7/8	11 3/4 (298)	4	5/8-11	6 (152)	3/4 (19)	0°
	4 (100)							7 1/2 (191)		
	6 (150)	1 1/2 (38)		3/4-10				9 1/2 (241)	13/16 (21)	
10 (250)	3 (80)	2 (51)	12	1	14 1/4 (362)	4	5/8-11	6 (152)	5/8 (16)	0°
	4 (100)							7 1/2 (191)	3/4 (19)	
	6 (150)			3/4-10				9 1/2 (241)	13/16 (21)	
	8 (200)							7/8-9		
12 (300)	6 (150)	2 (51)	8	3/4-10	17 (432)	8	3/4-10	9 1/2 (241)	13/16 (21)	0°
	8 (200)							11 3/4 (298)		
	10 (250)		12	7/8-9				14 1/4 (362)	1 1/4 (32)	

\* Most "H" bolt holes are threaded.  
 Example: In above table, 5/8-11 is threaded. 7/8 is not threaded.



# Carbon Steel Reducing Filler Flanges, PTFE-Lined

All sizes available lined with ATL  
 1" - 8" rated for Full Vacuum to 450 F (232 C)  
 Consult factory for weights  
 Dimension "A" = ASME Class 300 Flange OD  
 Also available in stainless steel and other alloys  
 Straight-through bore available in PTFE and PFA



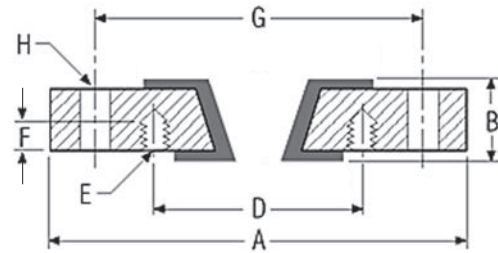
ASME B16.5 Class 300 Flanged										
Major Size NPS (DN)	Minor Size NPS (DN)	Thickness, B inch (mm)	H - Bolt Holes*			E - Bolt Holes				Bolt Hole Rotation
			No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)	
1 1/2 (40)	1 (25)	1 1/2 (38)	4	3/4-10	4 1/2 (114)	4	5/8-11	3 1/2 (89)	5/8 (16)	45°
2 (50)	1 (25)	1 1/2 (38)	8	5/8-11	5 (127)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°
	1 1/2 (40)						3/4-10	4 (102)		
3 (80)	1 (25)	1 1/2 (38)	8	3/4-10	6 5/8 (168)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°
	1 1/2 (40)						3/4-10	4 1/2 (114)		
	2 (50)						5/8-11	5 (127)	3/4 (19)	22.5°
4 (100)	1 (25)	2 (51)	8	7/8	7 7/8 (200)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°
	1 1/2 (40)						3/4-10	4 1/2 (114)		
	2 (50)	1 1/2 (38)		3/4-10		8	5/8-11	5 (127)	3/4 (19)	22.5°
	3 (80)						3/4-10	6 5/8 (168)		
6 (150)	1 (25)	2 (51)	12	7/8	10 5/8 (270)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°
	2 (50)						5 (127)			
	3 (80)	1 1/2 (38)		3/4-10		8	3/4-10	6 5/8 (168)	3/4 (19)	7.5°
	4 (100)						7 7/8 (200)			
8 (200)	3 (80)	2 (51)	12	1	13 (330)	8	3/4-10	6 5/8 (168)	3/4 (19)	0°
	4 (100)							7 7/8 (200)		
	6 (150)	1 1/2 (38)						7/8-9	12	10 5/8 (270)

\* Most "H" bolt holes are threaded.

Example: In above table, 5/8-11 is threaded. 7/8 is not threaded.

# Carbon Steel Reducing Filler Flanges, PFA/PTFE-Lined Non-Standard Sizes

Not vacuum rated  
 Consult factory for weights  
 Dimension "A" = ASME Class 150 Flange OD  
 Also available in stainless steel and other alloys  
 PFA-lined reducing filler flanges are straight bore

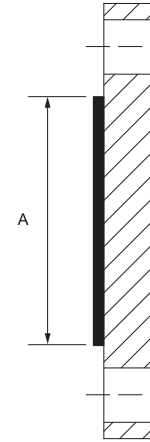


ASME B16.5 Class 150 Flanged											
Major Size NPS (DN)	Minor Size NPS (DN)	Liner	Thickness, B inch (mm)	H - Bolt Holes*			E - Bolt Holes				Bolt Hole Rotation
				No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)	
1 1/2 (40)	1/2 (15)	PFA	13/16 (21)	4	1/2-13	3 7/8 (98)	4	1/2-13	2 3/8 (67)	7/16 (11)	45°
	2 3/4 (70)								1/2 (13)		
	3 1/2 (89)										
2 (50)	1/2 (15)	PFA	7/8 (22)	4	5/8-11	4 3/4 (121)	4	1/2-13	2 3/8 (67)	1/2 (13)	45°
	2 3/4 (70)										
	3 1/2 (89)										
2 1/2 (65)	1 (25)	PFA	1 (25)	4	3/4	5 1/2 (140)	4	1/2-13	3 1/8 (79)	5/8 (16)	0°
	1 1/2 (40)				5/8-11				3 7/8 (98)		
	2 (50)	PTFE			4 3/4 (121)			9/16 (14)			
3 (80)	1 1/4 (32)	PFA	1 3/16 (30)	4	5/8-11	6 (152)	4	1/2-13	3 1/2 (89)	1/2 (13)	45°
	2 1/2 (65)	PTFE						5/8-11	5 1/2 (140)		
4 (100)	2 1/2 (65)	PTFE	1 3/16 (30)	8	5/8-11	7 1/2 (191)	4	5/8-11	5 1/2 (140)	11/16 (17)	0°
5 (125)	2 (50)	PTFE	1 3/16 (30)	8	7/8	8 1/2 (216)	4	5/8-11	4 3/4 (121)	11/16 (17)	0°
	3 (80)				3/4-10				6 (152)		
6 (150)	3/4 (20)	PFA	1 1/4 (32)	8	7/8	9 1/2 (241)	4	1/2-13	2 3/4 (70)	11/16 (17)	0°
8 (200)	1 (25)	PFA	1 3/8 (35)	8	7/8	11 3/4 (298)	4	1/2-13	3 1/8 (79)	11/16 (17)	0°
	1 1/2 (40)								3 7/8 (98)		
	2 (50)	PTFE						4 3/4 (121)	11/16 (17)		
10 (250)	1 (25)	PFA	1 7/16 (37)	12	1	14 1/4 (362)	4	1/2-13	3 1/8 (79)	3/4 (19)	0°
	1 1/2 (40)								3 7/8 (98)		
	2 (50)	PTFE						4 3/4 (121)	3/4 (19)		
12 (300)	1 (25)	PFA	1 1/2 (38)	12	1	17 (432)	4	1/2-13	3 1/8 (79)	3/4 (19)	0°
	1 1/2 (40)								3 7/8 (98)		
	2 (50)	PTFE						4 3/4 (121)			
	3 (80)							6 (152)			
4 (100)	8	7 1/2 (191)	15°								

\* Most "H" bolt holes are threaded.  
 Example: In above table, 5/8-11 is threaded. 7/8 is not threaded.

# Blind Flanges, PTFE-Lined

Available in carbon steel, stainless steel, and other alloys

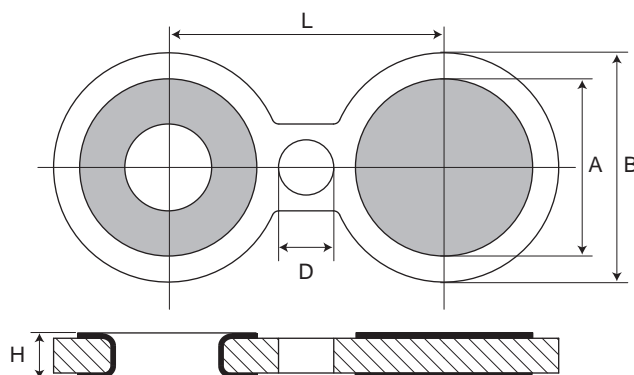


PTFE Liner Thickness = 3/16"

ASME B16.5 Class 150						ASME B16.5 Class 300					
Size (NPS)	Size (DN)	A		Weight		Size (NPS)	Size (DN)	A		Weight	
		Inch	mm	lbs.	kg			Inch	mm	lbs.	kg
1/2	15	1 3/4	35	1.1	0.5	1/2	15	1 3/4	35	1.5	0.7
3/4	20	1 11/16	43	1.2	0.5	3/4	20	1 11/16	43	2.3	1
1	25	2	51	1.9	0.9	1	25	2	51	3	1.4
1 1/2	40	2 7/8	73	3.7	1.7	1 1/2	40	2 7/8	73	6.3	2.9
2	50	3 5/8	92	6	2.7	2	50	3 5/8	92	7.8	3.5
3	80	5	127	9.9	4.5	3	80	5	127	14.1	6.4
4	100	6 3/16	157	16.8	7.6	4	100	6 3/16	157	26.7	12.1
6	150	8 1/2	216	28.5	13	6	150	8 1/2	216	49.6	22.5
8	200	10 5/8	270	47	21.4	8	200	10 5/8	270	79.3	36
10	250	12 3/4	324	67	30.5	10	250	12 3/4	324	121.3	55.1
12	300	15	381	114	51.8	12	300	15	381	192.3	87.4

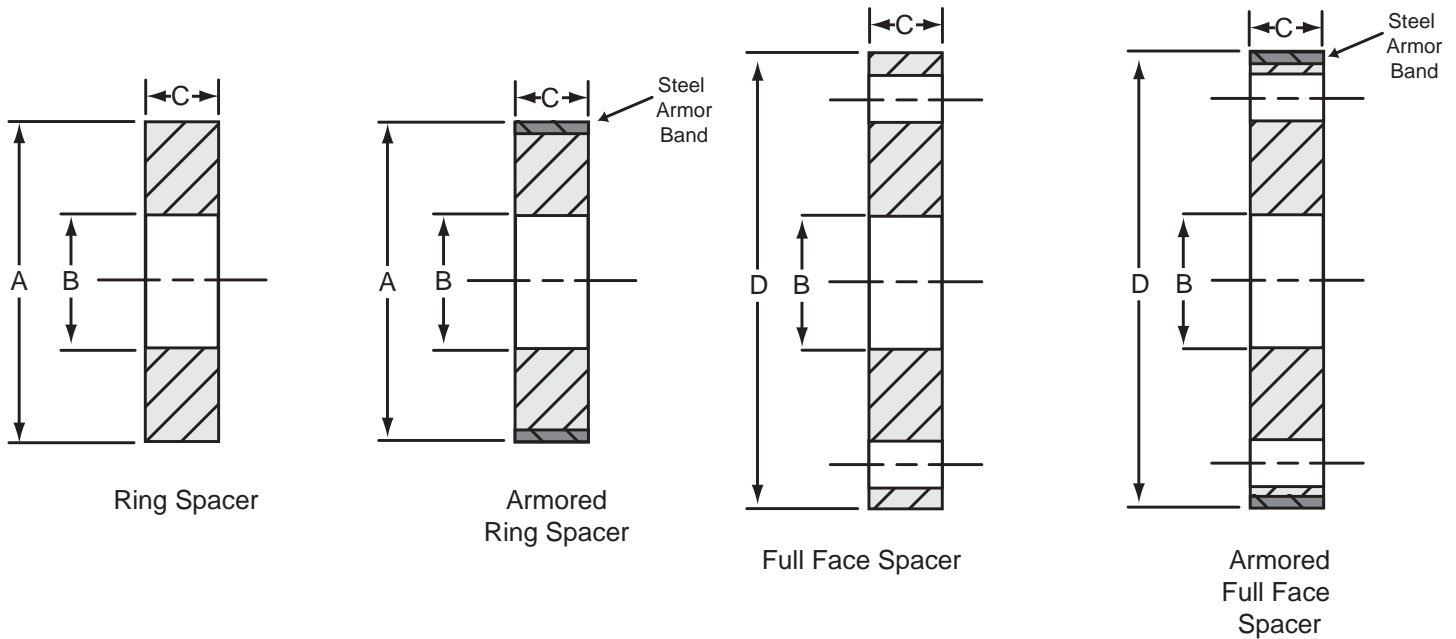
## Spectacle Blind Flanges, PTFE-Lined

Not vacuum rated  
 Consult factory for weights  
 Also available in stainless steel and other alloys  
 Dimensions are not per ASME B16.48



ASME Class 150													
Size		Dimensions										Weight	
NPS	DN	A		B		D		H		L		lb.	kg
		Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm		
1/2	15	1 3/4	35	1 3/4	44	5/8	16	5/8	16	2 3/8	60	1.4	0.6
3/4	20	1 11/16	43	2 1/8	54	5/8	16	5/8	16	3 1/2	89	1.5	0.7
1	25	2	51	2 1/2	64	5/8	16	3/4	19	3 1/8	79	1.6	0.7
1 1/2	40	2 7/8	73	3 1/4	83	5/8	16	7/8	22	3 7/8	98	2.8	1.3
2	50	3 5/8	92	4	102	3/4	19	7/8	22	4 3/4	121	2.9	1.3
3	80	5	127	5 1/4	133	3/4	19	1 1/8	29	6	152	5.8	2.6
4	100	6 3/16	157	6 3/4	171	3/4	19	1 1/8	29	7 1/2	191	8	3.6
6	150	8 1/2	216	8 5/8	219	7/8	22	1 1/8	29	9 1/2	241	10.8	4.9
8	200	10 5/8	270	10 7/8	276	7/8	22	1 1/4	32	11 3/4	298	15.2	6.9
10	250	12 3/4	324	13 1/4	337	1	25	1 3/8	35	14 1/4	362	16	7.3
12	300	15	381	16	406	1	25	1 3/8	35	17	432	20	9.1

# Spacers, Solid PTFE/PP/PVDF



Size In. (DN)	Ring		B (Class 150 and 300)		Class 150 Full Face			Class 300 Full Face		
	A		PTFE	PP/PVDF	D	Number and Dia. of Bolt Holes	Bolt Circle Diameter in. (mm)	D	Number and Dia. of Bolt Holes	Bolt Circle Diameter in. (mm)
	Class 150	Class 300								
	in. (mm)		in. (mm)	in. (mm)	in. (mm)	(no.) dia.*	in. (mm)	in. (mm)	in. (mm)	in. (mm)
1/2 (15)	1 7/8 (48)	2 1/8 (54)	0.5 (13)	1/2 (13)	3 1/2 (89)	(4) 5/8	2 3/8 (60)	3 3/4 (95)	(4) 5/8	2 5/8 (67)
3/4 (20)	2 1/4 (57)	2 5/8 (67)	0.625 (16)	5/8 (16)	3 7/8 (98)	(4) 5/8	2 3/4 (70)	4 5/8 (117)	(4) 3/4	3 1/4 (83)
1 (25)	2 5/8 (67)	2 7/8 (73)	1 (25)	11/16 (17)	4 1/4 (108)	(4) 5/8	3 1/8 (79)	4 7/8 (124)	(4) 3/4	3 1/2 (89)
1 1/2 (40)	3 3/8 (86)	3 3/4 (95)	1.5 (38)	1 5/16 (33)	4 5/8 (117)	(4) 5/8	3 7/8 (98)	6 1/8 (156)	(4) 7/8	4 1/2 (114)
2 (50)	4 1/8 (105)	4 3/8 (111)	2 (51)	1 3/4 (44)	6 (152)	(4) 3/4	4 3/4 (121)	6 1/2 (165)	(8) 3/4	5 (127)
3 (80)	5 3/8 (137)	5 7/8 (149)	3 (76)	2 11/16 (68)	7 1/2 (191)	(4) 3/4	6 (152)	8 1/4 (210)	(8) 7/8	6 5/8 (168)
4 (100)	6 7/8 (175)	7 1/8 (181)	4 (102)	3 5/8 (279)	9 (229)	(8) 3/4	7 1/2 (191)	10 (254)	(8) 7/8	7 7/8 (200)
6 (150)	8 3/4 (222)	9 7/8 (251)	6 (152)	5 9/16 (533)	11 (279)	(8) 7/8	9 1/2 (241)	12 1/2 (318)	(12) 7/8	10 5/8 (270)
8 (200)	11 (279)	12 1/8 (308)	8 (203)	7 1/2 (191)	13 1/2 (343)	(8) 7/8	11 3/4 (298)	15 (381)	(12) 1	13 (330)
10 (250)	13 3/8 (340)	14 1/4 (362)	10 (254)	9 11/16 (246)	16 (406)	(12) 1	14 1/4 (362)	17 1/2 (445)	(16) 1 1/8	15 1/4 (387)
12 (300)	16 1/8 (410)	16 5/8 (422)	12 (305)	12 (305)	19 (483)	(12) 1	17 (432)	20 1/2 (521)	(16) 1 1/4	17 3/4 (451)

\* Hole diameter in inches

Standard thickness "C" is 1/2". Custom thicknesses available. Maximum thickness = 3".

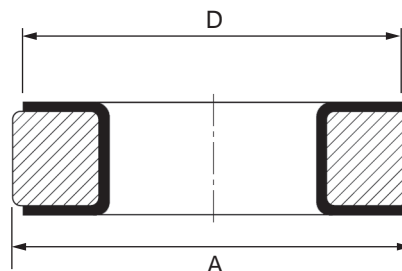
When using butterfly valves in a lined pipe system, spacers are recommended on each side of the valve to ensure the valve fully opens.

Consult factory for dimensions of spacers for use with butterfly valves.

Other spacer options include tapered spacers, butterfly valve spacers, radial drill and tap, reducing spacers, blind spacers, and custom ID spacers.

## Ring Spacers, PTFE-Lined

Not vacuum rated  
 Consult factory for weights  
 Also available in stainless steel and other alloys



ASME Class 150									
Size		Dimensions							
NPS	DN	A		D		Minimum Length		Maximum Length	
		Inch	mm	Inch	mm	Inch	mm	Inch	mm
1/2	15	1 3/4	44	1 3/8	35	1/2	13	3	76
3/4	20	2 1/16	53	1 11/16	43				
1	25	2 5/8	67	2	51				
1 1/2	40	3 3/8	86	2 7/8	73				
2	50	4 1/8	105	3 5/8	92				
3	80	5 3/8	137	5	127				
4	100	6 7/8	175	6 3/16	157	3/4	19		
6	150	8 3/4	222	8 1/2	216				
8	200	11	279	10 5/8	270				
10	250	13 3/8	340	12 3/4	324	1	25		
12	300	16 1/8	410	15	381				
14	350	17 5/8	447	16 1/4	412	1 9/16	40	12 1/2	318
16	400	20 1/16	510	18 1/2	470	1 9/16	40	18 3/4	476
18	450	21 1/2	545	21	534	1 9/16	40	13 3/8	340
20	500	23 3/4	602	23	585	2 3/8	60	14 3/8	365
24	600	28 1/8	714	27 1/4	692	2 3/8	60	14 3/4	375

# Bull's Eye Sight Flow Indicators, PFA / PTFE-Lined

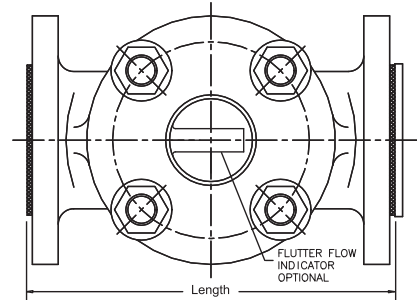
Resistoflex Bull's Eye Sight Indicators are ideal for observing fluid characteristics of severely corrosive liquids. Motion, flow and color can be inspected visually during the process, since these indicators are equipped with two heavy PYREX® tempered and polished glass windows for ASME Class 150 service.

Drip Lips of PTFE are suggested for use with Resistoflex Sight Indicators where, because of small quantity of liquid in line, it is difficult to determine if flow is present. These devices collect the liquid and allow it to spill from the drip lip, which is located at the center of the glass. Drip lips can only be used in vertical lines.

Flutter Flow Indicators are recommended in any service where it is necessary to determine if a line is completely full or completely empty. Movement in the flutter flow indicator shows that the line is full.

Notes: Ductile Iron (A395) Bull's Eye Sight Indicators have vacuum ratings as shown in the table and their maximum temperature rating is 400°F. 100% of Bull's Eye Sight Indicators are hydrostatically tested at 425 psig prior to shipment.

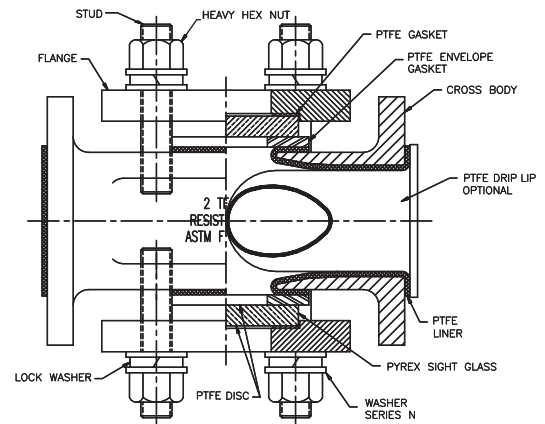
PYREX is a trademark of Corning Incorporated.



## Ductile Iron Bull's Eye Sight Indicator

ASME Class 150 Flanged						
Size		Liner	Length		Vacuum Rating	
NPS	DN		Inch	mm	in. Hg / Deg. F	Torr / Deg. C
1	25	PFA	7	178	29.9 / 300	0 / 148
1 1/2	40	PFA	8	203	29.9 / 250	0 / 121
2	50	PFA	9	229	29.9 / 250	0 / 121
3	80	PFA	11	279	29.9 / 200	0 / 93
4	100	PFA	13	330	25 / 200	125 / 93
6	150		16	406	No Vacuum	

FV = Full Vacuum. Vacuum ratings for this product are for steady-state vacuum, only. Frequent vacuum cycling may reduce service life.

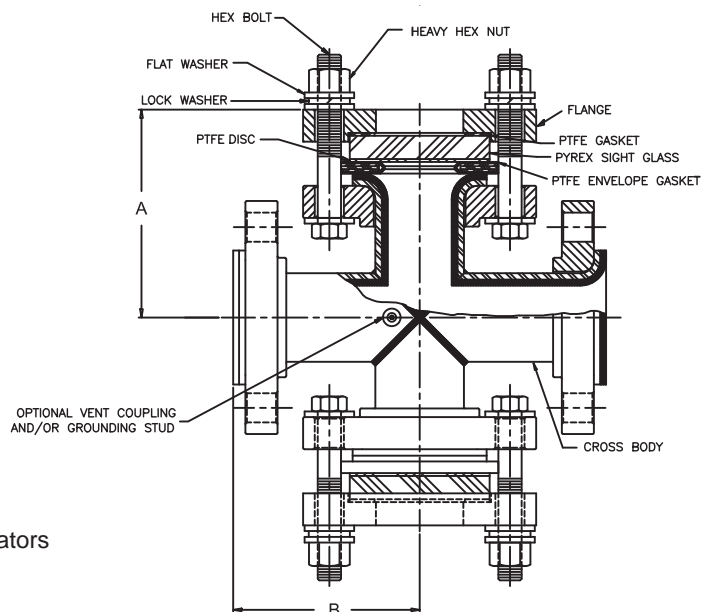


Ductile Iron Bull's Eye Sight Indicator

## Fabricated Bull's Eye Sight Indicator in CS or SS

ASME Class 150 Flanged					
Size		A		B	
NPS	DN	Inch	mm	Inch	mm
1	25	3.914	99	3 1/2	89
1 1/2	40	4.475	114	4	102
2	50	4.924	125	4 1/2	114
3	80	6.102	155	5 1/2	140
4	100	6.764	172	6 1/2	165
6	150	8.425	214	8	203

- Fabricated sight indicators are rated for full vacuum to 400°F.
- Drip Lip Option Not Available on Fabricated Bull's Eye Sight Indicators



Fabricated Bull's Eye Sight Indicator  
Crane ChemPharma & Energy

## RESISTOFLEX®ATL Superior Components

Resistoflex®ATL is the most cost effective solution for resolving permeation issues in severe service applications.

- The permeation rate is 60% lower compared to other available products
- Resistoflex®ATL provides up to 75% cost savings versus exotic alloys and glass-lined piping
- It has zero corrosion rate, and is full vacuum rated to 450 deg. F (230 deg. C)

Resistoflex®ATL PTFE liners are produced from carefully formulated resins and proprietary processing and lining techniques. The result is a molded PTFE liner that provides optimal crystallinity and strength. ATL PTFE liners provide the best permeation resistance in the industry.

**1** Optimized PTFE liner

Resistoflex®ATL PTFE pipe and fittings are designed to minimize any potential permeation attack of the housing by use of an advanced venting system that eliminates blockage and corrosion at the vent hole.

**2** Enhanced venting system

Resistoflex®ATL PTFE pipe and fittings are double coated with a highly chemical and temperature resistant paint. This paint is rated to 450°F (232°C) and can be used under insulation.

**3** Highly chemical and temperature resistant paint system



## RESISTOFLEX® ATL Breakthrough Liner Processing Technology

Paste Extrusion is the most widely utilized method for producing PTFE pipe and fitting liners, the process was introduced by Resistoflex® in the 50s, and served the chemical industry's corrosion resistant needs for many years. However as the chemical industry utilized PTFE lined piping systems in more aggressive processes, such as elevated temperatures and pressures and a wider range of chemical concentrations, the performance requirements for liner properties increased and a more suitable method for making pipe and fitting liners was required.

Resistoflex® has been processing PTFE resins for over 50 years and currently utilizes various methods for producing PTFE liners including; Isostatic Molding, Ram Extrusion, and Paste Extrusion. Each process yields different mechanical properties and we match those with end-use products that meet varying customer needs.

### Paste Extrusion Process

- Paste extruded PTFE liners most frequently acquire anisotropic mechanical properties, resulting in hoop strength not being equal to axial strength.
- Anisotropic properties negatively impact the liners ability to withstand vacuum and temperature cycling due to thermal expansion.
- Paste extruded PTFE liners also exhibited higher permeation rates due to inherent low molecular crystallinity which results in high void content.
- As noted, a key component in controlling the rate of permeation in PTFE is the molecular crystallinity. (High molecular crystallinity is desired for greater permeation resistance.)
- Independent testing of paste liners evaluating the crystallinity of the material revealed that paste extruded liners were found to have comparatively low crystallinity therefore exhibiting a high permeation rate.

### Glass-Lined Process

Glass-lined systems, a common option for lined piping, are generally extremely brittle and susceptible to thermal and mechanical shock. Glass-lined piping is also easily damaged with temperature cycling. Additional characteristics of this type of piping include the following:

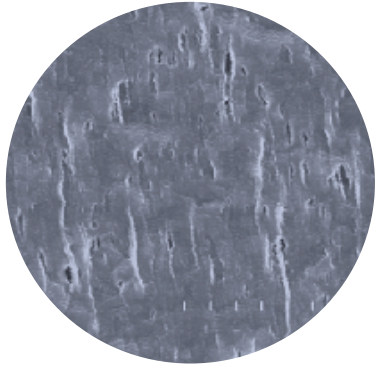
- Temperature and pressure ratings vary based on diameter.
- Risk of damaging pipe by thermal shock at operating temperatures above 121°C (450°F).
- Requires gaskets at each connection and if gaskets are not supplied by the manufacturer, warranty may be voided.
- Limited geometries (reducing fittings such as tees and elbow are not recommended).
- Typically, 25% more expensive than PTFE-lined piping systems.

### ATL PTFE Liner Processing Techniques - 60% BETTER!

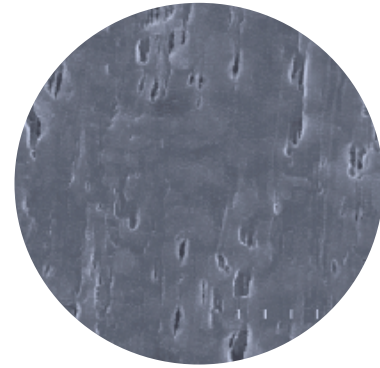
- Through years of testing and end market application Resistoflex® has found that the PTFE Isostatic Molding process is the best method for making Pipe & Fitting linings.
- PTFE Isostatically Molded liners have excellent isotropic mechanical properties, which results in high hoop and axial strength. The combination of the thick wall design and isotropic properties result in the ability of the finished products to withstand full vacuum at elevated temperatures (450°F/232°C) and high cycling conditions for all sizes ranging from 1" - 12" (25 - 300 mm).
- ATL PTFE liners are produced by combining the solid attributes of Isostatic Molding along with carefully formulated resins and proprietary processing techniques. The result is a molded PTFE liner that provides optimal crystallinity and strength. The crystalline areas are impermeable, meaning there is no space for the permeants to pass through.
- ATL PTFE liners provide the best permeation resistance in the industry.

# RESISTOFLEX®ATL Myths and Facts/Testing

A common myth in the industry is that paste extruded PTFE liners produced from fine powder resins yield a lower void content. The less voids in the liner, the less space for the permeants to pass through. With the controlled processing techniques developed by Resistoflex®, we have reduced the void content and thus reduced the rate of permeation. The micrographs below taken at 15,000X magnification illustrate the size and frequencies of the voids were significantly reduced in Resistoflex®ATL PTFE.



Paste Extruded - PTFE liner

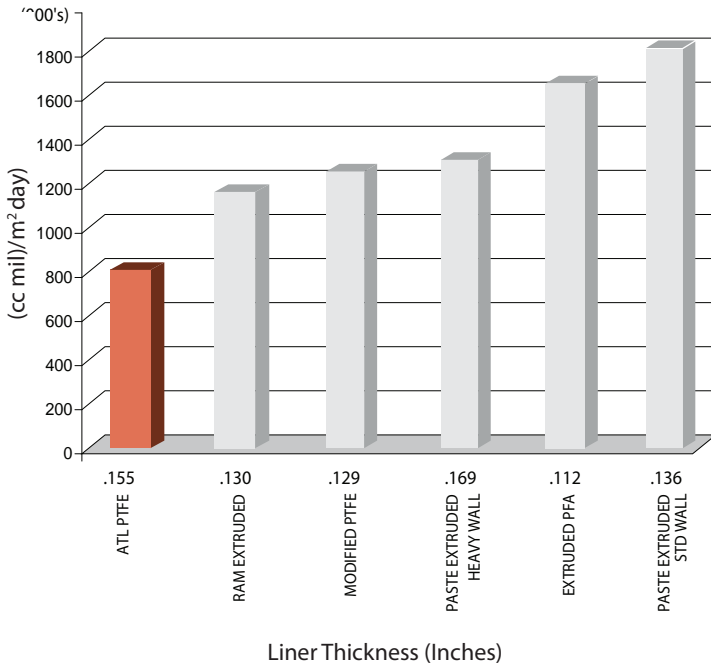


Resistoflex®ATL PTFE liner

Independent field and laboratory tests measured permeation resistance in piping systems provided by various manufacturing methodologies. Test results for various resins and processing techniques are illustrated below. These results show that the Resistoflex®ATL PTFE offers the best permeation performance available for lined pipe.

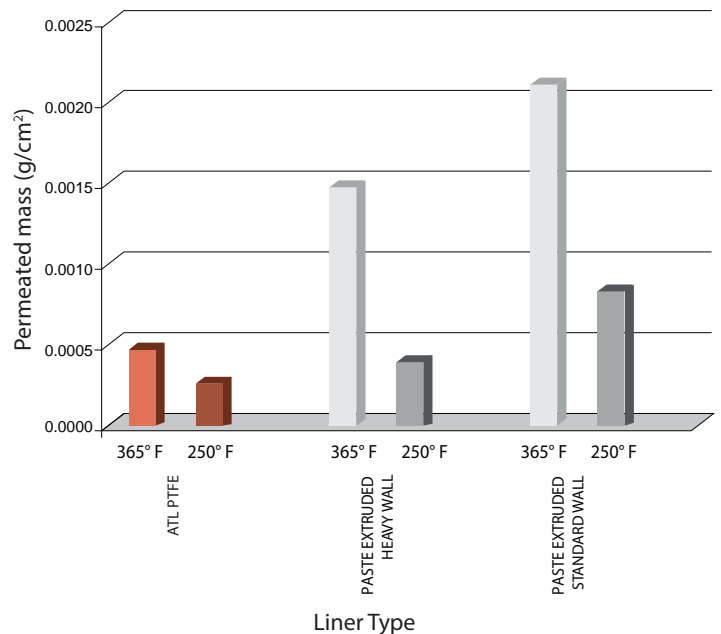
### Helium Permeation Rate at 350°F (177°C)

Result: Resistoflex®ATL outperforms all other PTFE liners  
Testing performed by an independent third party lab



### 36% Hydrochloric Acid Permeation Rate

Result: Resistoflex®ATL outperforms all other PTFE liners  
\*Testing performed by MERL UK - see back cover



## RESISTOFLEX® ATL Product Offering

### ATL Product Offering

A 1"-12" ANSI and DN25-300 DIN PTFE lined piping system that meets all ASTM F1545 requirements and the following:

- All 1" - 12" pipe and 1" - 12" standard PTFE-lined fittings in this catalog are available with ATL liner
- PTFE resin conforms to ASTM D-4894 and is certified for food contact in compliance with FDA regulation 21CFR 177.1550
- ATL PTFE is lined using Resistoflex® highly engineered and patented Thermalok® technology
- Product is available in carbon steel and stainless steel housings and flanges
- Approved to PED Cat III
- Resistoflex's Marion, NC facility has been ISO 9001 Certified since 1995



### ANSI Dimensional Standard Products

- All dimensions and tolerances according to ANSI B16.5 (see Resistoflex® Plastic Lined Pipe & Fittings Design Manual)
- Ductile iron (A395) fitting housings and flanges available
- Stainless steel housings available.
- ANSI B16.5 Class 150 & 300 flanged systems available

### DIN Dimensional Standard Products

Dimensions and tolerances according to DIN 2848:2000.

- TA Luft certification
- GKV / DIN 2874:2002-06 requirements for PTFE
- DVGW conformity
- DIN 2848 PN 10 & PN 25 flanged systems available

In addition to careful processing, adequate liner thickness and rigorous testing provide confidence that the liner will do its job under all process conditions. The table below illustrates typical advertising claims for various PTFE lined pipe suppliers.

## Standard Manufacturing: PTFE Liner Thickness Comparison

Diameter NPS (NB)	Resistoflex®ATL HD Isostatic Molded Liner	Competitor A Std Wall Paste Extruded Liner	Competitor B Std Wall Paste Extruded Liner	Competitor C Std Wall Paste Extruded Liner
1" (DN 25)	.130" (3.3 mm)	3.0	3.0	1.78
1.5" (DN 40)	.150" (3.8 mm)	3.0	3.0	2.3
2" (DN 50)	.155" (3.9 mm)	3.0	3.0	2.3
3" (DN 80)	.155" (3.9 mm)	3.5	3.0	2.3
4" (DN 100)	.160" (4.1 mm)	4.5	3.0	2.5
6" (DN 150)	.255" (6.5 mm)	5.0	5.0	3.8
8" (DN 200)	.310" (7.9 mm)	5.0	5.0	3.8
10" (DN 250)	.350" (8.9 mm)	5.0	5.0	3.8
12" (DN 300)	.450" (11.4 mm)	5.5	5.0	4.3
ASTM F1545 Documentation	Yes / ALL	Limited	Limited	Limited
Vacuum Rating	Full Vacuum / 450°F (232°C)	DN 25-100 FV / 150°C >100 mm: No	DN 25-100 FV / 100°C >100 mm: No	No

All dimensions and tolerances according to ANSI B16.5 (see Resistoflex® Plastic Lined Pipe & Fittings Design Manual).

## 90 Degree Elbows, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

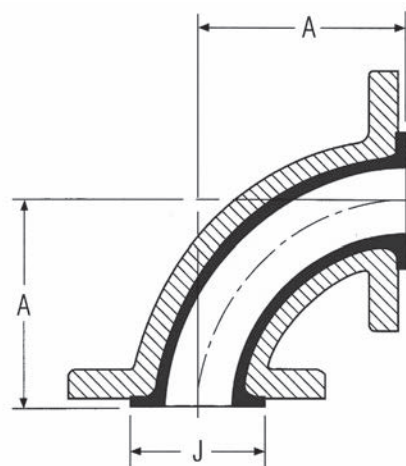
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP		PVDF		PFA	Weight	
		A		J		Cast DI A395	Cast Steel A216 WCB	Cast DI A395	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm							
1	25	3 1/2	89	2	51	●	●	●	●	●	6	2.7
1 1/2	40	4	102	2 7/8	73	●	●	●	●	●	10	4.5
2	50	4 1/2	114	3 5/8	92	●	●	●	●	●	14.5	6.6
3	80	5 1/2	140	5	127	●	●	●	●	●	26	11.8
4	100	6 1/2	165	6 3/16	157	●	●	●	●	●	47	21.4
6	150	8	203	8 1/2	216	●	●	●	●		70.5	32
8	200	9	229	10 5/8	270	●	●	●	●		116	52.7
10	250	11	279	12 3/4	324		●				135	61.4
12	300	12	305	15	381		●				208	94.5

ASME B16.5 Class 300 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP		PVDF		PFA	Weight	
		A		J		Cast DI A395	Cast Steel A216 WCB	Cast DI A395	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm							
1	25	4	102	2	51		●		●	●	7	3.2
1 1/2	40	4 1/2	114	2 7/8	73		●		●	●	11	5
2	50	5	127	3 5/8	92		●		●	●	16	7.3
3	80	6	152	5	127		●		●	●	29	13.2
4	100	7	178	6 3/16	157		●		●	●	52	23.7
6	150	8 1/2	216	8 1/2	216		●		●		78	35.5

## Reducing 90 Degree Elbows, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

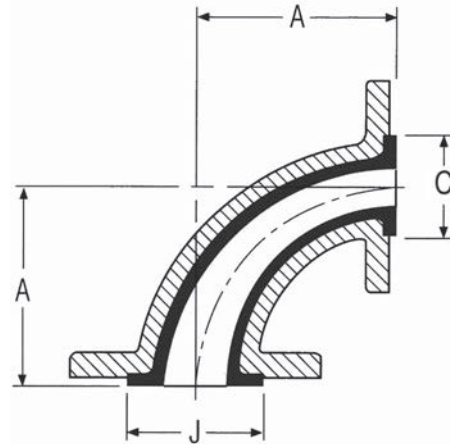
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions						PP	PVDF	PFA	Weight	
		A		J		C		Cast Steel A216 WCB				
		Inch	mm	Inch	mm	Inch	mm				lbs.	kg
1 1/2	1	4	102	2 7/8	73	2	51	●	●	●	7.1	3.2
2	1	4 1/2	114	3 5/8	92	2	51	●	●	●	9.3	4.2
	2 7/8					73	●	●	●	11.8	5.4	
3	1	5 1/2	140	5	127	2	51	●	●	●	14.9	6.8
	2 7/8					73	●	●	●	16.9	7.7	
	3 5/8					92	●	●	●	19	8.6	
4	1	6 1/2	165	6 3/16	157	2	51	●	●	●	22.1	10
	2 7/8					73	●	●	●	24.8	11.3	
	3 5/8					92	●	●	●	26.5	12	
	5					127	●	●	●	33	15	
6	2	8	203	8 1/2	216	3 5/8	92	●	●		44	20
	5					127	●	●		45	20.5	
	6 3/16					157	●	●		52	23.6	
8	4	9	229	10 5/8	270	6 3/16	157	●	●		85	38.6
	8 1/2					216	●	●		89	40.5	

## 45 Degree Elbows, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

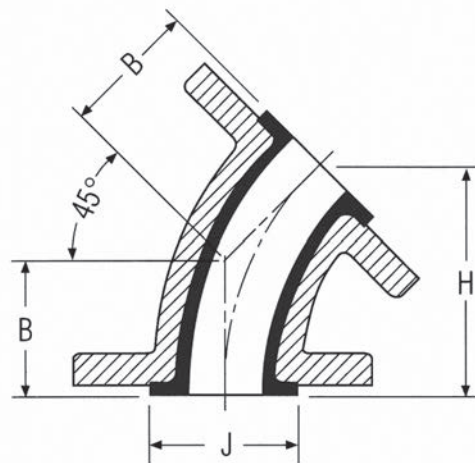
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services

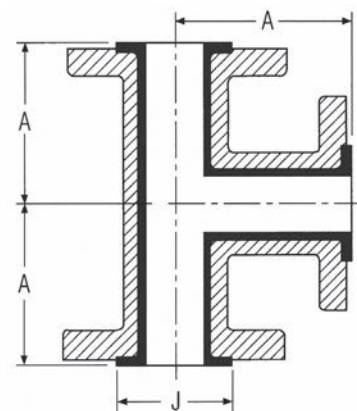


ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP		PVDF		PFA	Weight	
		B		J		Cast DI A395	Cast Steel A216 WCB	Cast DI A395	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm							
1	25	1 3/4	45	2	51	●	●	●	●	●	5.3	2.4
1 1/2	40	2 1/4	57	2 7/8	73	●	●	●	●	●	8	3.6
2	50	2 1/2	64	3 5/8	92	●	●	●	●	●	12.1	5.5
3	80	3	76	5	127	●	●	●	●	●	21.5	9.8
4	100	4	102	6 3/16	157	●	●	●	●	●	39.5	18
6	150	5	127	8 1/2	216	●	●	●	●	●	57.5	26.1
8	200	5 1/2	140	10 5/8	270	●	●	●	●	●	98.6	44.8
10	250	6 1/2	165	12 3/4	324		●				100	45.5
12	300	7 1/2	190	15	381		●				160	72.7

ASME B16.5 Class 300 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP	PVDF	PFA	Weight			
		A		J		Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg		
		Inch	mm	Inch	mm							
1	25	2 1/4	57	2	51	●	●	●	Consult Factory			
1 1/2	40	2 3/4	70	2 7/8	73	●	●	●				
2	50	3	76	3 5/8	92	●	●	●				
3	80	3 1/2	89	5	127	●	●	●				
4	100	4 1/2	114	6 3/16	157	●	●	●				
6	150	5 1/2	140	8 1/2	216	●	●	●				

# Equal Tees, PP / PVDF / PFA-Lined



1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services

ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP		PVDF		PFA	Weight	
		A		J		Cast DI A395	Cast Steel A216 WCB	Cast DI A395	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm							
1	25	3 1/2	89	2	51	●	●	●	●	●	9.5	4.3
1 1/2	40	4	102	2 7/8	73	●	●	●	●	●	14	6.4
2	50	4 1/2	114	3 5/8	92	●	●	●	●	●	20.5	9.3
3	80	5 1/2	140	5	127	●	●	●	●	●	40	18.2
4	100	6 1/2	165	6 3/16	157	●	●	●	●	●	65	29.5
6	150	8	203	8 1/2	216	●	●	●	●	●	100	45.5
8	200	9	229	10 5/8	270	●	●	●	●	●	183	83.2
10	250	11	279	12 3/4	324		●	●	●		257	116.8
12	300	12	305	15	381		●	●	●		395	179.5

ASME B16.5 Class 300 Flanged												
Size (NPS)	Size (DN)	Dimensions				PP	PVDF	PFA	Weight			
		A		J		Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg		
		Inch	mm	Inch	mm							
1	25	4	102	2	51	●	●	●	Consult Factory			
1 1/2	40	4 1/2	114	2 7/8	73	●	●	●				
2	50	5	127	3 5/8	92	●	●	●				
3	80	6	152	5	127	●	●	●				
4	100	7	178	6 3/16	157	●	●	●				
6	150	8 1/2	216	8 1/2	216	●	●	●				

## Reducing Tees, Class 150 PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

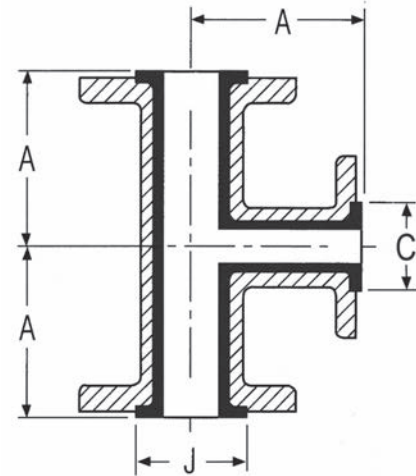
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



### ASME B16.5 Class 150 Flanged

Size NPS (DN)	Size NPS (DN)	Dimensions						PP Cast Steel A216 WCB	PVDF Cast Steel A216 WCB	PFA Cast Steel A216 WCB	Weight	
		A		J		C					lbs.	kg
		Inch	mm	Inch	mm	Inch	mm					
1 1/2 (40)	1 (25)	4	102	2 7/8	73	2	51	●	●	●	13	5.9
2 (50)	1 (25)	4 1/2	114	3 5/8	92	2	51	●	●	●	20	9.1
	1 1/2 (40)					2 7/8	73	●	●	●	21	9.5
3 (80)	1 (25)	5 1/2	140	5	127	2	51	●	●	●	31	14.1
	1 1/2 (40)					2 7/8	73	●	●	●	34	15.5
	2 (50)					3 5/8	92	●	●	●	36	16.4
4 (100)	1 (25)	6 1/2	165	6 3/16	157	2	51	●	●	●	54	24.5
	1 1/2 (40)					2 7/8	73	●	●	●	58	26.4
	2 (50)					3 5/8	92	●	●	●	59	26.8
	3 (80)					5	127	●	●	●	61	27.7
6 (150)	1 (25)	8	203	8 1/2	216	2	51	●	●	●	94	42.7
	1 1/2 (40)					2 7/8	73	●	●	●	95	43.2
	2 (50)					3 5/8	92	●	●	●	96	43.6
	3 (80)					5	127	●	●	●	97	44.1
	4 (100)					6 3/16	157	●	●	●	100	45.5
8	1 (25)	9	229	10 5/8	270	2	51	●	●	●	134	60.9
	1 1/2 (40)					2 7/8	73	●	●	●	135	61.4
	2 (50)					3 5/8	92	●	●	●	136	61.8
	3 (80)					5	127	●	●	●	140	63.6
	4 (100)					6 3/16	157	●	●	●	150	68.2
	6 (150)					8 1/2	216	●	●	●	160	72.7



## Reducing Tees, Class 150 PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

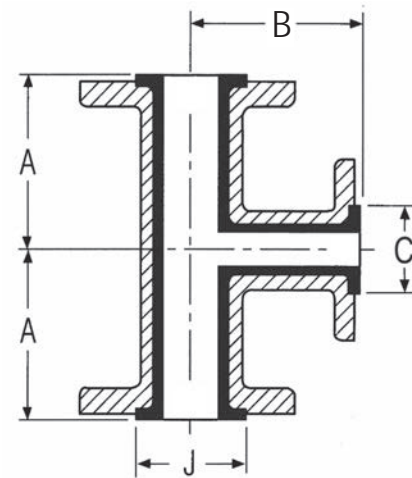
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Class 150 Flanged														
Size NPS (DN)	Size NPS (DN)	Dimensions								PP		Weight		
		A		B		J		C		Fabricated Steel	lbs.	kg		
		Inch	mm	Inch	mm	Inch	mm	Inch	mm					
10	4 (100)	11	279	11	279	12 3/4	324	6 3/16	157	•	Consult Factory			
	6 (150)							8 1/2	216	•				
	8 (200)							10 5/8	270	•				
12	6 (150)	12	305	12	305	15	381	8 1/2	216	•				
	8 (200)							10 5/8	270	•				
	10 (250)							12 3/4	324	•				
ASME B16.5 Class 300 Flanged														
Size NPS (DN)	Size NPS (DN)	Dimensions								PP	PVDF	PFA	Weight	
		A		B		J		C		Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm	Inch	mm					
1 1/2 (40)	1 (25)	4 1/2	114	4 1/2	114	2 7/8	73	2	51	•	•	•	20.6	9.4
2 (50)		5	127	5	127	3 5/8	92			•	•	•	22	10
3 (80)	2 (50)	6	152	6	152	5	127	3 5/8	92	•	•	•	36	16.4
4 (100)		7	178	7	178	6 3/16	157			•	•	•	59	26.8

# 1" (DN 25) Branch Instrument Tees, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

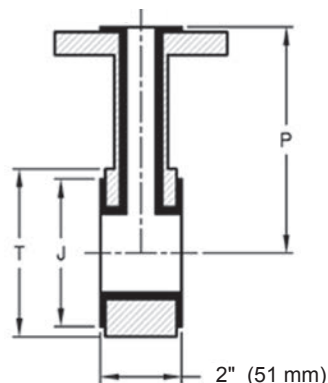
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions						PP Cast Steel A216 WCB	PVDF Cast Steel A216 WCB	PFA Cast Steel A216 WCB	Weight	
		P		J		T					lbs.	kg
		Inch	mm	Inch	mm	Inch	mm					
1 x 1	25 x 25	3 1/2	89	2	51	2 5/8	67	●	●	●	5	2.3
1 1/2 x 1	40 x 25	4	102	2 7/8	73	3 3/8	86	●	●	●	7	3.2
2 x 1	50 x 25	4 1/2	114	3 5/8	92	4 1/8	105	●	●	●	9	4.1
3 x 1	80 x 25	5 1/2	140	5	127	5 3/8	137	●	●	●	11	5
4 x 1	100 x 25	6 1/2	165	6 3/16	157	6 3/4	171	●	●	●	17	7.7
6 x 1	150 x 25	8	203	8 1/2	216	8 3/4	222	●	●	●	21	9.5
8 x 1	200 x 25	9	229	10 5/8	270	11	279	●	●	●	29	13.2
10 x 1	250 x 25	11	279	12 3/4	324	13 3/8	340	●			69	31.4
12 x 1	300 x 25	12	305	15	381	16 1/8	410	●			77	35

ASME B16.5 Class 300 Flanged												
Size (NPS)	Size (DN)	Dimensions						PP Cast Steel A216 WCB	PVDF Cast Steel A216 WCB	PFA Cast Steel A216 WCB	Weight	
		P		J		T					lbs.	kg
		Inch	mm	Inch	mm	Inch	mm					
1 x 1	25 x 25	4	102	2	51	2 7/8	73	●	●	●	6	2.7
1 1/2 x 1	40 x 25	4 1/2	114	2 7/8	73	3 3/4	95	●	●	●	8	3.6
2 x 1	50 x 25	5	127	3 5/8	92	4 3/8	111	●	●	●	11	5
3 x 1	80 x 25	6	152	5	127	5 7/8	149	●	●	●	13	5.9
4 x 1	100 x 25	7	178	6 3/16	157	7 1/8	181	●	●	●	19	8.6
6 x 1	150 x 25	8 1/2	216	8 1/2	216	9 7/8	251	●	●	●	23	10.5

## 1 1/2" (DN 40) Branch Instrument Tees, PP / PVDF-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

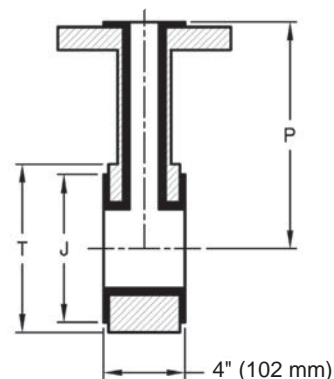
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Class 150 Flanged												
Size (NPS)	Size (DN)	Dimensions						PP	PVDF	PFA	Weight	
		P		J		T						
		Inch	mm	Inch	mm	Inch	mm	Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
1 1/2 x 1 1/2	40 x 40	4	102	2 7/8	73	3 3/8	86	●	●	●	13	5.9
2 x 1 1/2	50 x 40	4 1/2	114	3 5/8	92	4 1/8	105	●	●	●	16	7.3
3 x 1 1/2	80 x 40	5 1/2	140	5	127	5 3/8	137	●	●	●	22	10
4 x 1 1/2	100 x 40	6 1/2	165	6 3/16	157	6 3/4	171	●	●	●	31	14.1
6 x 1 1/2	150 x 40	8	203	8 1/2	216	8 3/4	222	●	●	●	41	18.6
8 x 1 1/2	200 x 40	9	229	10 5/8	270	11	279	●	●	●	60	27.3
10 x 1 1/2	250 x 40	11	279	12 3/4	324	13 3/8	340	●			77	35
12 x 1 1/2	300 x 40	12	305	15	381	16 1/8	410	●			104	47.3

## 2" (DN 50) Branch Instrument Tees, PP / PVDF-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

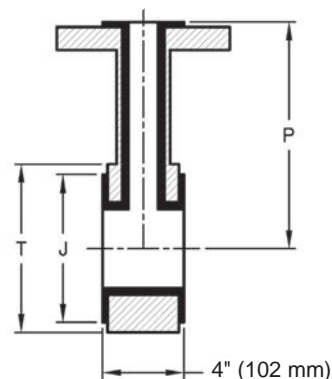
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



### ASME B16.5 Class 150 Flanged

Size (NPS)	Size (DN)	Dimensions						PP	PVDF	PFA	Weight	
		P		J		T		Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
		Inch	mm	Inch	mm	Inch	mm					
2 x 2	50 x 50	4 1/2	114	3 5/8	92	4 1/8	105	●	●	●	18	8.2
3 x 2	80 x 50	5 1/2	140	5	127	5 3/8	137	●	●	●	24	10.9
4 x 2	100 x 50	6 1/2	165	6 3/16	157	6 3/4	171	●	●	●	33	15
6 x 2	150 x 50	8	203	8 1/2	216	8 3/4	222	●	●	●	43	19.5
8 x 2	200 x 50	9	229	10 5/8	270	11	279	●	●	●	62	28.2
10 x 2	250 x 50	11	279	12 3/4	324	13 3/8	340	●		●	79	35.9
12 x 2	300 x 50	12	305	15	381	16 1/8	410	●			108	49.1

## Crosses, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

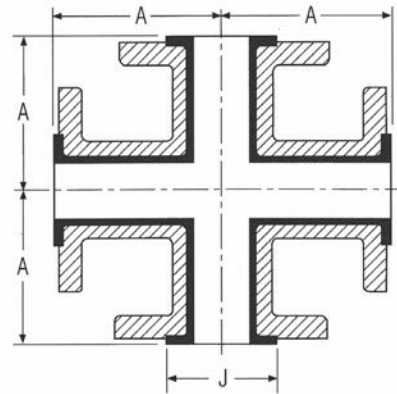
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



### ASME B16.5 Class 150 Flanged

Size (NPS)	Size (DN)	Dimensions				PP	PVDF	PFA	Weight	
		A		J						
		Inch	mm	Inch	mm	Cast Steel A216 WCB	Cast Steel A216 WCB	Cast Steel A216 WCB	lbs.	kg
1	25	3 1/2	89	2	51	●	●	●	14.1	6.4
1 1/2	40	4	102	2 7/8	73	●	●	●	21.6	9.8
2	50	4 1/2	114	3 5/8	92	●	●	●	32	14.5
3	80	5 1/2	140	5	127	●	●	●	54	24.5
4	100	6 1/2	165	6 3/16	157	●	●	●	88	40
6	150	8	203	8 1/2	216	●	●	●	152	69.1
8	200	9	229	10 5/8	270	●	●		238	108.2
10	250	11	279	12 3/4	324	●			Consult Factory	
12	300	12	305	15	381	●				

## 45° Laterals, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

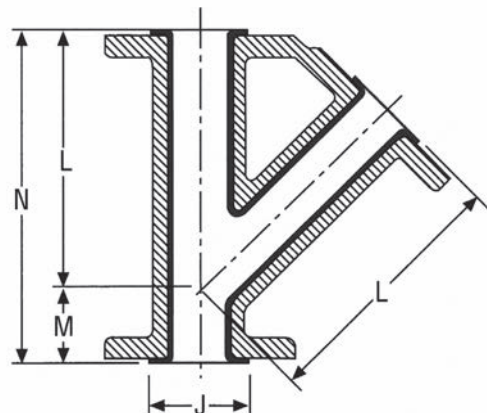
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



### ASME B16.5 Class 150 Flanged

Size (NPS)	Size (DN)	Dimensions								PP	PVDF	PFA	Weight	
		L		M		N		J					Cast Steel A216 WCB	Cast Steel A216 WCB
		Inch	mm	Inch	mm	Inch	mm	Inch	mm					
1	25	5 3/4	146	1 3/4	44	7 1/2	191	2	51	●	●	●	12	5.5
1 1/2	40	7	178	2	51	9	229	2 7/8	73	●	●	●	16.5	7.5
2	50	8	203	2 1/2	64	10 1/2	267	3 5/8	92	●	●	●	24	10.9
3	80	10	254	3	76	13	330	5	127	●	●	●	45	20.5
4	100	12	305	3	76	15	381	6 3/16	157	●	●	●	84	38.2
6	150	14 1/2	368	3 1/2	89	18	457	8 1/2	216	●	●		126	57.3
8	200	17 1/2	445	4 1/2	114	22	559	10 5/8	270	●	●		216	98.2
10	250	20 1/2	521	5	127	25 1/2	648	12 3/4	324	●			238	108.2
12	300	24 1/2	622	5 1/2	140	30	762	15	381	●			262	119.1

## Concentric Reducers, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

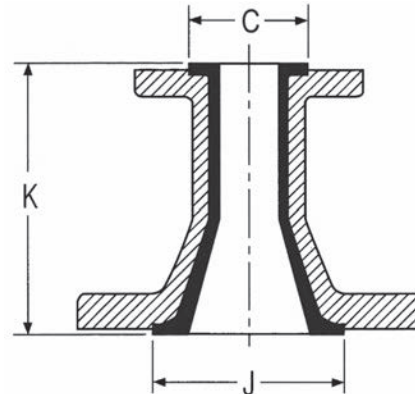
Consult factory for vacuum ratings on PFA-lined fittings.

Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



ASME B16.5 Flanged													
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions (same for Class 150 and Class 300)			PP			PVDF			PFA	Weight	
		K	J	C	Class 150 Cast DI A395	Class 150 Cast Steel A216 WCB	Class 300 Cast Steel A216 WCB	Class 150 Cast DI A395	Class 150 Cast Steel A216 WCB	Class 300 Cast Steel A216 WCB	Class 150 Cast Steel A216 WCB	lbs.	kg
		Inch (mm)	Inch (mm)	Inch (mm)									
1 1/2 (40)	1 (25)	4 1/2 (114)	2 7/8 (73)	2 (51)	•	•	•	•	•	•	•	6.5	3
2 (50)	1 (25)	5 (127)	3 5/8 (92)	2 (51)	•	•	•	•	•	•	•	9	4.1
	1 1/2 (40)			2 7/8 (73)	•	•	•	•	•	•	•	11	5
3 (80)	1 (25)	6 (152)	5 (127)	2 (51)	•	•	•	•	•	•	•	14	6.4
	1 1/2 (40)			2 7/8 (73)	•	•	•	•	•	•	•	15	6.8
	2 (50)			3 5/8 (92)	•	•	•	•	•	•	•	17	7.7
4 (100)	1 (25)	7 (178)	6 3/16 (157)	2 (51)	•	•		•	•		•	22	10
	1 1/2 (40)			2 7/8 (73)	•	•		•	•		•	25	11.4
	2 (50)			3 5/8 (92)	•	•	•	•	•	•	•	27	12.3
	3 (80)			5 (127)	•	•	•	•	•	•	•	33	15
6 (150)	1 (25)	9 (229)	8 1/2 (216)	2 (51)		•			•			42	19.1
	1 1/2 (40)			2 7/8 (73)		•			•			42	19.1
	2 (50)			3 5/8 (92)	•	•	•	•	•	•		42	19.1
	3 (80)			5 (127)	•	•	•	•	•	•		44	20
	4 (100)			6 3/16 (157)	•	•	•	•	•	•		52	23.6
8 (200)	1 (25)	11 (279)	10 5/8 (270)	2 (51)		•			•			46	20.9
	1 1/2 (40)			2 7/8 (73)		•			•			59	26.8
	2 (50)			3 5/8 (92)		•			•			63	28.6
	3 (80)			5 (127)	•	•			•			70	31.8
	4 (100)			6 3/16 (157)	•	•			•	•		83	37.7
	6 (150)			8 1/2 (216)	•	•			•	•		80	36.4

## Concentric Reducers, PP-Lined

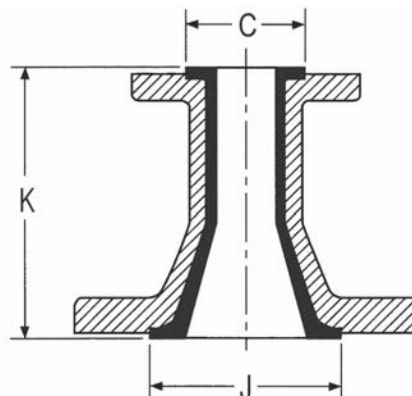
10" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

Fittings shown as Cast Steel have fixed flanges

PP-lined fittings available in CS with rotating flanges

PP-lined fittings available in SS with fixed or rotating flanges

10" (DN 250 and 12" (DN 300) PP liners are made with 25% glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide services



### ASME B16.5 Flanged

Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions (same for Class 150 and Class 300)			Class 150 Cast Steel A216 WCB	Fabricated Steel	Weight	
		K	J	C			lbs.	kg
		Inch (mm)	Inch (mm)	Inch (mm)				
10 (250)	4 (100)	12 (305)	12 3/4 (324)	6 3/16 (157)	•	•	97	44.1
	6 (150)			8 1/2 (216)	•	•	116	52.7
	8 (200)			10 5/8 (270)	•	•	132	60
12 (300)	6 (150)	14 (356)	15 (381)	8 1/2 (216)	•	•	144	65.5
	8 (200)			10 5/8 (270)	•	•	170	77.3
	10 (250)			12 3/4 (324)	•	•	190	86.4



## Eccentric Reducers, PP / PVDF / PFA-Lined

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings with Cast DI or Cast Steel construction are rated for full vacuum at 225°F.

Consult factory for vacuum ratings on PFA-lined fittings.

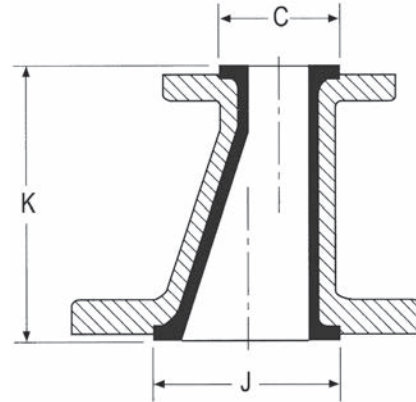
Fittings shown as Cast DI or Cast Steel have fixed flanges

PP/PVDF lined fittings available in CS with rotating flanges

PP/PVDF lined fittings available in SS with fixed or rotating flanges

Centerline offset is found by the following formula:

$(\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$



ASME B16.5 Class 150 Flanged									
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions			PP	PVDF	PFA	Weight	
		K	J	C	Cast Steel A216 WCB			lbs.	kg
		Inch (mm)	Inch (mm)	Inch (mm)					
1 1/2 (40)	1 (25)	4 1/2 (114)	2 7/8 (73)	2 (51)	•	•	•	6.5	3
2 (50)	1 (25)	5 (127)	3 5/8 (92)	2 (51)	•	•	•	9	4.1
	1 1/2 (40)			2 7/8 (73)	•	•	•	11	5
3 (80)	1 (25)	6 (152)	5 (127)	2 (51)	•	•	•	14	6.4
	1 1/2 (40)			2 7/8 (73)	•	•	•	15	6.8
	2 (50)			3 5/8 (92)	•	•	•	17	7.7
4 (100)	1 (25)	7 (178)	6 3/16 (157)	2 (51)	•	•	•	22	10
	1 1/2 (40)			2 7/8 (73)	•	•	•	25	11.4
	2 (50)			3 5/8 (92)	•	•	•	27	12.3
	3 (80)			5 (127)	•	•	•	33	15
6 (150)	1 (25)	9 (229)	8 1/2 (216)	2 (51)	•	•		36	16.4
	1 1/2 (40)			2 7/8 (73)	•	•		42	19.1
	2 (50)			3 5/8 (92)	•	•		42	19.1
	3 (80)			5 (127)	•	•		44	20
	4 (100)			6 3/16 (157)	•	•		52	23.6
8 (200)	1 (25)	11 (279)	10 5/8 (270)	2 (51)	•	•		46	20.9
	2 (50)			3 5/8 (92)	•	•		63	28.6
	3 (80)			5 (127)	•	•		70	31.8
	4 (100)			6 3/16 (157)	•	•		83	37.7
	6 (150)			8 1/2 (216)	•	•		80	36.4

## Eccentric Reducers, PP-Lined

Polypropylene-lined fittings are rated for full vacuum at 225°F.

Consult factory for vacuum ratings on PFA-lined fittings.

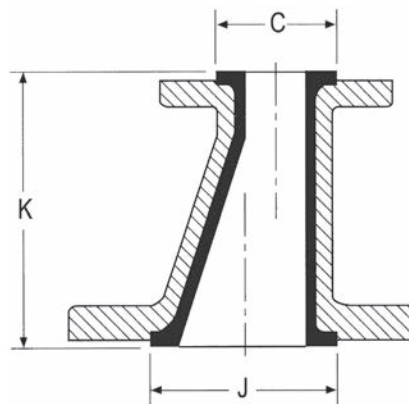
Fittings shown as Cast DI or Cast Steel have fixed flanges

PP-lined fittings available in CS with rotating flanges

PP-lined fittings available in SS with fixed or rotating flanges

Centerline offset is found by the following formula:

$(\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$



ASME B16.5 Class 150 Flanged								
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions			Class 150 Cast Steel A216 WCB	Fabricated Steel	Weight	
		K	J	C			lbs.	kg
		Inch (mm)	Inch (mm)	Inch (mm)				
10 (250)	4 (100)	12 (305)	12 3/4 (324)	6 3/16 (157)		●	97	44.1
	6 (150)			8 1/2 (216)		●	116	52.7
	8 (200)			10 5/8 (270)	●	●	132	60
12 (300)	6 (150)	14 (356)	15 (381)	8 1/2 (216)		●	144	65.5
	8 (200)			10 5/8 (270)		●	170	77.3
	10 (250)			12 3/4 (324)	●	●	190	86.4

## Reducing Filler Flanges, PP / PVDF / PFA-Lined

PFA is straight bore. Straight-bore with other liners available on request

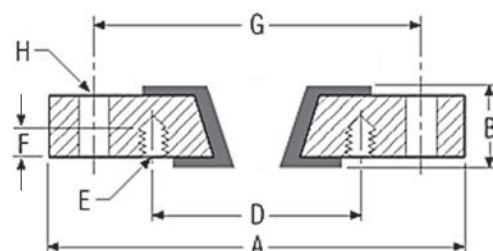
Available in carbon steel or stainless steel

**Vacuum Ratings:**

1" - 8" PVDF-lined fittings are rated for full vacuum at 275°F.

1" - 12" Polypropylene-lined fittings are rated for full vacuum at 225°F.

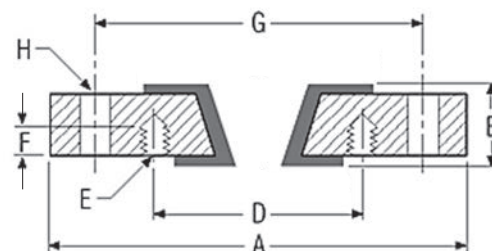
Consult factory for vacuum ratings on PFA-lined fittings.



● ASME B16.5 Class 150 Flanged													
Major Size NPS (DN)	Minor Size NPS (DN)	Liner Availability			Thickness, B inch (mm)	H - Bolt Holes			E - Bolt Holes				Bolt Hole Rotation
		P V D F	P P	P F A		No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)	
1 (25)	1/2 (15)	●	●	●	1 1/2 (38)	4	1/2-13	3 1/8 (79)	4	1/2-13	2 3/8 (67)	11/16 (17)	45°
	3/4 (20)	2 3/4 (70)											
1 1/2 (40)	1 (25)	●	●	●	1 1/2 (38)	4	1/2-13	3 7/8 (98)	4	1/2-13	3 1/8 (79)	9/16 (14)	45°
2 (50)	1 (25)	●	●	●	1 1/2 (38)	4	5/8-11	4 3/4 (121)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)	3 7/8 (98)	5/8 (16)	45°									
3 (80)	1 (25)	●	●	●	1 1/2 (38)	4	5/8-11	6 (152)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)										3 7/8 (98)		
	2 (50)										4 3/4 (121)	3/4 (19)	
4 (100)	1 (25)	●	●	●	2 (51)	8	3/4	7 1/2 (191)	4	1/2-13	3 1/8 (79)	9/16 (14)	0°
	1 1/2 (40)										3 7/8 (98)		
	2 (50)				4 3/4 (121)						3/4 (19)		
	3 (80)											6 (152)	
6 (150)	1 1/2 (40)	●	●	●	2 (51)	8	7/8	9 1/2 (241)	4	1/2-13	3 7/8 (98)	9/16 (14)	0°
	2 (50)										4 3/4 (121)		
	3 (80)				6 (152)						3/4 (19)		
	4 (100)											7 1/2 (191)	
8 (200)	3 (80)	●	●	●	2	8	7/8	11 3/4 (298)	4	5/8-11	6 (152)	3/4 (19)	0°
	4 (100)										7 1/2 (191)		
	6 (150)										3/4-10	9 1/2 (241)	
10 (250)	4 (100)	●	●	2 (51)	12	1	14 1/4 (362)	8	8	5/8-11	7 1/2 (191)	3/4 (19)	0°
	6 (150)										9 1/2 (241)		
	8 (200)										3/4-10	11 3/4 (298)	
12 (300)	6 (150)	●	●	2 (51)	8	3/4-10	17	8	8	3/4-10	9 1/2 (241)	13/16 (21)	0°
	8 (200)										11 3/4 (298)		
	10 (250)				12						7/8-9	12	

## Reducing Filler Flanges, PP / PVDF / PFA-Lined

Rated for full vacuum to liner maximum temperature  
 Consult factory for weights  
 Dimension "A" = ASME Class 300 Flange OD  
 Straight-bore available on request  
 Also available in stainless steel and other alloys



ASME B16.5 Class 300 Flanged														
Major Size NPS (DN)	Minor Size NPS (DN)	Liner Availability			Thickness, B inch (mm)	H - Bolt Holes			E - Bolt Holes				Bolt Hole Rotation	
		P P	P V D F	P F A		No.	Size	Bolt Circle Dia. G inch (mm)	No.	Size	Bolt Circle Dia. D inch (mm)	Depth F inch (mm)		
1 1/2 (40)	1 (25)	•	•	•	1 1/2 (38)	4	3/4-10	4 1/2 (114)	4	5/8-11	3 1/2 (89)	5/8 (16)	45°	
2 (50)	1 (25)	•	•	•	1 1/2 (38)	8	5/8-11	5 (127)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°	
	1 1/2 (40)	3/4-10	4 (102)											
3 (80)	1 (25)	•	•	•	1 1/2 (38)	8	3/4-10	6 5/8 (168)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°	
	1 1/2 (40)									3/4-10	4 1/2 (114)			
	2 (50)								5/8-11	5 (127)	3/4 (19)	22.5°		
4 (100)	1 (25)	•	•	•	2 (51)	8	7/8	7 7/8 (200)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°	
	1 1/2 (40)									3/4-10	4 1/2 (114)			
	2 (50)	•	•	•	1 1/2 (38)				8	3/4-10	5/8-11	5 (127)	3/4 (19)	22.5°
	3 (80)										3/4-10	6 5/8 (168)		
6 (150)	1 (25)	•	•	•	2 (51)	12	7/8	10 5/8 (270)	4	5/8-11	3 1/2 (89)	5/8 (16)	0°	
	2 (50)									5 (127)				
	3 (80)	•	•	•	1 1/2 (38)				8	3/4-10	6 5/8 (168)	3/4 (19)	7.5°	
	4 (100)										7 7/8 (200)			
8 (200)	3 (80)	•	•	•	2 (51)	12	1	13	8	3/4-10	6 5/8 (168)	3/4 (19)	0°	
	4 (100)										7 7/8 (200)			
	6 (150)	•	•	•	1 1/2 (38)				12	7/8-9	10 5/8 (270)	13/16 (21)	15°	

## Standard Materials Specifications for 14" (DN 350) - 48" (DN 1200) Pipe and Fittings

14" (DN 350) - 24" (DN 600) PTFE-lined pipe and fittings manufactured by Resistoflex are in full compliance with: ASTM F1545-15a, Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges as follows:

- Resistoflex purchases approved ASTM designations of resin used to for lining
- Resistoflex uses approved ASTM designations of materials of construction for flanged housings
- Resistoflex performs 30 kV electrostatic proof-testing for liner integrity on 100% of finished goods

Resistoflex large diameter also meet the following specifications/requirements:

<b>Liners:</b>	PTFE — Polytetrafluoroethylene, ASTM D4895 (14" - 24", only) ETFE — Ethylene Tetrafluoroethylene, ASTM D3159 PP — Polypropylene, ASTM D4101 HDPE — High Density Polyethylene											
<b>Pipe:</b>	<p><u>Carbon Steel*</u></p> <p>NPS 14 (DN 350) - NPS 28 (DN 700), 0.375" Wall per ASTM A53 ERW, Grade B Type E NPS 30 (DN 750) - NPS 48 (DN 1200), 0.375" wall per API 5L X42 DSAW</p> <p><u>Stainless Steel 304LSS or 316LSS*</u></p> <p>NPS 14 (DN 350) - NPS 36 (DN 900), 0.375" Wall Stainless Steel per ASTM A312 ERW NPS 38 (DN 950) - NPS 48 (DN 1200), 0.375" Wall Stainless Steel per ASTM A778 ERW</p> <p>* Note: Seamless pipe available on request</p>											
<b>Flanges:</b>	NPS 14 (DN 15) - NPS 24 (DN 600) = Carbon Steel, ASTM A105, ASME B16.5 Class 150 or Class 300 NPS 26 (DN 650) - NPS 48 (DN 1200) = Carbon Steel, ASTM A105, ASME B16.47 Series A Class 150 or Class 300 Flanges also available in ASTM A182 304L or 316L stainless steel											
<b>Flange Types:</b>	Lap-joint, Slip-On, Welding Neck											
	Standard Flange Configurations:	<table border="0"> <tr> <td>14" - 16" PTFE/PP/ETFE/HDPE-lined pipe</td> <td>- Lap joint x lap joint</td> </tr> <tr> <td>18" - 24" PTFE-lined pipe</td> <td>- Lap joint x slip-on</td> </tr> <tr> <td>14" - 24" PTFE-lined fittings</td> <td>- Slip-on x slip-on</td> </tr> <tr> <td>18" - 48" PP/ETFE/HDPE-lined pipe</td> <td>- Welding neck x welding neck</td> </tr> <tr> <td>18" - 48" PP/ETFE/HDPE-lined fittings</td> <td>- Welding neck x welding neck</td> </tr> </table>	14" - 16" PTFE/PP/ETFE/HDPE-lined pipe	- Lap joint x lap joint	18" - 24" PTFE-lined pipe	- Lap joint x slip-on	14" - 24" PTFE-lined fittings	- Slip-on x slip-on	18" - 48" PP/ETFE/HDPE-lined pipe	- Welding neck x welding neck	18" - 48" PP/ETFE/HDPE-lined fittings	- Welding neck x welding neck
14" - 16" PTFE/PP/ETFE/HDPE-lined pipe	- Lap joint x lap joint											
18" - 24" PTFE-lined pipe	- Lap joint x slip-on											
14" - 24" PTFE-lined fittings	- Slip-on x slip-on											
18" - 48" PP/ETFE/HDPE-lined pipe	- Welding neck x welding neck											
18" - 48" PP/ETFE/HDPE-lined fittings	- Welding neck x welding neck											
<b>Fittings:</b>	Fabricated Carbon Steel: Components per ASTM A53 Gr. B and/or ASTM A234 Fabricated Stainless Steel: Components per ASTM A312 and/or ASTM A403											
<b>Fabrication:</b>	<p>Pipe and Fittings Tolerances:</p> <table border="1"> <thead> <tr> <th>Dimension</th> <th>Tolerance, in.</th> </tr> </thead> <tbody> <tr> <td>Length and Centerline Dimensions</td> <td>± 1/8" (3.2 mm)</td> </tr> <tr> <td>Fixed Flange Bolt Hole Alignment</td> <td>± 1/16" (1.6 mm)</td> </tr> <tr> <td>Flange Perpendicularity (with Pipe Centerline)</td> <td>3/32 in/ft (7.8 mm/m) of nominal pipe diameter</td> </tr> </tbody> </table>		Dimension	Tolerance, in.	Length and Centerline Dimensions	± 1/8" (3.2 mm)	Fixed Flange Bolt Hole Alignment	± 1/16" (1.6 mm)	Flange Perpendicularity (with Pipe Centerline)	3/32 in/ft (7.8 mm/m) of nominal pipe diameter		
Dimension	Tolerance, in.											
Length and Centerline Dimensions	± 1/8" (3.2 mm)											
Fixed Flange Bolt Hole Alignment	± 1/16" (1.6 mm)											
Flange Perpendicularity (with Pipe Centerline)	3/32 in/ft (7.8 mm/m) of nominal pipe diameter											

# 14" (DN 350) - 48" (DN 1200) Flange and Pipe Data

14" (DN 350) - 24" (DN 600) ASME B16.5 Flanges 26" (DN 650) - 48" (DN 1200) ASME B16.47 Series A Flanges					ASME B36.10 Pipe			
Class 150					Standard Wall			
Size NPS (DN)	Outside Diameter in. (mm)	Thickness in. (mm)	No. and Diameter of Bolt Holes	Bolt Circle Diameter in. (mm)	Outside Diameter in. (mm)	Wall Thickness		
14 (350)	21 (533)	1 3/8 (35)	(12) 1 1/8	18 3/4 (476)	14 (356)	0.375 (10)		
16 (400)	23 1/2 (597)	1 7/16 (37)	(16) 1 1/8	21 1/4 (540)	16 (406)	0.375 (10)		
18 (450)	25 (635)	1 9/16 (40)	(16) 1 1/4	22 3/4 (578)	18 (457)	0.375 (10)		
20 (500)	37 1/2 (953)	1 11/16 (43)	(20) 1 1/4	25 (635)	20 (508)	0.375 (10)		
24 (600)	32 (813)	2 7/8 (73)	(20) 1 3/8	29 1/2 (749)	24 (610)	0.375 (10)		
26 (650)	34 1/4 (870)	2 5/8 (67)	(24) 1 3/8	31 3/4 (806)	26 (660)	0.375 (10)		
28 (700)	36 1/2 (927)	2 3/4 (70)	(28) 1 3/8	24 (610)	28 (711)	0.375 (10)		
30 (750)	38 3/4 (984)	2 7/8 (73)	(28) 1 3/8	36 (914)	30 (762)	0.375 (10)		
32 (800)	41 3/4 (1060)	3 1/8 (79)	(28) 1 5/8	38 1/2 (978)	32 (813)	0.375 (10)		
34 (850)	43 3/4 (1111)	3 3/16 (81)	(32) 1 5/8	40 1/2 (1,029)	34 (864)	0.375 (10)		
36 (900)	46 (1168)	3 1/2 (89)	(32) 1 5/8	42 3/4 (1,086)	36 (914)	0.375 (10)		
38 (950)	48 3/4 (1238)	3 3/8 (86)	(32) 1 5/8	45 1/4 (1,149)	38 (965)	0.375 (10)		
40 (1,000)	50 3/4 (1289)	3 1/2 (89)	(36) 1 5/8	47 1/4 (1,200)	40 (1,016)	0.375 (10)		
42 (1,050)	53 (1346)	3 3/4 (95)	(36) 1 5/8	49 1/2 (1,257)	42 (1,067)	0.375 (10)		
44 (1,100)	55 1/4 (1403)	3 15/16 (100)	(40) 1 5/8	51 3/4 (1,314)	44 (1,118)	0.375 (10)		
46 (1,150)	57 1/4 (1454)	4 (102)	(40) 1 5/8	53 3/4 (1,365)	46 (1,168)	0.375 (10)		
48 (1,200)	59 1/2 (1511)	4 3/16 (106)	(44) 1 5/8	56 (1,422)	48 (1,219)	0.375 (10)		

## 14" (DN 350) - 48" (DN 1200) Pipe Spools

Standard flange types:

14" - 16" PTFE/ETFE/PP/HDPE-lined spools are flanged as rotating lap joint both ends

18" - 24" PTFE-lined spools are flanged as rotating lap joint by welded slip-on.

26" - 48" ETFE/PP/HDPE-lined spools are weld neck both ends

Other flange types are available.

14" (DN 350) - 24" (DN 600): ASME B16.5 Class 150 Flanged 26" (DN 650) - 48" (DN 1200): ASME B16.47 Seris A Class 150 Flanged									
Size NPS (DN)	Liner Thickness		Max. Length		Weight, PTFE		ETFE/PP/ HDPE	ETFE	PP/ HDPE
	ETFE/PP/ HDPE	PTFE	ETFE/PP/ HDPE	PTFE	(2) Flanges, lbs. (kg)	Per Foot, lbs. (per mtr., kg)	(2) Flanges, lbs. (kg)	Per Foot, lbs. (per mtr., kg)	Per Foot, lbs. (per mtr., kg)
	Inch (mm)	Inch (mm)	Ft. (Mtr)	Ft. (Mtr)					
14 (350)	0.200 (5)	0.354 (9)	20 (6)	9.8 (3)	210 (95)	85 (57)	114 (52)	63 (94)	60 (89)
16 (400)	0.200 (5)	0.394 (10)	20 (6)	8.2 (2.5)	280 (127)	102 (68)	140 (64)	72 (107)	69 (103)
18 (450)	0.200 (5)	0.256 (6.5)	20 (6)	11.5 (3.5)	325 (148)	130 (87)	165 (75)	81 (121)	77 (115)
20 (500)	0.200 (5)	0.256 (6.5)	20 (6)	8.2 (2.5)	405 (184)	155 (104)	197 (90)	90 (134)	86 (128)
24 (600)	0.200 (5)	0.177 (4.5)	20 (6)	4.5 (1.37)	545 (248)	204 (137)	268 (122)	108 (161)	103 (154)
26 (650)	0.200 (5)	--	20 (6)	--	--	--	600 (273)	118 (176)	112 (167)
28 (700)	0.200 (5)	--	20 (6)	--	--	--	690 (314)	127 (189)	120 (179)
30 (750)	0.200 (5)	--	20 (6)	--	--	--	800 (364)	136 (203)	129 (192)
32 (800)	0.200 (5)	--	20 (6)	--	--	--	1010 (459)	145 (216)	138 (206)
34 (850)	0.200 (5)	--	20 (6)	--	--	--	1080 (491)	154 (230)	146 (218)
36 (900)	0.200 (5)	--	20 (6)	--	--	--	1280 (582)	164 (245)	155 (231)
38 (950)	0.200 (5)	--	20 (6)	--	--	--	1240 (564)	173 (258)	164 (245)
40 (1000)	0.200 (5)	--	20 (6)	--	--	--	1550 (705)	182 (271)	172 (256)
42 (1050)	0.200 (5)	--	20 (6)	--	--	--	1780 (809)	191 (285)	181 (270)
44 (1100)	0.200 (5)	--	20 (6)	--	--	--	1980 (900)	200 (298)	189 (282)
46 (1150)	0.200 (5)	--	20 (6)	--	--	--	2120 (964)	209 (312)	198 (295)
48 (1200)	0.200 (5)	--	20 (6)	--	--	--	2370 (1077)	218 (325)	207 (309)

Consult factory for vacuum ratings

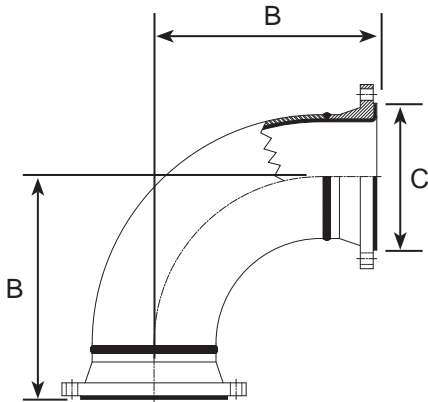
Consult factory for minimum spool lengths

All sizes are available in stainless steel and other alloys

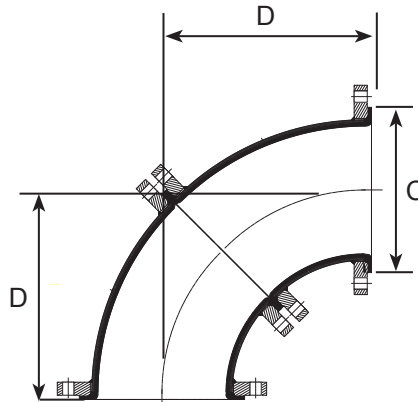
All sizes are available with flanges of other types and pressure class

Weights are approximate

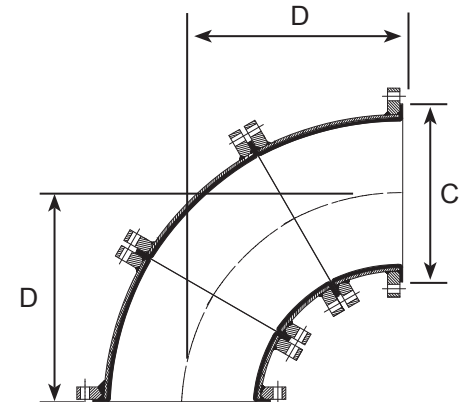
# 14" (DN 350) - 48" (DN 1200) 90 Degree Elbows



14" (DN 350) - 48" (DN 1200)  
ETFE, PP, and HDPE-Lined



16" (DN 400) - 18" (DN 450)  
PTFE-Lined



20" (DN 500) - 24" (DN 600)  
PTFE-Lined

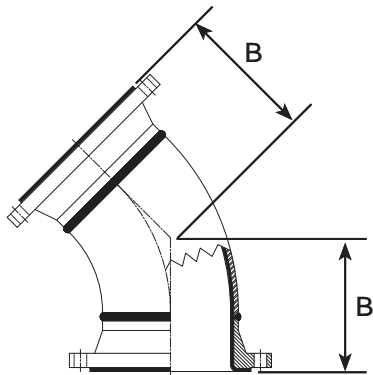
**14" (DN 350) - 24" (DN 600): ASME B16.5 Class 150 Flanged**  
**26" (DN 650) - 48" (DN 1200): ASME B16.47 Series A Class 150 Flanged**

Size (NPS)	Size (DN)	Dimensions		Weight PP/HDPE -Lined		Weight ETFE-Lined		Dimensions		Weight PTFE-Lined		C (All Liners)	
		B (PP, ETFE-Lined)		lbs.	kg	lbs.	kg	D (PTFE-Lined)		lbs.	kg	Inch	mm
		Inch	mm					Inch	mm				
14	350	26 3/8	670	397	181	406	185	21 1/2	546	363	165	16 1/4	413
16	400	29 3/8	746	503	229	515	235	24	610	422	192	18 1/2	470
18	450	32 3/4	832	613	279	629	286	26 1/2	673	517	235	21	533
20	500	36	914	744	339	764	348	29	736	616	280	23	584
24	600	42 1/4	1073	1039	473	1067	485	34	864	869	395	27 1/4	692
26	650	44	1118	1194	543	1229	559	--	--	--	--	29 1/2	737
28	700	47 1/4	1200	1349	614	1389	632	--	--	--	--	31 1/2	787
30	750	50 5/8	1286	1579	718	1625	739	--	--	--	--	33 3/8	838
32	800	54	1372	1871	851	1924	875	--	--	--	--	36	914
34	850	57 1/8	1451	2054	934	2113	961	--	--	--	--	38	965
36	900	60 1/2	1537	2404	1093	2471	1124	--	--	--	--	40 1/4	1016
38	950	63 1/2	1613	2657	1208	2731	1242	--	--	--	--	42 1/4	1067
40	1000	66 3/4	1695	2897	1317	2979	1355	--	--	--	--	44 1/4	1118
42	1050	70	1778	3264	1484	3355	1525	--	--	--	--	47	1194
44	1100	73 1/4	1861	3611	1642	3711	1687	--	--	--	--	49	1245
46	1150	76 5/8	1946	3904	1775	4013	1825	--	--	--	--	51	1295
48	1200	79 7/8	2029	4521	2055	4640	2110	--	--	--	--	53 1/2	1346

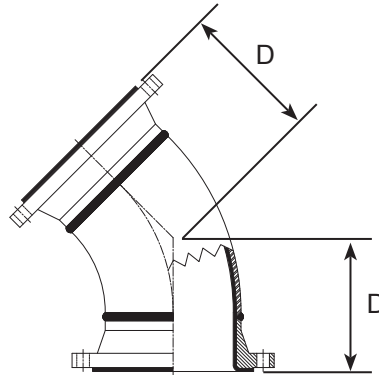
14" (DN350) is single piece construction with slip-on flanges  
 Consult factory for vacuum ratings  
 All sizes are available in stainless steel and other alloys  
 All sizes are available with flanges of other pressure class  
 Weights are approximate



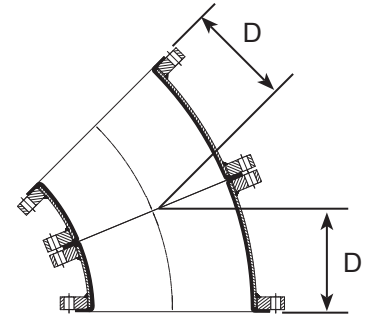
# 14" (DN 350) - 48" (DN 1200) 45 Degree Elbows



14" (DN 350) - 48" (DN 1200)  
ETFE, PP, and HDPE-Lined



14" (DN 350) - 18" (DN 450)  
PTFE-Lined



20" (DN 500) - 24" (DN 600)  
PTFE-Lined

**14" (DN 350) - 24" (DN 600): ASME B16.5 Class 150 Flanged**  
**26" (DN 650) - 48" (DN 1200): ASME B16.47 Series A Class 150 Flanged**

Size (NPS)	Size (DN)	Dimensions		Weight PP/HDPE-Lined		Weight ETFE-Lined		Dimensions		Weight PTFE-Lined		C (All Liners)	
		B (PP, ETFE-Lined)		lbs.	kg	lbs.	kg	D (PTFE-Lined)		lbs.	kg	Inch	mm
		Inch	mm					Inch	mm				
14	350	14	356	310	141	314	143	7 1/2	191	275	125	16 1/4	413
16	400	15 1/4	387	387	176	392	179	10**	254	319	145	18 1/2	470
18	450	17	432	465	212	472	215	12**	305	407	185	21	533
20	500	18 1/2	470	560	255	569	259	13 1/2**	343	462	210	23	584
24	600	21 1/4	540	775	353	788	359	15 1/2**	394	Consult Factory		27 1/4	692
26	650	21	533	883	402	898	409	--	--	--	--	29 1/2	737
28	700	22 1/2	572	1018	463	1036	471	--	--	--	--	31 1/2	787
30	750	24 1/8	613	1175	535	1196	544	--	--	--	--	33 3/8	838
32	800	25 3/4	654	1437	654	1460	664	--	--	--	--	36	914
34	850	27 1/8	689	1564	711	1590	723	--	--	--	--	38	965
36	900	28 3/4	730	1820	828	1850	841	--	--	--	--	40 1/4	1016
38	950	30 1/8	765	2044	930	2077	945	--	--	--	--	42 1/4	1067
40	1000	31 5/8	803	2218	1009	2254	1025	--	--	--	--	44 1/4	1118
42	1050	33	838	2516	1144	2557	1163	--	--	--	--	47	1194
44	1100	34 5/8	879	2789	1268	2834	1289	--	--	--	--	49	1245
46	1150	36 1/4	921	3006	1367	3054	1389	--	--	--	--	51	1295
48	1200	37 3/4	959	3333	1515	3386	1540	--	--	--	--	53 1/2	1346

Consult factory for vacuum ratings

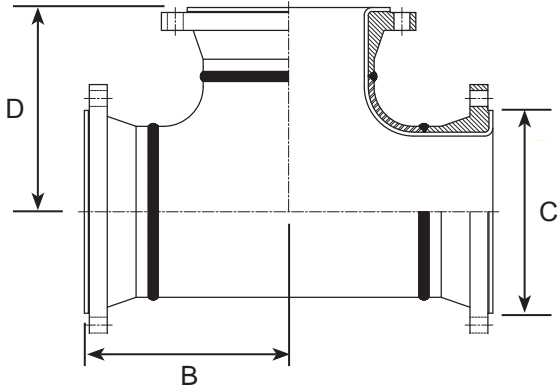
All sizes are available in stainless steel and other alloys

All sizes are available with flanges of other pressure class

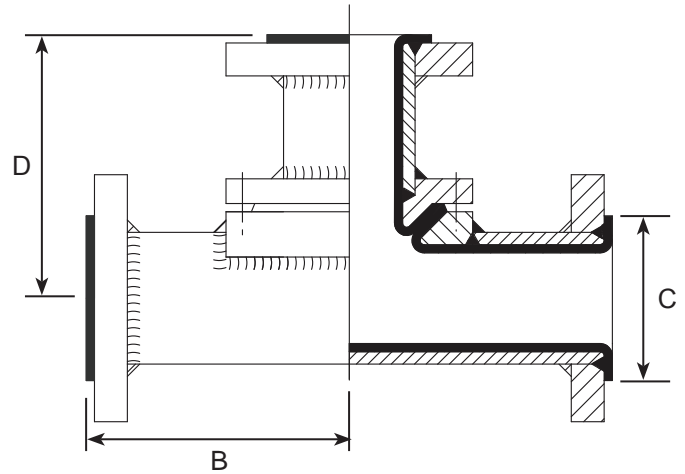
Weights are approximate

# 14" (DN 350) - 48" (DN 1200) Equal Tees

14" (DN 350) - 48" (DN 1200)  
ETFE, PP, and HDPE-Lined



14" (DN 350) - 24" (DN 600) PTFE-Lined



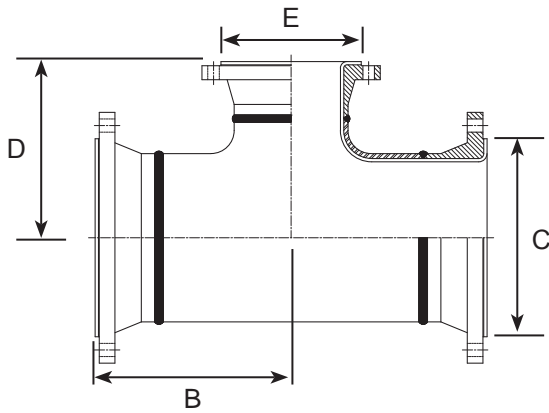
**14" (DN 350) - 24" (DN 600): ASME B16.5 Class 150 Flanged**  
**26" (DN 650) - 48" (DN 1200): ASME B16.47 Seris A Class 150 Flanged**

Size (NPS)	Size (DN)	Dimensions (ETFE, PP, HDPE)				Weight PP/HDPE -Lined		Weight ETFE-Lined		Dimensions (PTFE-Lined)		Weight PTFE-Lined		C (All Liners)	
		B		D		lbs.	kg	lbs.	kg	B = D		lbs.	kg	Inch	mm
		Inch	mm	Inch	mm					Inch	mm				
14	350	16 1/4	415	16 1/4	415	474	216	483	220	14	356	686	312	16 1/4	413
16	400	17 1/4	440	17 1/4	440	581	265	593	270	15	381	825	375	18 1/2	470
18	450	19 1/4	491	19 1/4	491	700	319	715	325	16 1/2	419	880	400	21	533
20	500	21	534	21	534	844	384	862	392	18	457	924	420	23	584
24	600	23 1/4	593	23 1/4	593	1141	519	1164	530	22	559	1276	580	27 1/4	692
26	650	24 1/2	624	24 1/2	624	1326	603	1355	616	--	--	--	--	29 1/2	737
28	700	25 3/4	654	25 3/4	654	1513	688	1546	703	--	--	--	--	31 1/2	787
30	750	27 5/8	704	27 5/8	704	1750	796	1787	813	--	--	--	--	33 3/4	838
32	800	29 1/2	750	29 1/2	750	2139	973	2181	992	--	--	--	--	36	914
34	850	31 1/8	793	31 1/8	793	2328	1059	2374	1080	--	--	--	--	38	965
36	900	33	839	33	839	2714	1234	2765	1257	--	--	--	--	40 1/4	1016
38	950	34 1/2	877	34 1/2	877	3046	1385	3102	1410	--	--	--	--	42 1/4	1067
40	1000	36 1/4	921	36 1/4	921	3307	1504	3368	1531	--	--	--	--	44 1/4	1118
42	1050	37	942	35	891	3682	1674	3747	1704	--	--	--	--	47	1194
44	1100	39 1/4	999	37 1/4	948	4106	1867	4178	1900	--	--	--	--	49	1245
46	1150	41 1/8	1045	39 1/4	994	4425	2012	4502	2047	--	--	--	--	51	1295
48	1200	42 7/8	1089	40 4/8	1039	4915	2235	5000	2273	--	--	--	--	53 1/2	1346

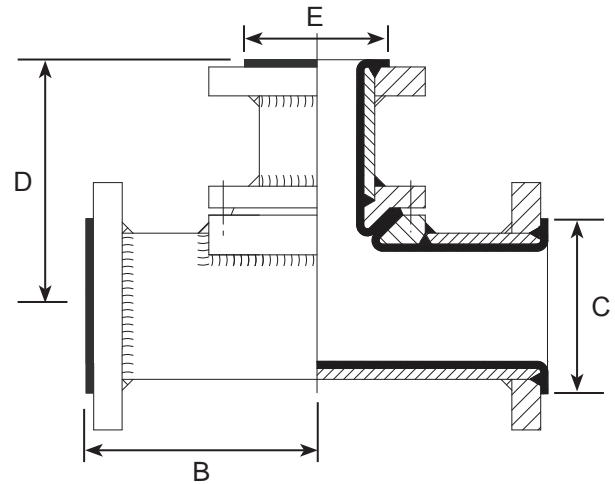
Consult factory for vacuum ratings  
All sizes are available in stainless steel and other alloys  
All sizes are available with flanges of other pressure class  
Weights are approximate

# 14" (DN 350) - 20" (DN 500) Reducing Tees

14" (DN 350) - 20" (DN 500)  
ETFE, PP, and HDPE-Lined



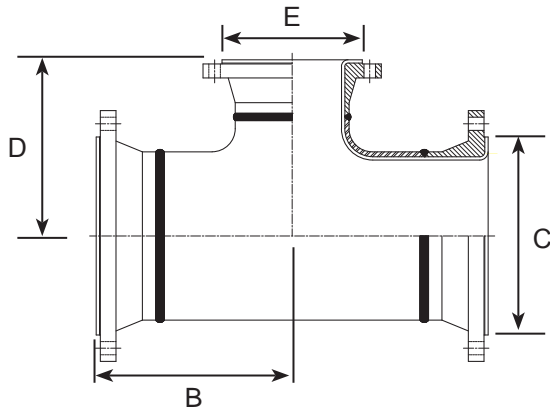
14" (DN 350) - 20" (DN 500) PTFE-Lined



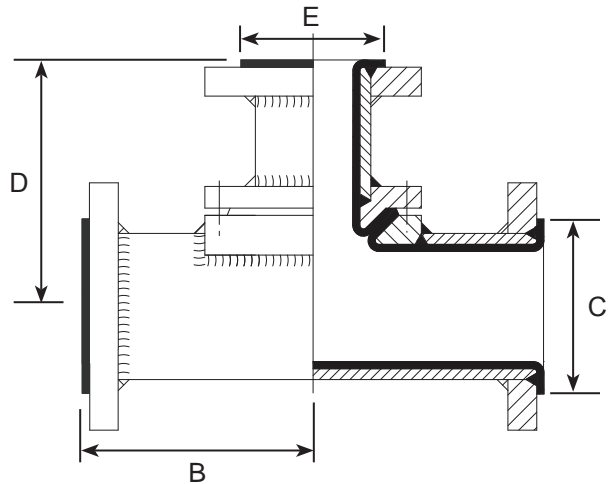
14" (DN 350) - 24" (DN 600): ASME B16.5 Class 150 Flanged 26" (DN 650) - 48" (DN 1200): ASME B16.47 Series A Class 150 Flanged																	
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE-Lined)				Weight PP/HDPE-Lined		Weight ETFE-Lined		Dimensions (PTFE-Lined)		Weight PTFE-Lined		C (All Liners)		E (All Liners)	
		B		D		lbs.	kg	lbs.	kg	B = D		lbs.	kg	Inch	mm	Inch	mm
		Inch	mm	Inch	mm					Inch	mm						
14 (350)	12 (300)	16 3/8	416	15 3/8	391	481	219	491	223	14	356	646.8	294	16 1/4	413	15	381
	14 3/8			365	443	201	453	206	660			300	12 3/4			324	
	14			356	429	195	438	199	677.6			308	10 5/8			270	
16 (400)	14 (350)	17 3/8	441	17 3/8	441	629	286	641	291	15	381	783.2	356	18 1/2	470	16 1/4	413
	16 3/8			416	594	270	606	275	796.4			362	15			381	
	15 3/8			391	544	247	556	253	814			370	12 3/4			324	
18 (450)	16 (400)	19 3/8	492	18 3/8	467	771	350	786	357	16 1/2	419	836	380	21	533	18 1/2	470
	18 3/8			467	733	333	748	340	795			361	16 1/4			413	
	17 3/8			441	697	317	712	324	756			344	15			381	
20 (500)	18 (450)	21	533	20 1/4	514	937	426	955	434	18	457	878	399	23	584	21	533
	19 1/4			489	897	408	915	416	835			380	18 1/2			470	
	19 1/4			489	859	390	876	398	794			361	16 1/4			413	

## 24" (DN 600) - 30" (DN 750) Reducing Tees

24" (DN 350) - 30" (DN 750)  
ETFE, PP, and HDPE-Lined



24" (DN 600) PTFE-Lined

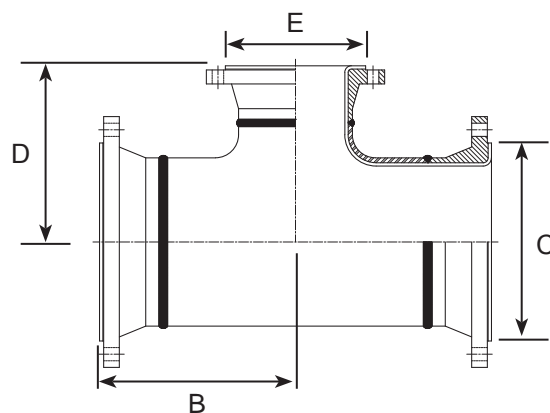


**24" (DN 600): ASME B16.5 Class 150 Flanged**  
**26" (DN 650) - 30" (DN 750): ASME B16.47 Series A Class 150 Flanged**

Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)				Weight PP/HDPE-Lined		Weight ETFE-Lined		Dimensions (PTFE-Lined)		Weight PTFE-Lined		C (All Liners)		E (All Liners)	
		B		D		lbs.	kg	lbs.	kg	B = D		lbs.	kg	Inch	mm	Inch	mm
		Inch	mm	Inch	mm					Inch	mm						
24 (600)	20 (500)	23 1/4	591	23	584	1268	576	1292	587	22	559	1212	551	27 1/4	692	23	584
	18 (450)			22 1/4	565	1220	555	1243	565			1151	523			21	533
	16 (400)			21 1/4	540	1183	538	1206	548			1093	497			18 1/2	470
26 (650)	24 (600)	24 1/2	622	25 1/4	641	1548	704	1577	717	--	--	--	--	29 1/2	749	27 1/4	692
	20 (500)			24	610	1425	648	1454	661							23	584
	18 (450)			23 1/4	591	1291	587	1319	600							21	533
28 (700)	26 (650)	25 3/4	654	25 1/2	648	1465	666	1498	681	--	--	--	--	31 1/2	800	29 1/2	749
	24 (600)			26 1/4	667	1424	647	1456	662							27 1/4	692
	20 (500)			25	635	1518	690	1550	705							23	584
30 (750)	28 (700)	27 5/8	702	26 3/4	679	1689	768	1726	785	--	--	--	--	33 3/4	857	31 1/2	800
	26 (650)			26 1/2	673	1635	743	1672	760							29 1/2	749
	24 (600)			27 1/4	692	1594	725	1630	741							27 1/4	692

## 32" (DN 800) - 38" (DN 900) Reducing Tees

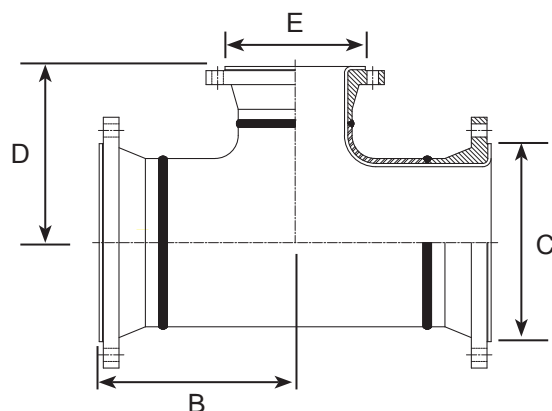
32" (DN 800) - 38" (DN 750)  
ETFE, PP, and HDPE-Lined



32" (DN 800) - 38" (DN 950): ASME B16.47 Seris A Class 150 Flanged													
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)				Weight PP/HDPE -Lined		Weight ETFE-Lined		C (All Liners)		E (All Liners)	
		B		D		lbs.	kg	lbs.	kg	Inch	mm	Inch	mm
		Inch	mm	Inch	mm								
32 (800)	30 (750)	29 1/2	749	28 5/8	727	2025	920	2067	940	36	914	33 3/4	857
	28 (700)			27 5/8	702	1961	891	2002	910			31 1/2	800
	26 (650)			27 1/2	699	1912	869	1953	888			29 1/2	749
34 (850)	32 (800)	31 1/8	791	30 1/2	775	2285	1039	2332	1060	38	965	36	914
	30 (750)			29 5/8	752	2175	989	2221	1010			33 3/4	857
	28 (700)			28 5/8	727	2116	962	2161	982			31 1/2	800
36 (900)	34 (850)	33	838	31 1/8	791	2608	1185	2660	1209	40 1/4	1022	38	965
	32 (800)			31 1/2	800	2566	1166	2617	1190			36	914
	30 (750)			30 5/8	778	2454	1115	2505	1139			33 3/4	857
38 (950)	36 (900)	34 1/2	876	34 1/2	876	2958	1345	3015	1370	42 1/4	1073	40 1/4	1022
	34 (850)			33 5/8	854	2847	1294	2903	1320			38	965
	32 (800)			33	838	2800	1273	2856	1298			36	914

## 40" (DN 950) - 48" (DN 1200) Reducing Tees

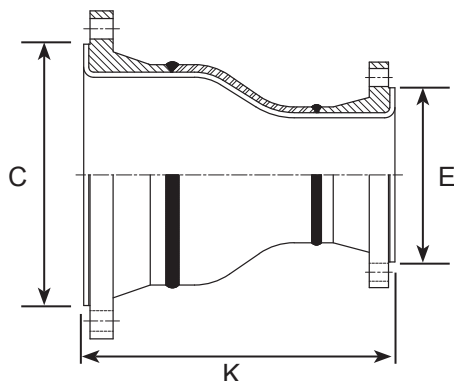
40" (DN 1000) - 48" (DN 1200) ETFE, PP, and HDPE-Lined



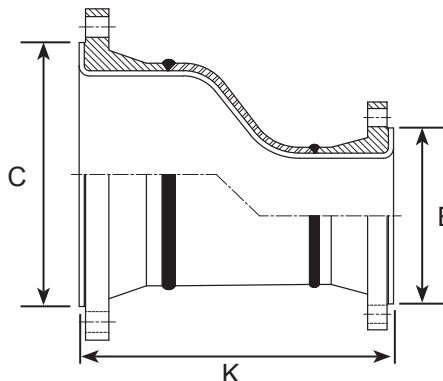
40" (DN 1000) - 48" (DN 1200): ASME B16.47 Seris A Class 150 Flanged													
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)				Weight PP/HDPE -Lined		Weight ETFE-Lined		C (All Liners)		E (All Liners)	
		B		D		lbs.	kg	lbs.	kg	Inch	mm	Inch	mm
		Inch	mm	Inch	mm								
40 (1000)	38 (950)	36 1/4	883	36	914	3246	1475	3308	1504	44 1/4	1124	42 1/4	1073
	36 (900)			35 1/2	902	3651	1660	4113	1870			40 1/4	1022
	34 (850)			34 5/8	879	3039	1381	3100	1409			38	965
42 (1050)	40 (1000)	37	940	34 3/4	883	3561	1619	3627	1649	47	1194	44 1/4	1124
	38 (950)			34 1/2	876	3502	1592	3567	1621			42 1/4	1073
	36 (900)			34 1/2	876	3417	1553	3482	1583			40 1/4	1022
44 (1100)	42 (1050)	39 1/4	997	37	940	4002	1819	4074	1852	49	1245	47	1194
	40 (1000)			36 1/4	921	3871	1760	3943	1792			44 1/4	1124
	38 (950)			26 1/2	673	3805	1730	3876	1762			42 1/4	1073
46 (1150)	44 (1100)	41 1/8	1045	38 3/4	984	4350	1977	4428	2013	51	1295	49	1245
	42 (1050)			38	965	4236	1925	4314	1961			47	1194
	40 (1000)			37 1/4	946	4106	1866	4183	1901			44 1/4	1124
48 (1200)	46 (1150)	42 7/8	1089	40 5/8	1032	4782	2174	4867	2212	53 1/2	1359	51	1295
	44 (1100)			40 1/4	1022	4708	2140	4793	2179			49	1245
	42 (1050)			39	991	4587	2085	4672	2124			47	1194

# 14" - 20" Concentric / Eccentric Reducers

14" (DN 350) - 20" (DN 500)  
ETFE, PP, and HDPE-Lined



14" (DN 350) - 20" (DN 500) PTFE-Lined



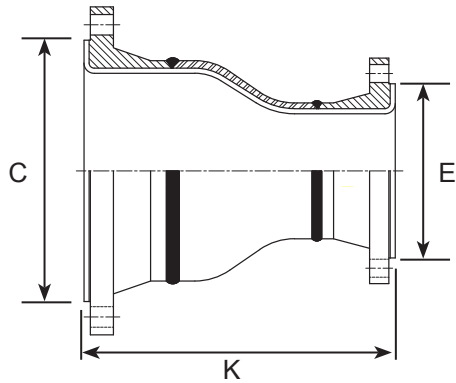
14" (DN 350) - 20" (DN 500): ASME B16.5 Class 150 Flanged															
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)		Weight PP/HDPE-Lined		Weight ETFE-Lined		Dimensions (PTFE-Lined)		Weight PTFE-Lined		C (All Liners)		E (All Liners)	
		K		lbs.	kg	lbs.	kg	K		lbs.	kg	Inch	mm	Inch	mm
		Inch	mm					Inch	mm						
14 (350)	12 (300)	23	584	264	120	268	122	16	406	210	96	16 1/4	413	15	381
	10 (250)	22 1/2	572	225	102	229	104			196	90			12 3/4	324
	8 (200)	22 1/2	572	208	95	212	96	N/A						10 5/8	270
16 (400)	14 (350)	24 1/2	622	329	150	334	152	18	457	253	115	18 1/2	470	16 1/4	413
	12 (300)	24	610	299	136	304	138			231	105			15	381
	10 (250)	23 1/2	597	261	119	265	120	N/A						12 3/4	324
18 (450)	16 (400)	26	660	404	184	416	189	19	483	345	157	21	533	18 1/2	470
	14 (350)	26	660	372	169	384	175			326	148			16 1/4	413
	12 (300)	25 1/2	648	340	155	351	160	N/A						15	381
20 (500)	18 (450)	31 3/4	806	507	230	523	238	20	508	480	218	23	584	21	533
	16 (400)	31 1/4	794	474	215	489	222			462	210			18 1/2	470
	14 (350)	31 1/4	794	441	200	455	207	N/A						16 1/4	413

Centerline offset is found by the following formula:

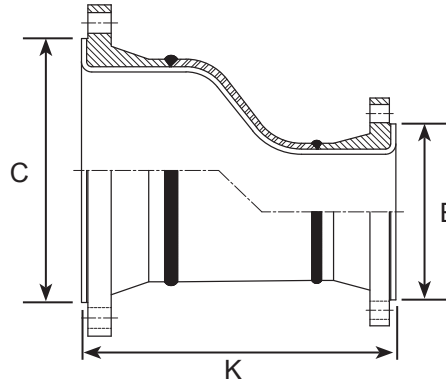
$$(Large\ Size\ Pipe\ OD - Small\ Size\ Pipe\ OD) / 2$$

## 24" - 30" Concentric / Eccentric Reducers

24" (DN 350) - 30" (DN 750)  
ETFE, PP, and HDPE-Lined



24" (DN 600) PTFE-Lined



**24" (DN 600): ASME B16.5 Class 150 Flanged**  
**26" (DN 650) - 30" (DN 750): ASME B16.47 Seris A Class 150 Flanged**

Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)		Weight PP/HDPE-Lined		Weight ETFE-Lined		Dimensions (PTFE-Lined)		Weight PTFE-Lined		C (All Liners)		E (All Liners)	
		K		lbs.	kg	lbs.	kg	K		lbs.	kg	Inch	mm	Inch	mm
		Inch	mm					Inch	mm						
24 (600)	20 (500)	32 1/4	819	634	288	654	297	24	610	640	291	27 1/4	692	23	584
	18 (450)	32	813	595	270	614	279			620	282			21	533
	16 (400)	31 1/2	800	563	256	580	264	--	--	--	--			18 1/2	470
26 (650)	24 (600)	35 1/4	895	797	362	823	374	--	--	--	--	29 1/2	749	27 1/4	692
	20 (500)	35	889	715	325	739	336	--	--	--	--			23	584
	18 (450)	34 3/4	883	674	306	696	316	--	--	--	--			21	533
28 (700)	26 (650)	34 1/4	870	895	407	924	420	--	--	--	--	31 1/2	800	29 1/2	749
	24 (600)	35 1/2	902	852	387	879	400	--	--	--	--			27 1/4	692
	20 (500)	35 1/8	892	770	350	795	361	--	--	--	--			23	584
30 (750)	28 (700)	34 7/8	886	1015	461	1047	476	--	--	--	--	33 3/4	857	31 1/2	800
	26 (650)	34 5/8	879	959	436	990	450	--	--	--	--			29 1/2	749
	24 (600)	35 7/8	911	917	417	946	430	--	--	--	--			27 1/4	692

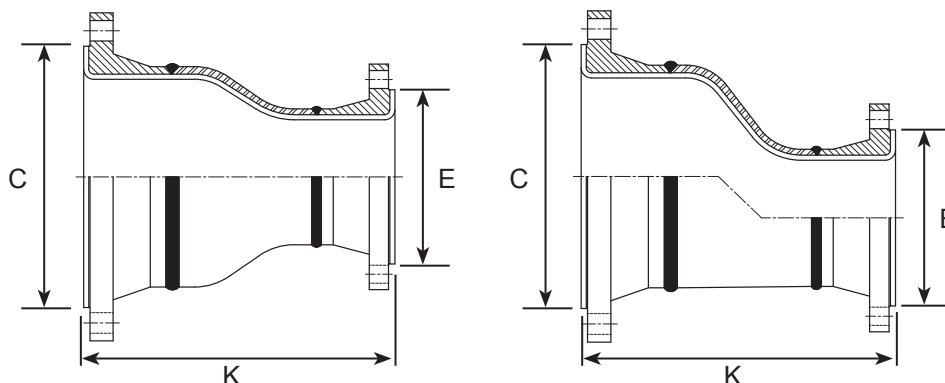
Centerline offset is found by the following formula:

$$(\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$$



# 32" - 38" Concentric / Eccentric Reducers

32" (DN 800) - 38" (DN 750)  
 ETFE, PP, and HDPE-Lined



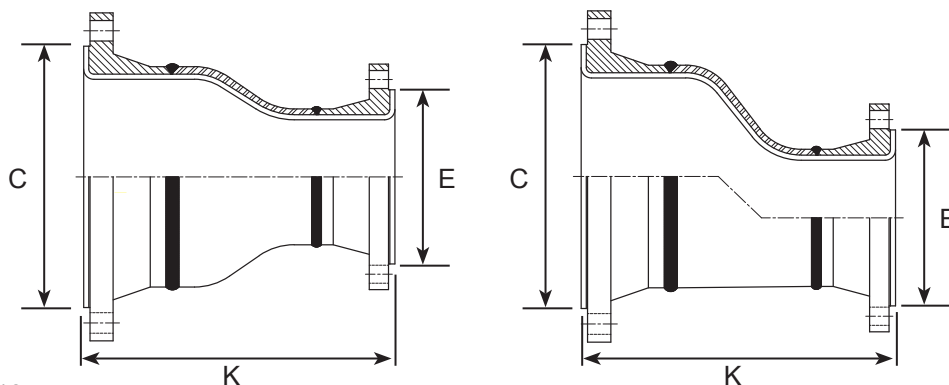
32" (DN 800) - 38" (DN 950): ASME B16.47 Series A Class 150 Flanged											
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)		Weight PP/HDPE -Lined		Weight ETFE-Lined		C (All Liners)		E (All Liners)	
		K		lbs.	kg	lbs.	kg	Inch	mm	Inch	mm
		Inch	mm								
32 (800)	30 (750)	35 5/8	905	1193	542	1229	559	36	914	33 3/4	857
	28 (700)	35 1/8	892	1130	514	1164	529			31 1/2	800
	26 (650)	35	889	1075	489	1107	503			29 1/2	749
34 (850)	32 (800)	36 1/8	918	1353	615	1392	633	38	965	36	914
	30 (750)	35 3/4	908	1239	563	1276	580			33 3/4	857
	28 (700)	35 3/8	899	1173	533	1209	550			31 1/2	800
36 (900)	34 (850)	36 5/8	930	1509	686	1551	705	40 1/4	1022	38	965
	32 (800)	36 3/8	924	1464	665	1504	684			36	914
	30 (750)	36 1/8	918	1348	613	1387	630			33 3/4	857
38 (950)	36 (900)	37	940	1710	777	1755	798	42 1/4	1073	40 1/4	1022
	34 (850)	36 5/8	930	1598	726	1642	746			38	965
	32 (800)	36 3/8	924	1555	707	1597	726			36	914

Centerline offset is found by the following formula:

$$(\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$$

# 40" - 48" Concentric / Eccentric Reducers

40" (DN 1000) - 48" (DN 1200) ETFE, PP, and HDPE-Lined

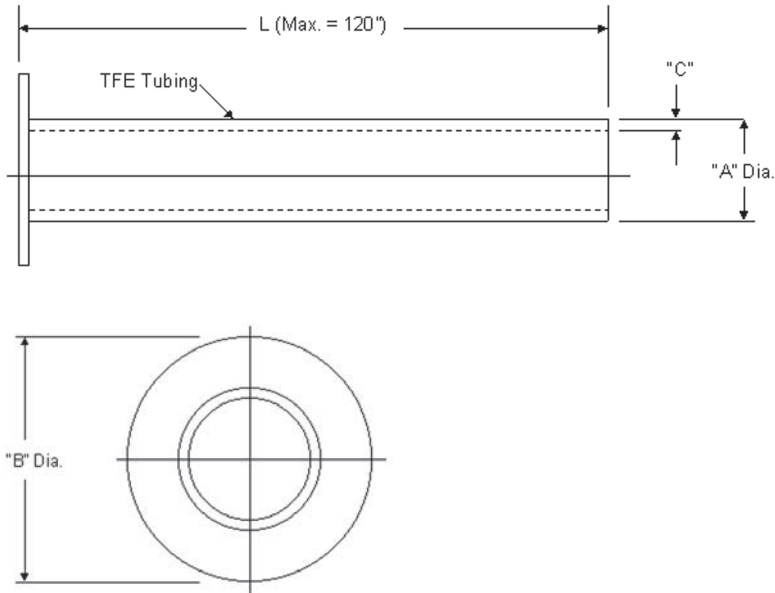


Centerline offset is found by the following formula:

$$\text{Centerline offset} = (\text{Large Size Pipe OD} - \text{Small Size Pipe OD}) / 2$$

40" (DN 1000) - 48" (DN 1200): ASME B16.47 Series A Class 150 Flanged											
Major Size in. (DN)	Major Size in. (DN)	Dimensions (ETFE, PP, HDPE)		Weight PP/HDPE -Lined		Weight ETFE-Lined		C (All Liners)		E (All Liners)	
		K		lbs.	kg	lbs.	kg	Inch	mm	Inch	mm
		Inch	mm								
40 (1000)	38 (950)	37 1/8	943	1864	847	1912	869	44 1/4	1124	42 1/4	1073
	36 (900)	37 1/8	943	1775	807	1822	828			40 1/4	1022
	34 (850)	36 7/8	937	1665	757	1710	777			38	965
42 (1050)	40 (1000)	37 3/4	959	2054	934	2107	958	47	1194	44 1/4	1124
	38 (950)	37 1/2	953	1991	905	2042	928			42 1/4	1073
	36 (900)	37 1/2	953	1900	864	1949	886			40 1/4	1022
44 (1100)	42 (1050)	38 1/4	972	2221	1010	2221	1010	49	1245	47	1194
	40 (1000)	38	965	2097	953	2097	953			44 1/4	1124
	38 (950)	37 3/4	959	2033	924	2033	924			42 1/4	1073
46 (1150)	44 (1100)	42 7/8	1089	2466	1121	2466	1121	51	1295	49	1245
	42 (1050)	42 5/8	1083	2357	1071	2357	1071			47	1194
	40 (1000)	42 1/4	1073	2231	1014	2231	1014			44 1/4	1124
48 (1200)	46 (1150)	43 3/8	1102	2678	1217	2678	1217	53 1/2	1359	51	1295
	44 (1100)	42 1/8	1070	2600	1182	2600	1182			49	1245
	42 (1050)	42 7/8	1089	2491	1132	2491	1132			47	1194

## PTFE Nozzle Liners

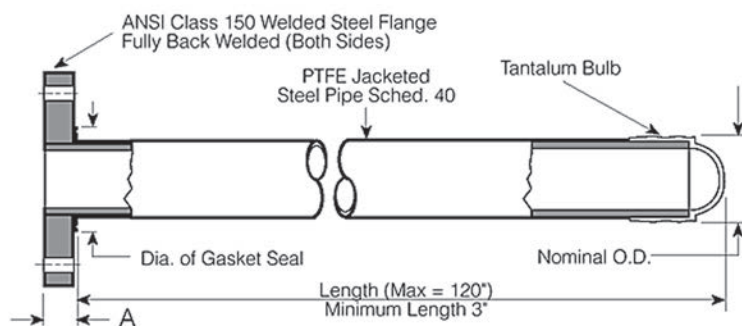


The non-adhesive characteristic of PTFE retards build-up of solids. When installed in the nozzle opening of reactors and other process equipment, the PTFE liner can be easily cleaned without damaging fragile linings of expensive equipment. PTFE liners are designed to reduce transmission of vibration or shock to flange faces of such equipment and the smooth, tough surface of PTFE minimizes the effects of erosion. Liner is designed to fit inside Schedule 80 Pipe.

Size (NPS)	Size (DN)	Dimensions					
		A		B		C	
		inch	mm	inch	mm	inch	mm
1/2	15	0.525	13	1 3/8	35	0.055	1.4
3/4	20	0.700	18	1 11/16	43	0.055	1.4
1	25	0.900	23	2	51	0.060	1.5
1 1/2	40	1.460	37	2 7/8	73	0.060	1.5
2	50	1.900	48	3 5/8	92	0.065	1.7
3	80	2.840	72	5	127	0.073	1.9
4	100	3.770	96	6 3/16	157	0.125	3.2
6	150	5.700	145	8 1/2	216	0.140	3.6
8	200	7.500	191	10 5/8	270	0.160	4.1
10	250	10.010	254	12 3/4	324	0.185	4.7
12	300	11.950	304	15	381	0.185	4.7
14	350	11.575	294	16 1/4	412	0.217	5.5
16*	400	14.055	357	18 1/2	470	0.256	6.5
18*	450	16.299	414	20 1/2	520	0.256	6.5
20*	500	17.480	444	23	585	0.256	6.5
24*	600	22.047	560	27	685	0.177	4.5

## Thermowell Baffles - PTFE Jacketed

PTFE Jacketed Thermowell-baffles for inserting thermocouples below the liquid level of corrosion mixtures are designed to withstand immersion in all acids, except hydrofluoric, at temperatures to 350°F. Their corrosion resistance and strength are a designed to provide long-life and maintenance-free operation of both thermowells and vessels. They are constructed of a PTFE jacketed steel pipe with a special tantalum bulb swaged on the bottom end. Heat conductivity of 0.130 cal./cm<sup>2</sup>/°C/sec. is provided through the tantalum bulb, which combines good chemical resistance with high thermal conductivity.



Dimensional Data												
Part Number	Thermowell Size		Flange Size		Gasket Seal Dia.		A		Nominal O.D.*		Max. Recommended Unsupported Length	
	NPS	DN	NPS	DN	in.	mm	In.	mm	In.	mm	in.	mm
R19282A-08-L	1/2	15	1	25	1 7/8	48	11/16	17	1	25	36	914
R19282A-16-L	1	25	1.5	40	2 3/4	70	13/16	21	1 15/32	37	48	1219
R19282A-24-L	1 1/2	40	2	50	3 1/2	89	7/8	22	2 1/16	52	60	1524
R19282A-32-L	2	50	3	80	4 3/8	111	1 1/16	27	2 9/16	65	72	1829

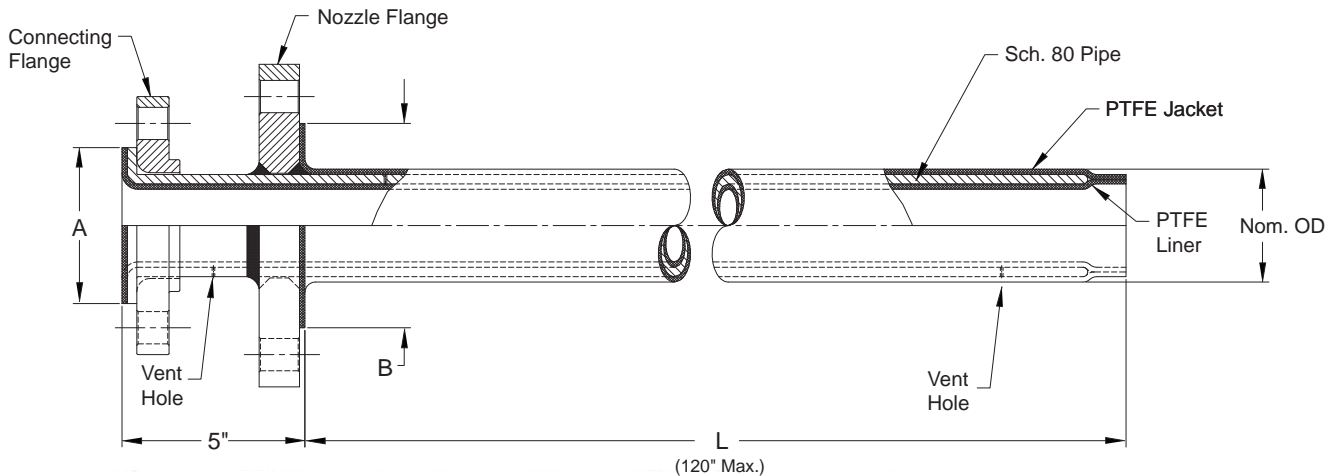
\*Thermowells have oversize O.D., which will not fit directly into standard size vessel nozzles. By selecting a smaller size pipe and a R60692 Special Reducing Flange, the correct fit can be achieved.

\*\*Recommended maximum length for mild agitation is shown as a general guide for liquids having about the same density and viscosity as water. For longer lengths or more severe operating loads (density, viscosity and velocity of fluid at the pipe), a larger size or internal bracing should be employed. Exceeding the maximum recommended service temperature and/or pressure or maximum recommended unsupported length can result in premature failure and possible personnel and equipment hazard.

Notes: Maximum Length = 10 ft.

## PTFE-Lined and Jacketed Dip Pipes

Lined and Jacketed with PTFE for Loading, Unloading and Decanting  
(Note: Standard liner and jacket color is black)



Resistoflex Dip Pipes are designed to provide the ultimate in corrosion-resistant, non-contaminating construction to 350°F for loading vessels below the liquid level, and decanting and unloading without the need for bottom outlets. The maximum recommended operating pressure is 150 psi.

They are designed to withstand high mechanical loads imposed by mixing or agitation in process vessels and reactors. The schedule 80 steel pipe (also available is SS, Alloy 20, Hastelloy, etc.) is protected from corrosion by an extruded, high density, chemically inert PTFE liner and jacket which are fused together at the bottom. Both the liner and the jacket are applied in a manner which compensates for thermal expansion, using the Resistoflex Thermalok process.

Warning: Exceeding the maximum recommended service temperature and/or pressure, or recommended unsupported length can result in premature failure and personnel and/or equipment hazard.

Dimensional Data												
Part Number	Pipe and Connecting Flange Size		Nozzle Flange Size		Gasket Seal Diameter, "B"		Diameter of Liner Gasket Seal, "A"		Nominal O.D.*		Max. Recommended Unsupported Length	
	NPS	DN	NPS	DN	in.	mm	in.	mm	in.	mm	in.	mm
R6808-16-L	1/2	15	1	25	1 7/8	48	1 3/8	35	1	25	36	914
R6816-24-L	1	25	1.5	40	2 3/4	70	2	51	1 7/16	37	48	1219
R6824-32-L	1 1/2	40	2	50	3 1/2	89	2 7/8	73	2 1/4	51	60	1524
R6832-48-L	2	50	3	80	4 3/8	111	3 5/8	92	2 1/2	64	72	1829
R6848-64-L	3	80	4	100	5 7/16	138	5	127	3 5/8	92	96	2438

\* "L" = 120" max.

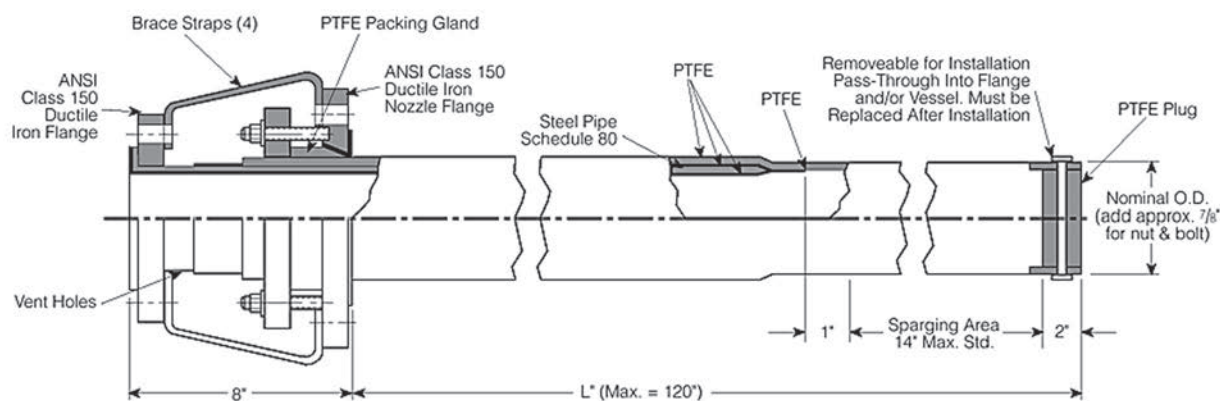
\*\*Recommended maximum length for mild agitation is shown as a general guide for liquids having about the same density and viscosity as water. For longer lengths, or more severe operating loads (density, viscosity and velocity of fluid at the pipe), a larger size of internal bracing should be employed.

Note: The nozzle flange sizes shown are the only sizes available. To connect a dip pipe to a larger nozzle, a reducing flange must be used. Use Resistoflex Reducing Flanges (seen on Page 65) to adapt for larger nozzles.

Solid PTFE dip pipes and spargers are also available.

## PTFE-Lined and Jacketed Spargers

Lined and Jacketed with PTFE for Injecting Steam & Other Vapors.



Resistoflex Spargers for injecting steam and other vapors below the liquid level are designed to be highly resistant to mechanical fatigue and thermal shock, and provide the ultimate in corrosion-resistant, non-contaminating construction to 350°F.

Resistoflex Spargers use schedule 80 pipe, lined and jacketed with PTFE and are designed to withstand the high mechanical loads associated with mixing or agitation in reactors or other process vessels. An external heavy wall PTFE tube is then applied which extends beyond the weld of the lined and jacketed steel reinforcement to provide a sparging section at the bottom. A PTFE plug, held by PTFE bolts and nuts, is installed at the end of this heavy tube and minimizes corrosion deposits and its nonstick surface retards buildup of precipitated solids at the orifices. Good erosion resistance maintains contamination free service. The packing gland provides gas-tight seals up to 50 psi.

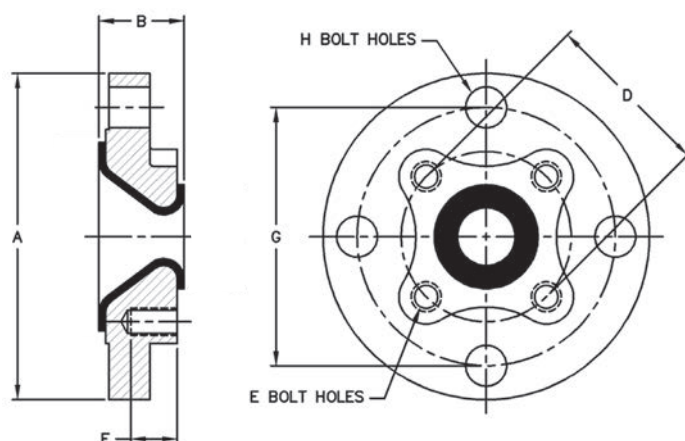
Warning: Exceeding the maximum recommended service temperature and/or pressure, or recommended unsupported length can result in premature failure and personnel and/or equipment hazard.

Dimensional Data								
Part Number	Pipe and Connecting Flange Size		Flange Size		Nominal O.D.*		Max. Recommended Unsupported Length	
	NPS	DN	NPS	DN	In.	mm	in.	mm
R671632-L-XX	1	25	2	50	1 15/16	49	48	1219
R672448-L-XX	1 1/2	40	3	80	2 9/16	65	60	1524
R672464-L-XX	1 1/2	40	4	100	2 33/64	64	60	1524
R673264-L-XX	2	50	4	100	3	76	72	1829
R674864-L-XX	3	80	4	100	4 1/8	105	96	2438
R674896-L-XX	3	80	6	150	4 1/8	105	96	2438

Note: The nozzle flange sizes shown are the only sizes available. To connect a sparger to a larger nozzle, a reducing flange must be used. Contact factory for more information as not all standard reducing flanges are suitable.

# PTFE-Lined Reducing Flanges for Dip Pipes

Ductile Iron conforms to ASTM A395  
 Consult factory for weights  
 Consult factory for bolt hole rotation  
 Dimension "A" = ASME Class 150 Flange OD



ASME B16.5 Class 150 Flanged													
Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions Inch (mm)											
		Actual Smallest ID	B	K	C	"H" Holes			"E" Holes				
						No. of Holes	Dia.	D (BCD)	No. of Holes	Thrd.	G (BCD)	Depth	
1 (25)	1/2 (15)	13/32 (10)	1 5/8 (41)	2 (51)	1 3/8 (35)	4	5/8 (16)	3 1/8 (79)	4	1/2-13	2 3/8 (60)	7/8 (22)	
1 (25)	3/4 (20)	5/8 (16)	1 5/8 (41)	2 (51)	1 11/16 (43)	4	5/8 (16)	3 1/8 (79)	4	1/2-13	2 3/4 (70)	7/8 (22)	
1 1/2 (40)	1 (25)	1 1/8 (29)	1 9/16 (40)	2 7/8 (73)	2 (51)	4	5/8 (16)	3 7/8 (98)	4	1/2-13	3 1/8 (79)	7/8 (22)	
2 (50)	1 (25)	1 1/8 (29)	1 9/16 (40)	3 5/8 (92)	2 (51)	4	3/4 (19)	4 3/4 (121)	4	1/2-13	3 1/8 (79)	7/8 (22)	
2 (50)	1 1/2 (40)	1 5/8 (41)	1 9/16 (40)	3 5/8 (92)	2 7/8 (73)	4	3/4 (19)	4 3/4 (121)	4	1/2-13	3 7/8 (98)	7/8 (22)	
2 1/2 (65)	2 (50)	2 1/8 (54)	1 9/16 (40)	4 1/8 (105)	3 5/8 (92)	4	3/4 (19)	5 1/2 (140)	4	5/8-11	4 3/4 (121)	7/8 (22)	
3 (80)	1 (25)	1 1/8 (29)	1 5/8 (41)	5 (127)	2 (51)	4	3/4 (19)	6 (152)	4	1/2-13	3 1/8 (79)	3/4 (19)	
3 (80)	1 1/2 (40)	1 5/8 (41)	1 5/8 (41)	5 (127)	2 7/8 (73)	4	3/4 (19)	6 (152)	4	1/2-13	3 7/8 (98)	7/8 (22)	
3 (80)	2 (50)	2 1/8 (54)	1 3/4 (44)	5 (127)	3 5/8 (92)	4	3/4 (19)	6 (152)	4	5/8-11	4 3/4 (121)	7/8 (22)	
3 (80)	2 1/2 (65)	2 3/16 (56)	1 5/8 (41)	5 (127)	4 1/8 (105)	4	3/4 (19)	6 (152)	4	5/8-11	5 1/2 (140)	7/8 (22)	
4 (100)	1 (25)	1 1/8 (29)	1 7/8 (48)	6 3/16 (157)	2 (51)	8	3/4 (19)	7 1/2 (191)	4	1/2-13	3 1/8 (79)	11/16 (17)	
4 (100)	1 1/2 (40)	1 5/8 (41)	1 5/8 (41)	6 3/16 (157)	2 7/8 (73)	8	3/4 (19)	7 1/2 (191)	4	1/2-13	3 7/8 (98)	7/8 (22)	
4 (100)	2 (50)	2 1/8 (54)	2 (51)	6 3/16 (157)	3 5/8 (92)	8	3/4 (19)	7 1/2 (191)	4	5/8-11	4 3/4 (121)	7/8 (22)	
4 (100)	3 (80)	2 25/32 (71)	1 3/4 (44)	6 3/16 (157)	5 (127)	8	3/4 (19)	7 1/2 (191)	4	5/8-11	6 (152)	7/8 (22)	
5 (125)	4 (100)	3 3/4 (95)	1 5/8 (41)	7 5/16 (186)	6 3/16 (157)	8	7/8 (22)	8 1/2 (216)	8	5/8-11	7 1/2 (191)	1 (25)	
6 (150)	1 1/2 (40)	1 5/8 (41)	1 7/8 (48)	8 1/2 (216)	2 7/8 (73)	8	7/8 (22)	9 1/2 (241)	4	1/2-13	3 7/8 (98)	11/16 (17)	
6 (150)	2 (50)	2 1/8 (54)	1 7/8 (48)	8 1/2 (216)	3 5/8 (92)	8	7/8 (22)	9 1/2 (241)	4	5/8-11	4 3/4 (121)	3/4 (19)	
6 (150)	3 (80)	2 31/32 (75)	1 3/4 (44)	8 1/2 (216)	5 (127)	8	7/8 (22)	9 1/2 (241)	4	5/8-11	6 (152)	1 (25)	
6 (150)	4 (100)	3 3/4 (95)	2 1/8 (54)	8 1/2 (216)	6 3/16 (157)	8	7/8 (22)	9 1/2 (241)	8	5/8-11	7 1/2 (191)	7/8 (22)	
8 (200)	4 (100)	3 29/32 (99)	2 (51)	10 5/8 (270)	6 3/16 (157)	8	7/8 (22)	11 3/4 (298)	8	5/8-11	7 1/2 (191)	7/8 (22)	
10 (250)	4 (100)	4 1/16 (103)	2 7/16 (62)	12 3/4 (324)	6 3/16 (157)	12	1 (25)	14 1/4 (362)	8	5/8-11	7 1/2 (191)	7/8 (22)	

# Solid PTFE Dip Pipes and Spargers

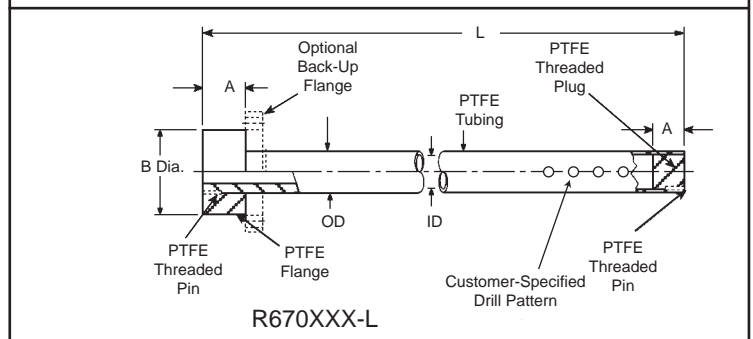
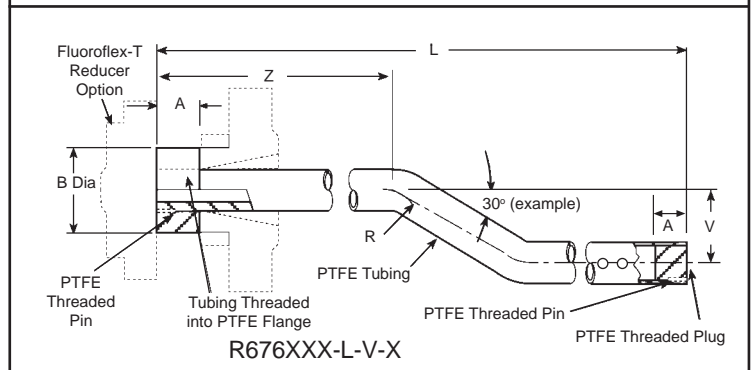
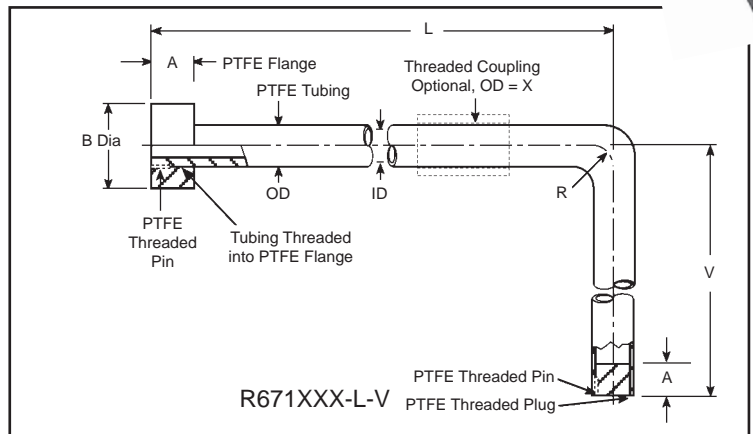
The superior advantages of PTFE are also offered without steel reinforcement in both dip pipes and spargers. Support is provided by using the tank baffle or similar projection within the vessel. The solid PTFE tube is ideally suited for application where the presence of the steel pipe in the process vessel is undesirable. Because of the support offered by the baffle, this construction may also be used where excess length or agitation would rule out the use of other designs. Often, the force of agitation is sufficient to hold the pipe in place against the baffle, but additional clamping may be necessary.

Resistoflex Solid PTFE Spargers used for applications in top loading vessels, such as open kettles and pickling tanks where bent or curved assemblies are required, are available in heavy walled, solid PTFE construction. They are designed to withstand erosion by steam and other vapors at elevated temperatures and pressures, and to eliminate contamination. Specially designed PTFE flanges are securely threaded and pinned to the tube. Plugs, where desired, are also threaded and pinned in place. The maximum recommended operating pressure is 150 psig at 350°F.

**WARNING:** Exceeding the maximum recommended service temperature and/or pressure can result in premature failure and personnel and/or equipment hazard.



Dimensional Data, in. (mm)				
Tubing Size		Flange and Plug Thickness A	Bend Radius R	Coupling O.D. X
OD	ID			
1 1/4 (32)	1/2 (13)	1 (25)	2 (51)	2 1/8 (54)
1 3/8 (35)	3/4 (19)	1 (25)	2 (51)	2 1/4 (57)
1 3/4 (44)	1 (25)	1 1/2 (38)	3 (76)	2 5/8 (67)
2 1/4 (57)	1 1/2 (38)	2 (51)	4 (102)	3 3/8 (86)
3 (76)	2 (51)	2 1/2 (64)	8 (203)	4 3/8 (111)



Part Number Code:

R6 X X X X X - L - V - Z

PTFE

Style

5 = Dip Pipe  
7 = Sparger

Shape

0 = Straight  
1 = 1 bend 90°  
2 = 1 bend 45°  
6 = 2 bends 30°  
7 = 2 bends 45°  
8 = 2 bends 90°

Length Callout

Back-up Flange

0 = None  
1 = Back-up Flange  
2 = PTFE Flange to be removable

PTFE Flange Dia. "B"

1 = 2" (For 1" Flange)  
2 = 2 7/8" (For 1.5")  
3 = 3 5/8" (For 2" Fl.)  
4 = 5" (For 3" Fl.)  
5 = 6 3/16" (For 4" Fl.)

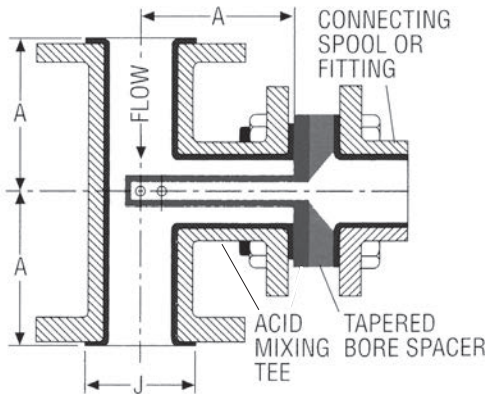
Tubing Size

1 = 1 1/4" OD x 1/2" ID  
2 = 1 3/8" OD x 3/4" ID  
3 = 1 3/4" OD x 1" ID  
4 = 2 1/4" OD x 1 1/2" ID  
5 = 3" OD x 2" ID



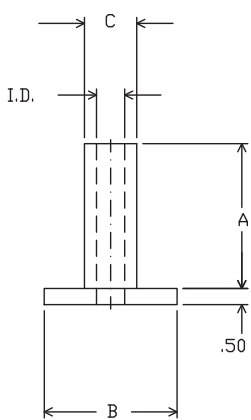
# Solid PTFE Mixing Tee Nozzles for Tees and Reducing Tees

Solid PTFE nozzle is specially designed to disperse acid uniformly into the process. Various nozzle sizes are available for different outlet diameters. When selecting a tee, be sure the heat of reaction does not exceed the temperature rating of the plastic liner. Note: Mixing tee nozzles purchased separately may not always fit in an existing Resistoflex tee. Mixing tees and nozzles should be purchased together to enable a factory fit.

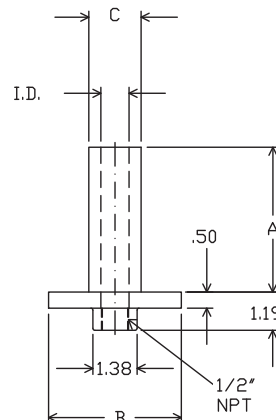


For Equal Tees					
Size Code	Size NPS (DN)	Dimensions, inch (mm)			
		A	B	C	ID
10	1 (25)	3 1/2 (89)	2 5/8 (67)	9/16 (14)	1/4 (6)
B0	1 1/2 (40)	4 (102)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
20	2 (50)	4 1/2 (114)	4 1/8 (105)	1 3/8 (35)	7/8 (22)
C0	2 1/2 (65)	5 (127)	4 7/8 (124)	1 3/4 (44)	1 (25)
30	3 (80)	5 1/2 (140)	5 3/8 (137)	2 1/2 (64)	1 1/2 (38)
40	4 (100)	7 3/8 (187)	6 7/8 (175)	2 1/2 (64)	1 1/2 (38)
60	6 (150)	9 3/8 (238)	8 3/4 (222)	2 1/2 (64)	1 1/2 (38)
80	8 (200)	11 (279)	11 (279)	2 1/2 (64)	1 1/2 (38)

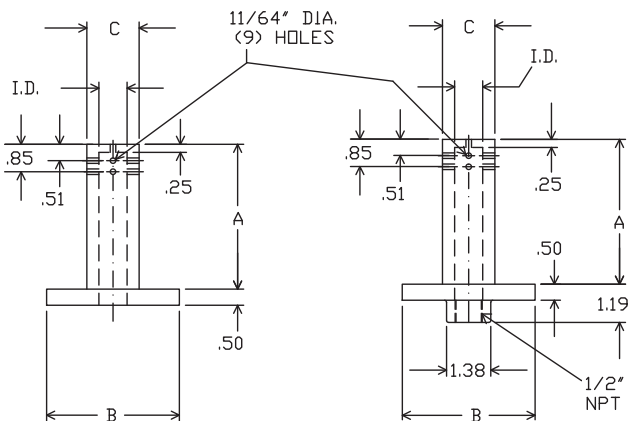
For Reducing Tees						
Size Code	Major Size NPS (DN)	Minor Size NPS (DN)	Dimensions inch (mm)			
			A	B	C	ID
B1	1 1/2 (40)	1 (25)	4 (102)	2 5/8 (67)	9/16 (14)	1/4 (6)
21	2 (50)	1 (25)	4 1/2 (114)	2 5/8 (67)	9/16 (14)	1/4 (6)
2B	2 (50)	1 1/2 (40)	4 1/2 (114)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
31	3 (80)	1 (25)	5 1/2 (140)	2 5/8 (67)	9/16 (14)	1/4 (6)
3B	3 (80)	1 1/2 (40)	5 1/2 (140)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
32	3 (80)	2 (50)	5 1/2 (140)	4 1/8 (105)	1 3/8 (35)	7/8 (22)
41	4 (100)	1 (25)	7 3/8 (187)	2 5/8 (67)	9/16 (14)	1/4 (6)
4B	4 (100)	1 1/2 (40)	7 3/8 (187)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
42	4 (100)	2 (50)	7 3/8 (187)	4 1/8 (105)	1 3/8 (35)	7/8 (22)
43	4 (100)	3 (80)	7 3/8 (187)	5 3/8 (137)	2 1/2 (64)	1 1/2 (38)
61	6 (150)	1 (25)	9 3/8 (238)	2 5/8 (67)	9/16 (14)	1/4 (6)
6B	6 (150)	1 1/2 (40)	9 3/8 (238)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
62	6 (150)	2 (50)	9 3/8 (238)	4 1/8 (105)	1 3/8 (35)	7/8 (22)
63	6 (150)	3 (80)	9 3/8 (238)	5 3/8 (137)	2 1/2 (64)	1 1/2 (38)
64	6 (150)	4 (100)	9 3/8 (238)	6 7/8 (175)	2 1/2 (64)	1 1/2 (38)
81	8 (200)	1 (25)	11 (279)	2 5/8 (67)	9/16 (14)	1/4 (6)
8B	8 (200)	1 1/2 (40)	11 (279)	3 3/8 (86)	1 1/8 (29)	1/2 (13)
82	8 (200)	2 (50)	11 (279)	4 1/8 (105)	1 3/8 (35)	7/8 (22)
83	8 (200)	3 (80)	11 (279)	5 3/8 (137)	2 1/2 (64)	1 1/2 (38)
84	8 (200)	4 (100)	11 (279)	6 7/8 (175)	2 1/2 (64)	1 1/2 (38)
86	8 (200)	6 (150)	11 (279)	8 3/4 (222)	2 1/2 (64)	1 1/2 (38)



Detail 1  
(open end, no thread)  
Part No.: WM0WM00000\_0  
Size Code



Detail 2  
(open end, threaded connection)  
Part No.: WM0XM00000\_0  
Size Code



Detail 3  
(radial holes, no thread)  
Part No.: WM0YM00000\_0  
Size Code

Detail 4  
(radial holes, threaded connection)  
Part No.: WM0ZM00000\_0  
Size Code

Made with 25% glass-filled PTFE. Not recommended for hydrofluoric acid or sodium hydroxide service

## Complex Shapes Lined With ETFE, PVDF, PP, and HDPE

Melt-processable resins such as ETFE (ethylene tetrafluoroethylene), PP (polypropylene), HDPE (high-density polyethylene) and PVDF (polyvinylidene fluoride), in conjunction with rotational lining, allow Resistoflex to provide lined steel piping products with custom or complex dimensions - with the same excellent quality the CPI has come to expect, at a price lower than expensive alloys.

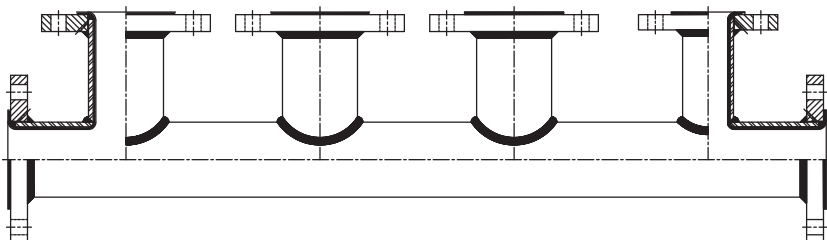
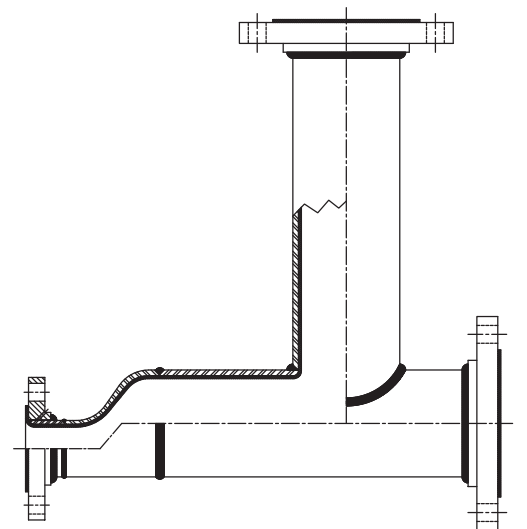
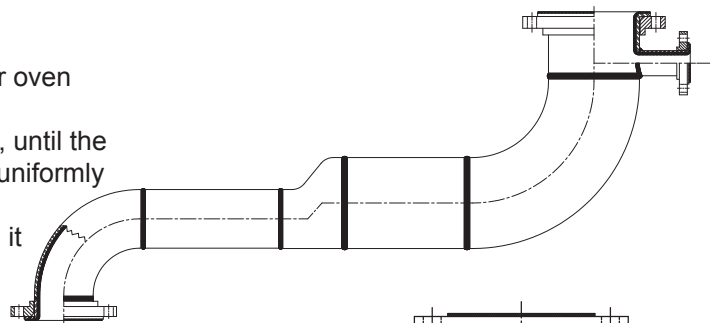
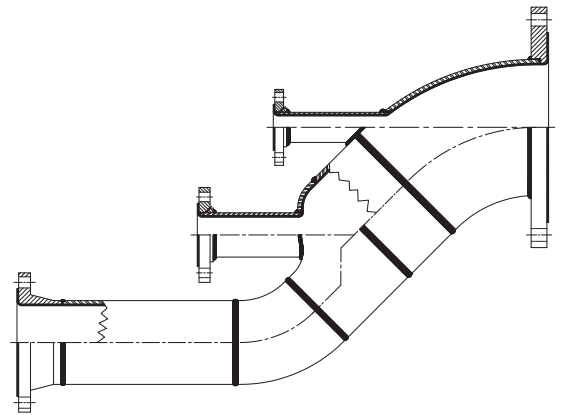
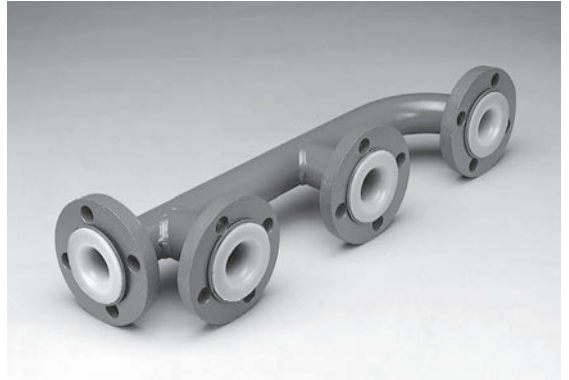
We can supply your corrosive resistant lining requirements for large diameters and custom-dimension fittings.

- ETFE has better chemical resistance to 300 deg F than any plastic except PTFE. Available up to NPS 48 (DN 1200)
- PVDF is rated to 275 deg. F on most chemicals, and is well-suited for halogenated compounds. Available up to NPS 8 (DN 200)
- PP is rated to 225 deg. F on a wide variety of chemicals, and is excellent in HCl service to 200 F with no permeation issues. Available up to NPS 48 (DN 1200)
- HDPE is rated to 180 deg., and has good general chemical resistance. Available up to NPS 48 (DN 1200)
- Liner is seamless with uniform thickness.
- Liner is mechanically bonded to metal substrate.
- Standard liner thickness is .200" nominal, with thicker liner available.
- Resistoflex can line customer-supplied housings.

The Process: Rotational lining is an ideal method to line the interior surfaces of complex metal fabrications:

- A pre-weighed amount of resin in place inside the part.
- With the flanges sealed, the fitting is heated in a forced-air oven while being rotated on two axes simultaneously.
- The bi-axial rotation transfers the heat evenly to the fitting, until the resin's melt temperature is reached. As the resin melts, it uniformly coats the interior, regardless of the geometry of the fitting.
- The heat is turned off and the fitting continues to rotate as it cools, allowing the resin to set.
- The result is a seamless, heavy-duty plastic lining with available thicknesses up to .250".
- Prior to shipping, all complex shapes must pass a 12,500 volt electrostatic test or 425 psig hydrostatic test.

No expensive tooling or molds are required. The lining is continuous and homogeneous, with no seams, welds or stresses. The thick lining also allows for machining of critical flare faces and o-ring grooves. Rotational lining is superior to sheet linings, powder coatings, and spray coatings.



## Multi-Axis® Bent Piping

- Available in 1" - 4" CS lined with PTFE, PP, and PVDF.
- 3 x diameter (3D) bend radius
- Up to 3 bends in 3 planes in a single piece of pipe.
- Sections are bent at any angle up to 90° with a tolerance of ±1°.
- Longer bend radius reduces pressure drop across the bend and reduces energy costs.
- 5D, 8D, 12D, and other bend radius available in PTFE-lined single bend.

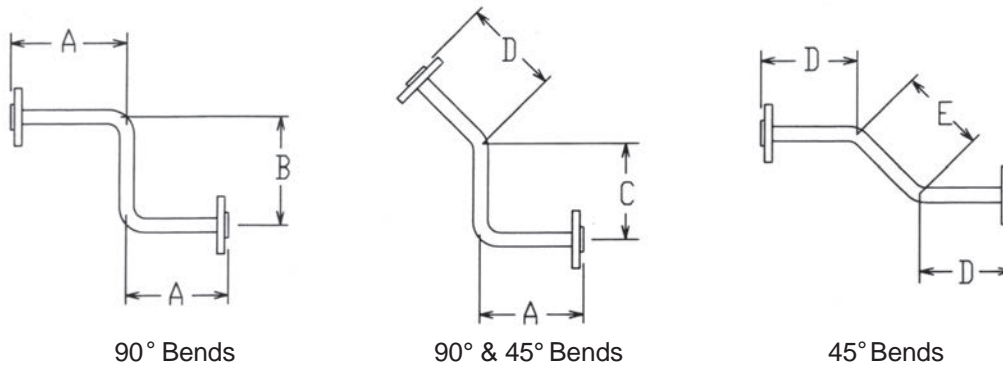


### The Bending Process

Although the concept behind MULTI-AXIS pipe is simple, successfully bending swaged plastic-lined pipe is not. It is considerably more difficult than bending unlined pipe. As for loose-lined pipe, it is virtually impossible to bend without distorting the liner. The liner in Resistoflex Plastic-Lined Pipe is locked into position and resists distortion.

Resistoflex uses special bending equipment and proprietary manufacturing techniques to provide bends in any angle up to 90° and compound bends on a single section of pipe. MULTI-AXIS pipe is a high-quality product with dimensional tolerances of ±0.125" (3.2mm), even on pieces with multiple bends. Due to the complexity of the bending operation, field bending of MULTI-AXIS pipe is not available. MULTI-AXIS pipe can be supplied with Class 150 steel rotatable flanges or with plain ends that can be joined in the field with other plastic-lined pipe sections using CONQUEST® flangeless connections.

When considering MULTI-AXIS pipe, it's important to carefully examine directional changes in a system to determine whether the centerline-to-face or centerline-to-centerline dimensional requirements of bent pipe can be met within the parameters of the initial design. If not, design adjustments may be required.



Minimum Dimensions for MULTI-AXIS					
Size NPS (DN)	A	B	C	D	E
1 (25)	6 1/8 (156)	11 3/8 (289)	8 1/2 (216)	4 1/4 (108)	6 3/4 (171)
1 1/2 (40)	9 3/16 (233)	15 3/16 (386)	12 1/2 (318)	6 7/16 (164)	9 3/4 (248)
2 (50)	11 1/4 (286)	18 1/4 (464)	14 5/8 (371)	8 (203)	10 3/4 (273)
3 (80)	15 (381)	26 11/16 (678)	22 (559)	10 (254)	15 3/4 (400)
4 (100)	19 3/4 (502)	36 1/2 (927)	29 1/2 (749)	12 7/8 (327)	22 1/4 (565)

Tolerances:

Center-center and center-face dimensions = +/- 1/8" (3 mm)

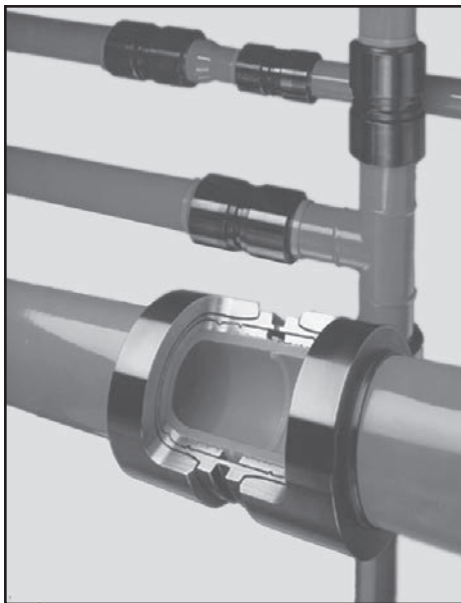
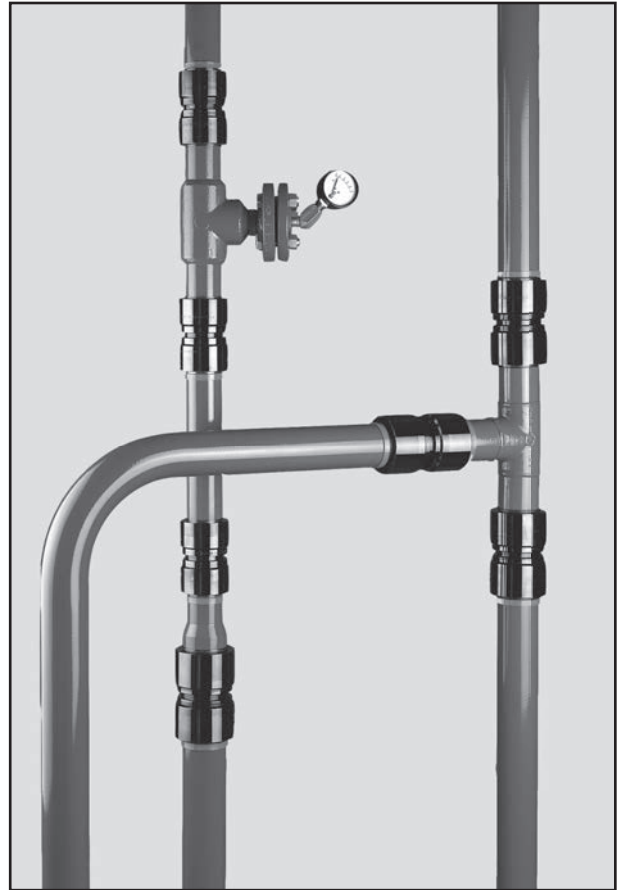
Bend angle = +/- 1°

Note: If there is a long run of straight pipe after the bend, this can result in the center of the next bend or the face of the flare being offset an inch or more from what was intended. In most cases, this can be compensated for in the field installation. In the case of bolting Multi-Axis to flanged equipment that is in a permanent fixed location, the offset may present an installation problem.

## CONQUEST® Flangeless Lined Piping System

### *Available in 1" - 4" PTFE, PP and PVDF*

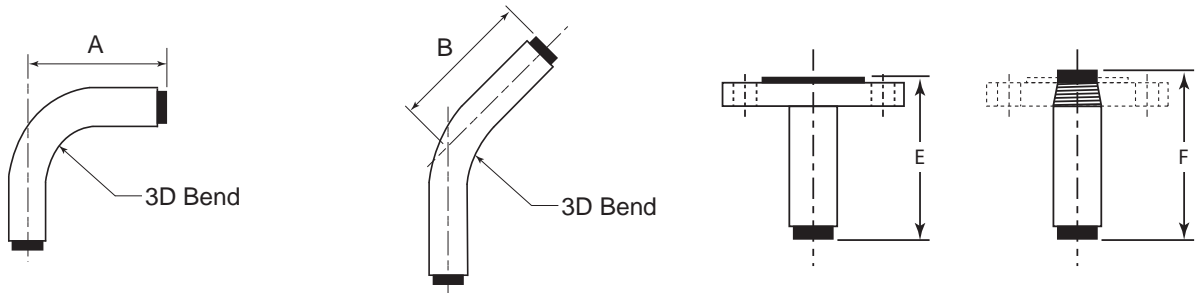
Our flangeless systems are designed to reduce the maintenance and risk associated with flanged joints. These systems include Conquest® flangeless piping, Extra-Long Pipe (up to 40 ft long), and MultiAxis piping. These technologies can be used separately, but the best systems combine elements to balance reduced risk with installation and operational flexibility. Connections can be reduced by 90%.



Final on-site assembly is done using Resistoflex butt-fusion weld tooling that can be rented or purchased.

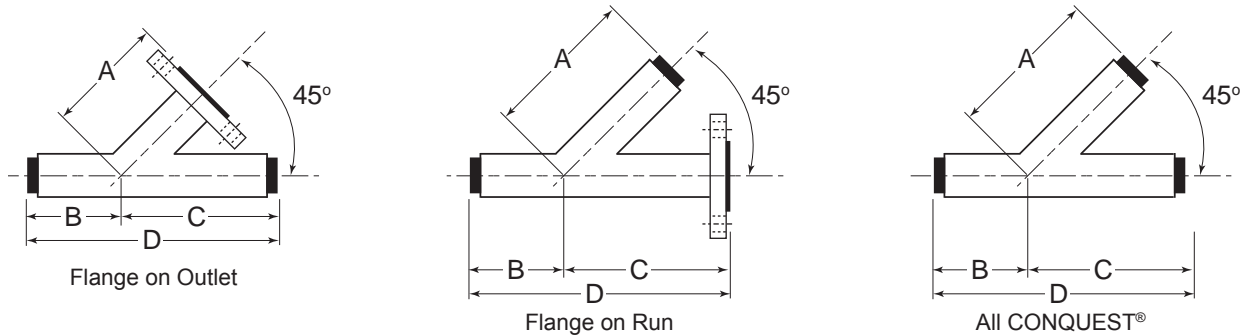
Contact Resistoflex to inquire about CONQUEST™ Fabrication Certification Training that can be provided at your site or at our plant.

# CONQUEST® Elbows and Laterals



Carbon Steel Construction. Available Liners are PTFE, PP, and PVDF

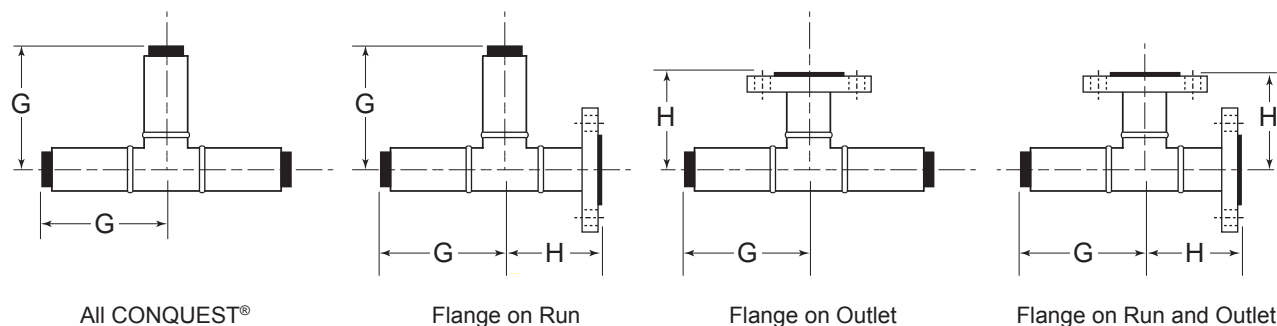
90 Degree Elbows		45 Degree Elbows		Adapters		
Size NPS (DN)	A inch (mm)	Size NPS (DN)	B inch (mm)	Size NPS (DN)	E (Adapter with Flange) inch (mm)	F (Adapter without Flange) inch (mm)
1 (25)	11 (279)	1 (25)	8 (203)	1 (25)	10 (254)	4 (102)
1 1/2 (40)	13 (330)	1 1/2 (40)	9 (229)	1 1/2 (40)	11 (279)	5 (127)
2 (50)	15 (381)	2 (50)	10 (254)	2 (50)	12 (305)	6 (152)
3 (80)	21 (533)	3 (80)	13 (330)	3 (80)	15 1/2 (394)	8 (203)
4 (100)	26 (660)	4 (100)	17 (432)	4 (100)	18 (457)	8 (203)



Carbon Steel Laterals, PTFE-Lined, Only

Size NPS (DN)	Option	A		B		C		D	
		in.	mm	in.	mm	in.	mm	in.	mm
2 (50)	Flange on Outlet	6 5/8	168	4 13/16	122	8 3/16	208	13	330
2 (50)	Flange on Run	8 3/16	208	4 13/16	122	8 1/8	206	12 15/16	329
3 (80)	Flange on Outlet	10	254	8	203	14	356	22	559
3 (80)	Flange on Run	14	356	8	203	10	254	18	457
3 (80)	All Conquest	14	356	8	203	14	356	22	559
3 (80) X 2 (50)	All Conquest	9	229	8	203	13 1/2	343	21 1/2	546
4 (100)	Flange on Outlet	12	305	8 1/2	216	15	381	23 1/2	597
4 (100)	Flange on Run	15	381	8 1/2	216	12	305	20 1/2	521
4 (100)	All Conquest	15	381	8 1/2	216	15	381	23 1/2	597
4 (100) X 3 (80)	All Conquest	14	356	8 1/2	216	15	381	23 1/2	597

## CONQUEST® Tees and Reducing Tees



All CONQUEST®

Flange on Run

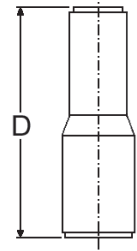
Flange on Outlet

Flange on Run and Outlet

Carbon Steel Tees								
Size NPS (DN)	Option	Available Liner			G		H	
		PTFE	PP	PVDF	in.	mm	in.	mm
1 (25)	All Conquest	•	•	•	5 1/2	140	3 1/2	89
	Flange on Stack	•	•	•				
	Flange on Run	•	•	•				
	Flange on Run and Outlet	•	•	•				
1 1/2 (40)	All Conquest	•	•	•	6	152	4	102
	Flange on Stack	•	•	•				
	Flange on Run	•	•	•				
	Flange on Run and Outlet	•	•	•				
2 (50)	All Conquest	•	•	•	6 1/2	165	4 1/2	114
	Flange on Stack	•	•	•				
	Flange on Run	•	•	•				
	Flange on Run and Outlet	•	•	•				
3 (80)	All Conquest	•	•	•	7 1/2	191	5 1/2	140
	Flange on Stack	•	•	•				
	Flange on Run	•	•	•				
	Flange on Run and Outlet	•	•	•				
3 (80) x 2 (50)	All Conquest	•			7 1/2	191	5 1/2	140
	Flange on Stack	•						
4 (100)	All Conquest	•	•	•	9 1/2	241	6 1/2	165
	Flange on Stack	•	•	•				
	Flange on Run	•	•	•				
	Flange on Run and Outlet	•	•	•				
4 (100) x 3 (80)	All Conquest	•			9 1/2	241	6 1/2	165
	Flange on Stack	•						

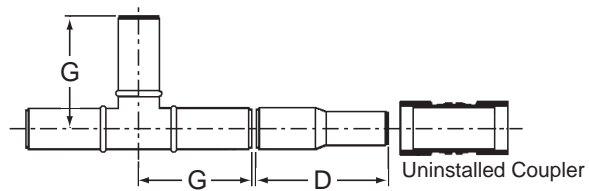
# CONQUEST® Concentric Reducers and Minimum Dimensions

Carbon Steel Concentric Reducers				
Size NPS (DN)	D inch (mm)	Available Liner		
		PTFE	PP	PVDF
1 1/2 (40) x 1 (25)	6 1/2 (165)	•	•	•
2 (50) x 1 (25)	7 1/2 (191)	•	•	•
2 (50) x 1 1/2 (40)	7 1/2 (191)	•	•	•
3 (80) x 2 (50)	10 1/2 (267)	•	•	•
4 (100) x 3 (80)	13 (330)	•	•	•



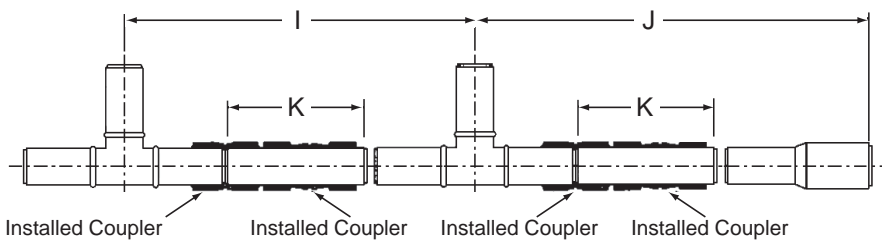
Minimum Connection Dimensions					
Size NPS (DN)	D inch (mm)	G inch (mm)	I inch (mm)	J inch (mm)	K inch (mm)
1 (25)	--	5 1/2 (140)	20 (508)	21 (533)	9 3/8 (238)
1 1/2 (40)	6 1/2 (165)	6 (152)	23 3/4 (603)	23 3/4 (603)	10 5/8 (270)
2 (50)	7 1/2 (191)	6 1/2 (165)	24 5/8 (625)	28 5/8 (727)	12 (305)
3 (80)	10 1/2 (267)	7 1/2 (191)	30 1/2 (775)	31 1/2 (800)	15 7/8 (403)
4 (100)	13 (330)	9 1/2 (241)	37 1/4 (945)	40 3/4 (1035)	18 1/4 (464)

## Standard Tee-to-Concentric Reducer



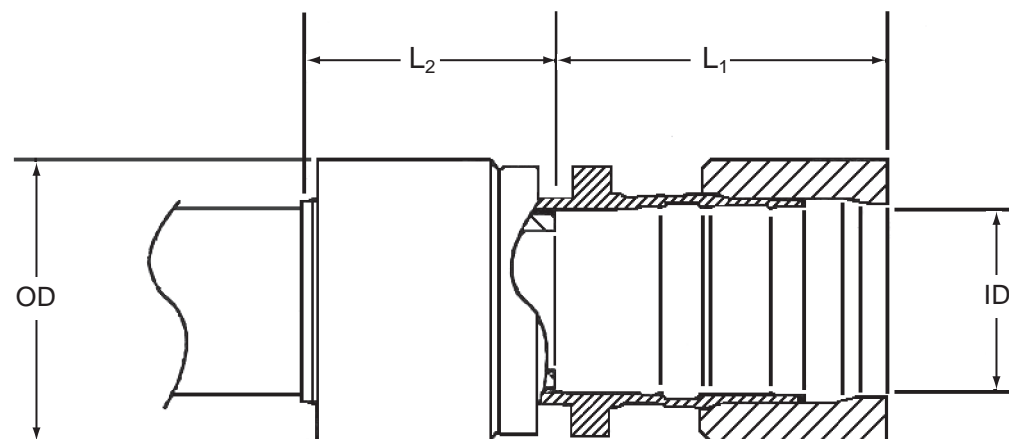
Tee-to-decreasing size concentric reducer, no filler pipe needed.

## Standard Tee-to-Tee, or Tee-to-Concentric Reducer



Minimum tee-to-tee or tee-to-increasing size concentric reducer length.

## CONQUEST® Coupler Dimensions



Coupler Dimensions				
Size NPS (DN)	Overall Length Max Prior to Installation (2 x L <sub>1</sub> ) in. (mm)	Overall Length Max After Installation (2 x L <sub>2</sub> ) in. (mm)	OD Outside Diameter Max. in. (mm)	ID Inside Diameter Max. in. (mm)
1 (25)	4.55 (115.6)	3.42 (86.9)	1.97 (50)	1.338 (34)
1 1/2 (40)	5.44 (138.2)	4.10 (104.1)	2.64 (67.1)	1.923 (48.8)
2 (50)	6.54 (166.1)	5.03 (127.8)	3.28 (83.3)	2.415 (61.3)
3 (80)	9.55 (242.6)	6.80 (172.7)	4.45 (113)	3.536 (89.8)
4 (100)	11.03 (280.2)	7.77 (197.4)	5.60 (142.2)	4.441 (112.8)

Couplers are designed for use on Resistoflex Sch. 40 plastic-lined pipe.

Couplers are made from AISI 15V24 micro alloyed steel

Standard coating for swage rings is black oxide. Contact factory for other coatings.

Couplers available with vent holes for PTFE-lined systems



# Tapped Vent CONQUEST® Coupler

CONQUEST Plastic Lined Piping uses a mechanical coupler over a welded liner to provide a leak-free, flangeless joint. PTFE lined systems require a venting system to prevent permeants from collecting between the liner and steel shell. The tapped vent coupler provides more flexibility by allowing a variety of devices to be attached to the coupler:

- **Vent Extenders**

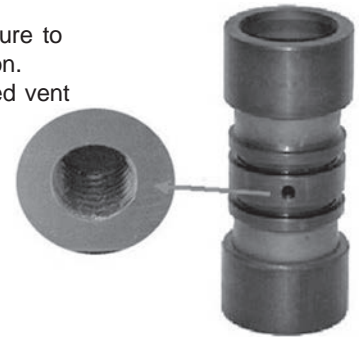
For insulated pipe, vent paths should be provided between vent holes and the atmosphere. Failure to do so often results in accelerated corrosion of the steel shell and contamination of the insulation. PTFE-lined CONQUEST is designed to vent at the coupling. The coupling has a 1/8" NPT tapped vent hole which allows extenders to be threaded in, and routed through the insulation.

- **Leak Detection**

A breach in the liner or weld can result in fluid traveling between the liner OD and metal ID to the annular space between the butt weld and the coupling body. Attachment of sensors to the tapped vent may provide early warning of a liner failure.

- **Collection Systems**

In some cases, venting of even minute quantities of permeants to the atmosphere is undesirable. This may be true with extremely hazardous or toxic chemicals, or in environmentally sensitive areas. The tapped vent allows attachment of collection systems to prevent permeant release to atmosphere.

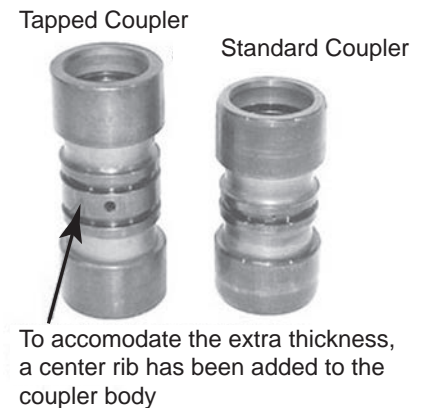


### High Integrity vent extender featuring Fire-Safe Design

A Hastelloy® porous disc vent fitting is shipped with the coupler as an optional addition to the completed installation. It's porous nature allows permeated gases to escape the system, but contains any entrained liquids which may result from a liner breach. The vent fitting is also designed according to the same principles as the Fire-Safe Factory Mutual approved HIF system.

### Dimension Differences

The tapped vent coupler is different than the standard vented coupler. The tapped vent holes required a thicker cross section in the coupler body than is possible with the standard coupler. The groove that accommodates the jaw of the installation tool was previously located in the center of the coupler. The new center rib requires that the groove be located on both sides of the new rib. These changes add to the overall length of the coupler. There is adequate design tolerance in the CONQUEST® fittings to use the longer tapped vent coupler without concern for joint make-up clearance. The exact length of standard vented and the tapped vent couplers are as follows:



Coupler Dimensions				
Size NPS (DN)	Standard Coupler w/ or w/o vent holes		Tapped Vent Coupler	
	As-Shipped Length in. (mm)	Installed Length in. (mm)	As-Shipped Length in. (mm)	Installed Length in. (mm)
1 (25)	4.55 (115.6)	3.37 (85.6)	5.64 (143.3)	4.51 (114.6)
1 1/2 (40)	5.44 (138.2)	4.06 (103.1)	6.55 (166.4)	5.21 (132.3)
2 (50)	6.54 (166.1)	5 (127)	7.68 (195.1)	6.15 (156.2)
3 (80)	9.55 (242.6)	6.81 (173)	10.76 (273.3)	8.16 (207.3)
4 (100)	11.03 (280.2)	7.75 (196.9)	12.02 (305.3)	9 (228.6)

# CONQUEST® Flangeless Piping

## Design Considerations

### Thermal Expansion Considerations

Like other piping materials, CONQUEST flangeless piping from Crane Resistoflex requires the designer or specifier to consider system movement caused by thermal expansion and contraction of piping components. This movement can typically be compensated for by using expansion loops and direction changes, along with the proper placement of piping supports and anchors.

You may find it necessary to conduct a computer-generated stress analysis of your piping system because of its size and complexity. Although most stress

analysis programs simulate the movement of a single piping materials and plastic-lined piping is a composite of plastic and steel, use the coefficient of thermal expansion for steel in your stress analysis. That's because Crane Resistoflex Plastic-Lined Piping Products uses a swaging fabrication process for CONQUEST piping that locks the liner inside the steel shell and restricts its movement relative to the steel. The locking process distributes the liner's thermal expansion and contraction stress evenly throughout the entire steel pipe.

Material	$\alpha$ (in/in/°F)	$\alpha$ (mm/mm/°C)
Polypropylene (PP)	$4.8 \times 10^{-5}$	$8.64 \times 10^{-5}$
VDF/Hexafluoropropylene (PVDF/HFP Copolymer)	$7.8 \times 10^{-5}$	$14 \times 10^{-5}$
Polytetrafluoroethylene (PTFE)	$5.5 \times 10^{-5}$	$9.9 \times 10^{-5}$
Steel	$5.9 \times 10^{-6}$	$10.6 \times 10^{-6}$

### How to Calculate Expansion Loop

Size and Dimensional Change - The expansion and contraction ( $\Delta L$ ) of a piping system is a function of the coefficient of thermal expansion for the piping material ( $\alpha$ ), the length of the pipe, and the upper and lower temperature limits of the system. These limits are the highest and lowest temperatures the system will experience at start-up, shut-down, and during operation.

Use Equation 1 to calculate the growth of shrinkage of pipe after a thermal cycle, where:

$\Delta L$  = Dimensional change due to thermal expansion or contraction (inches).

$\alpha$  = Expansion coefficient (in./in./°F or mm/mm/°C), refer to Table 1 for steel.

$(T_1 - T_2)$  = Change in temperature (°F or °C).

$L$  = Length (in inches or mm) of straight pipe being considered.

Equation 1:  $\Delta L = \alpha \times (T_1 - T_2) \times L$

The minimum offset and loop size can be determined from the calculated dimensional change using Equation 1 & 2.

The loop size is a function of the pipe diameter and the length the pipe moves during a thermal cycle. See Equation 2. The expansion loop depicted in Figure 1 can be fabricated by using a combination of straight pipe, elbows, and/or MULTI-AXIS® precision-bent pipe.

## CONQUEST® Flangeless Piping

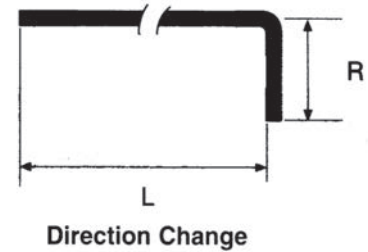
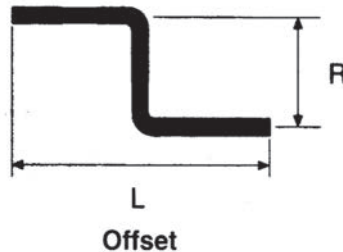
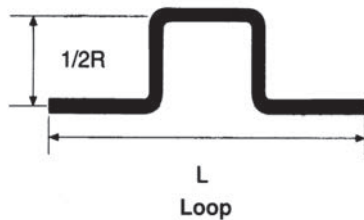
To calculate loop size, use Equation 2 where:

R = Minimum expansion loop length  
(in feet or mm)

D = Actual outside diameter of the pipe  
(in inches or mm)

$\Delta L$  = Change in length (in inches or mm) due to  
expansion or contraction

Equation 2:  $R = 6.35 \times (D \times \Delta L)^{1/2}$   
(Metric)  $R = 76.4 \times (D \times \Delta L)^{1/2}$



Example: To determine how much expansion and contraction will occur in a 530-foot straight length of 2" PVDF-lined pipe and how long the expansion loop will have to be to compensate for this, you must first determine the highest and lowest temperatures the system will experience. Assume the pipe will be installed at 60°F, operated at 75°F, and experience temperatures of 0°F in winter and 120°F in summer.

With this information, use Equation 1 to determine the dimensional change of the straight pipe section.

$$\Delta L = 5.9 \times 10^{-6} \times (120-0) \times 530 \times 12 = 4.5 \text{ inches}$$

The change in length of the straight pipe section due to expansion is 4.5 inches. Substituting 4.5 inches for  $\Delta L$  in Equation 2, determines the loop size to compensate for this expansion.

$$R = 6.35 \times (2.375 \times 4.50)^{1/2} = 20.8 \text{ ft.}$$

Therefore, the minimum expansion length offset or direction change is 20.8 feet.

### Torque Considerations for the CONQUEST Coupling

Torsional loading is a consideration in the design of any piping system, but is particularly important with CONQUEST flangeless piping. Reason: The inner plastic liner of adjacent pipe sections are butt-welded together and, therefore, cannot act independently of each other. If torsional loading on the joint exceeds the mechanical coupling's ability to resist turning, the plastic liner may twist and break at the connection.

Torsional loading can occur in many situations, particularly where there are direction changes, during the transport of a flangeless assembly, or while lifting a flangeless assembly into a pipe truss.

Table 2 lists the torque values that are not to be exceeded for the CONQUEST Connection after the mechanical coupling is installed.

Pipe Size inches (mm)	Allowable Torque ft-lb (N-m)
1 (25)	450 (610)
1 1/2 (40)	750 (1017)
2 (50)	1000 (1356)
3 (80)	2100 (2848)
4 (100)	3100 (4204)

# CONQUEST® Flangeless Piping for PTFE

## Testing and Verification Data for CONQUEST Flangeless Piping Systems 1" to 4" PTFE - Lined Systems

To verify the integrity of the CONQUEST flangeless connection, Resistoflex conducted tests on three separate components of the connection:

- The mechanical coupling, which has been developed by LOKRING for use with RESISTOFLEX Plastic-Lined Piping.
- The liner butt weld.
- The CONQUEST flangeless connection as a whole.

### Testing of the RESISTOFLEX / LOKRING™ Mechanical Coupling

#### A. Coupling Bend Test

**Test Procedure-** Mechanical couplings were used to join two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products. These newly created sections of joined pipe were then subjected to a full reverse bend test.

These tests were performed by the Lokring Corporation at their facility in Foster City, California. The load applied to the bend was the equivalent to subjecting the pipe to a minimum stress of 30 psi (2.07 bar). The minimum number of cycles required to pass the test was set at 7,000 cycles. The test was carried out until either 7,000 cycles were completed or coupling failure was observed.

**Results-** All four pipe sizes tested passes the minimum requirement of 7,000 cycles. The test on the 1" (25 mm) size was allowed to continue in order to determine approximately how many full reversing cycles the pipe could actually withstand. The test terminated after 71,089 cycles and still no failure was observed.

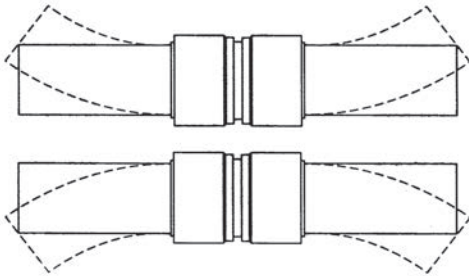


Table 1 - Bend Test Results

Pipe Size in. (mm)	Number of Cycles	Result
1 (25)	71,089	PASS
1 1/2 (40)	7,399	PASS
2 (50)	7,251	PASS
3 (80)	7,500	PASS

#### B. Coupling Burst Test

**Test Procedure-** Test samples were produced by connecting two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products with a mechanical coupling. Each end was then capped. The cap at one end was equipped with a connection that permitted internal hydraulic pressure to be applied. The requirement to pass the test was set at having the pipe fail before the coupling. Internal pressure was then applied and steadily increased. These tests were performed by the Lokring Corporation at their facility in Foster City, California.

**Results-** The internal pressure was increased until the coupling failed or the pipe burst. Testing was completed for three different sizes of plastic-lined pipe and is summarized in Table 2. Note that in each case the pipe burst, which demonstrates that the coupling is actually stronger than the steel pipe.

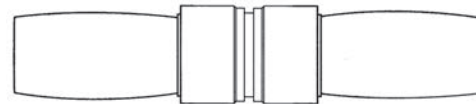


Table 2 - Coupling Burst Test Results

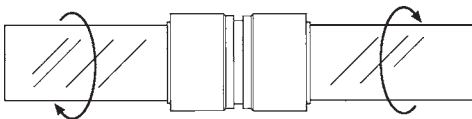
Pipe Size in. (mm)	Burst Pressure psi (Bar)	Result
2 (50)	7,500 (517)	Pipe Rupture
3 (80)	10,000 (690)	Pipe Rupture
4 (100)	5,200 (359)	Pipe Rupture

## CONQUEST® Flangeless Piping for PTFE

### C. Coupling Torsion Test

**Test Procedure-** Pipe samples were produced by connecting two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products with mechanical couplings. Three samples of each size were produced and testing was performed by Lokring Corporation in Foster City, California. The minimum torques required to pass the test were set at 450 ft-lbs (610 N-m), 750 ft-lbs (1017 N-m) and 1,000 ft-lbs (1356 N-m) for each pipe size, respectively. Lokring Corporation conducted initial torque testing up to 600 ft-lbs (813 N-m), which is the maximum torque Capability of their apparatus. Torque was then applied until either the maximum torque capability of 600 ft-lbs (813 N-m) was reached or movement of the pipe in the coupling was detected. The test samples were then shipped to E.J. Daiber Company, Inc. in Cleveland, Ohio in order to complete the testing at torques greater than 600 ft-lbs (813 N-m). Here, the samples were fixed between a torque transducer and pneumatic torque generator. Torque was increased until movement was detected. The average torque at which movement was detected for the three test specimens of each size was then recorded.

**Results-** All samples passed torque tests up to 600 ft-lbs (813 N-m) conducted by Lokring Corporation. In torque tests conducted by E.J. Daiber Company, Inc., all samples exceeded the minimum torque requirements before movement of the pipe in the coupling was detected. The average torque size is shown in Table 3. The 3" was also tested by Lokring Corporation and passed the 600 ft-lbs (813 N-m) requirement.



Pipe Size in. (mm)	Minimum Torque Requirement ft-lbs (N-m)	Average Torque Test Results ft-lbs (N-m)	Result
1 (25)	450 (610)	848 (1150)	Pass
1 1/2 (40)	750 (1017)	942 (1277)	Pass
2 (50)	1,000 (1356)	1,159 (1571)	Pass

### Testing of the Liner Butt Weld

To test the integrity of the liner butt weld, it was subjected to tests in two separate categories: burst and pressure fatigue. Testing was performed on Resistoflex pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. These tests were conducted on 1", 2", and 4" diameter PTFE welded pipe.

All PTFE test samples were 36" (914 mm) long and were butt welded at their mid-point using the PFA Film method, wrapped with PTFE adhesive tape and vent coupling installed. The ends of each sample were flanged and blanked, and equipped with connections that permitted internal hydraulic pressure to be applied. The coupling prevents the butt weld from being subjected to tensile stress produced by the internal pressure on the flanged ends.

#### A. Liner Butt Weld Burst Test

**Test Procedure-** Liner butt welds were fabricated using standard fabrication techniques described in Resistoflex's PTFE Technical Data Sheet "Joint Fabrication Procedures for CONQUEST Flangeless Piping Systems with PTFE Liners". Two samples of each size and liner type were produced. Samples were filled with water and connected to a hand pump with a 10,000 psi (690 bar) capability. A 5,000 psi (345 bar) pressure gauge was attached to the pump outlet. The requirement to pass the test was set at a minimum of 1,100 psi (76 bar). Samples were pressurized to 500 psi (34.5 bar) and held there for three minutes, then increased in 1000 psi (69 bar) increments to a maximum test pressure of 45 psi (310 bar). The unit was held at each increment for a minimum of three minutes. Either the burst pressure in which failure occurred for the two test specimens of each size, or the maximum pressure attained, was recorded.

**Results-** All samples exceeded the minimum burst pressure requirement of 1,100 psi (76 bar). Pressure was ultimately released when the gaskets failed on the flared ends. The samples were sectioned for visual inspection after each test. The inspection revealed that all welds were 100% intact and were not compromised in any way by the burst testing.

## CONQUEST® Flangeless Piping for PTFE

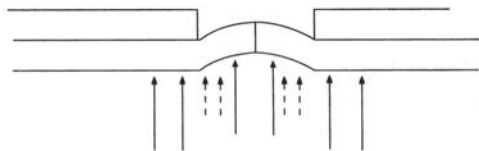


Table 4 - Burst Test Results

Pipe Size in. (mm)	Liner Type	Minimum Burst Pressure Requirement psi (Bar)	Max. Burst Test Pressure psi (Bar)
1 (25)	PTFE	1,100 (76)	4,500 (310) <sup>†</sup>
2 (50)	PTFE	1,100 (76)	4,500 (310) <sup>†</sup>
4 (100)	PTFE	1,100 (76)	4,500 (310) <sup>†</sup>

<sup>†</sup>Gaskets on flared ends failed without compromising the weld integrity.

### B. Liner Butt Weld Pressure Fatigue Test

**Test Procedure-** Test samples were 36" (914 mm) long and were butt-welded together at their mid-point. The samples were connected to a high-pressure piston pump capable of producing 1,400 psi (97 bar). Description of pressure fatigue test cycle: increase internal pressure to 550 psi (38 bar), hold for 10 seconds, reduce pressure to 50 psi (3.4 bar), hold for 5 seconds, then increase to 550 psi (38 bar) to repeat the cycle. The minimum requirement to pass the test was set at 7,000 cycles.

**Results-** All samples withstood the minimum 7,000 cycles without displaying any evidence of failure. All tests were allowed to continue in order to determine approximately how many pressure fatigue cycles the butt weld could actually withstand. The test was terminated after 100,000 cycles and still no failure was observed. The samples were sectioned for a visual inspection after each test. The inspection revealed that all welds were 100% intact and were not compromised in any way by the fatigue testing.

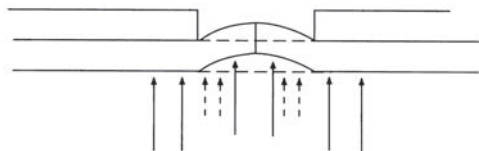


Table 5 - Pressure Fatigue Test Results

Pipe Size in. (mm)	Liner Type	Minimum Number of Cycles Required	Actual Number of Cycles Achieved
1 (25)	PTFE	7,000	100,000
2 (50)	PTFE	7,000	100,000
4 (100)	PTFE	7,000	100,000

### Testing of CONQUEST connection

To test the integrity of the CONQUEST connection, it was subjected to tests in two separate categories: ASTM Steam/Cold Water and Cold Temperature.

#### A. ASTM Steam/Cold Water

**Test Procedure-** Testing was performed on RESISTOFLEX Plastic-Lined Pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. Tests were conducted on two sets of 1", 1-1/2", 2", 3", and 4" welded diameter PTFE-lined pipe spools. Plastic-lined pipe spools were subjected to the appropriate ASTM Steam/Cold Water test for lined pipe. Each spool was 20 feet (12.2 m) long, consisting of two 10-foot (6.1 m) lengths joined by CONQUEST flangeless connection at the mid-point. The test spools contained the standard flanged connection at each end. The test involved subjecting the spool to 100 alternating cycles of heating with steam, then cooling with water.

**Results-** All spools passed the requirements of the ASTM Steam/Cold Water test. These samples were sectioned for a visual inspection after each test. The inspection revealed that all welds were 100% intact and were not compromised in any way by the Steam/Cold Water testing.

#### B. Cold Temperature Test

**Test Procedure-** Testing was performed on RESISTOFLEX Plastic-Lined Pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. Spools were fabricated by joining two 10-foot (3 m) sections with a CONQUEST flangeless connection at the mid-point. Testing included 1", 1-1/2", 2", 3", and 4" diameter welded PTFE-lined pipe spools. The test involved inserting a sample into a freezer with a -40°F (-40°C) capability and cooling it until either the liner failed or the maximum low temperature was reached. Description of test procedure: Insert sample into freezer with temperature set at 20°F (-7°C) and hold for a minimum of 8 hours. Visually inspect each sample and, if no liner failure has occurred, reduce the temperature in 10°F (6°C) increments and hold at each increment for a minimum of 8 hours. Visually inspect each sample after each 8-hour interval.

**Results-** All spools withstood a low freezer temperature of -20°F (-29°C). The samples were sectioned for a visual inspection after each test. The inspection revealed that all welds were 100% intact and were not compromised in any way by the freeze testing.

## CONQUEST® Flangeless Piping for PP and PVDF

### Testing and Verification Data for CONQUEST Flangeless Piping Systems with 1" to 4" PP and 1" to 4" PVDF

To verify the integrity of the CONQUEST flangeless connection, Resistoflex conducted tests on three separate components of the connection:

- The mechanical coupling, which has been developed by LOKRING for use with RESISTOFLEX Plastic-Lined Piping.
- The liner butt weld.
- The CONQUEST flangeless connection as a whole.

### Testing of the RESISTOFLEX / LOKRING™ Mechanical Coupling

#### A. Coupling Bend Test

**Test Procedure-** Mechanical couplings were used to join two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products. These newly created sections of joined pipe were then subjected to a full reverse bend test.

These tests were performed by the Lokring Corporation at their facility in Foster City, California. The load applied to the bend was the equivalent to subjecting the pipe to a minimum stress of 30 psi (2.07 bar). The minimum number of cycles required to pass the test was set at 7,000 cycles. The test was carried out until either 7,000 cycles were completed or coupling failure was observed.

**Results-** All four pipe sizes tested passes the minimum requirement of 7,000 cycles. The test on the 1" (DN 25) size was allowed to continue in order to determine approximately how many full reversing cycles the pipe could actually withstand. The test stopped after 71,089 cycles with no failure.

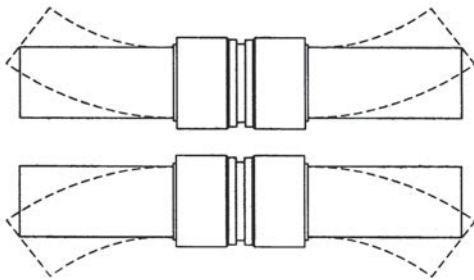


Table 1 - Bend Test Results

Pipe Size in. (mm)	Number of Cycles	Result
1 (25)	71,089	Pass
1 1/2 (40)	7,399	Pass
2 (50)	7,251	Pass
3 (80)	7,500	Pass

#### B. Coupling Burst Test

**Test Procedure-** Test samples were produced by connecting two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products with a mechanical coupling. Each end was then capped. The cap at one end was equipped with a connection that permitted internal hydraulic pressure to be applied. The requirement to pass the test was set at having the pipe fail before the coupling. Internal pressure was then applied and steadily increased. These tests were performed by the Lokring Corporation at their facility in Foster City, California.

**Results-** The internal pressure was increased until the coupling failed or the pipe burst. Testing was completed for three different sizes of plastic-lined pipe and is summarized in Table 2. Note that in each case the pipe burst, which demonstrates that the coupling is actually stronger than the steel pipe.

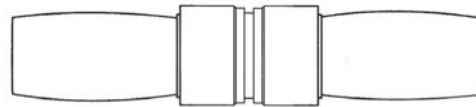


Table 2 - Coupling Burst Test Results

Pipe Size in. (mm)	Burst Pressure psi (Bar)	Result
2 (50)	7,500 (517)	Pipe Rupture
3 (80)	10,000 (690)	Pipe Rupture
4 (100)	5,200 (359)	Pipe Rupture

## CONQUEST® Flangeless Piping for PP and PVDF

### C. Coupling Torsion Test

**Test Procedure** Pipe samples were produced by connecting two sections of plastic-lined pipe from RESISTOFLEX Plastic-Lined Piping Products with mechanical couplings. Three samples of each size were produced and testing was performed by Lokring Corporation in Foster City, California. The minimum torques required to pass the test were set at 450 ft-lbs (610 N-m), 750 ft-lbs (1017 N-m) and 1,000 ft-lbs (1356 N-m) for each pipe size, respectively. Lokring Corporation conducted initial torque testing up to 600 ft-lbs (813 N-m), which is the maximum torque Capability of their apparatus. Torque was then applied until either the maximum torque capability of 600 ft-lbs (813 N-m) was reached or movement of the pipe in the coupling was detected. The test samples were then shipped to E.J. Daiber Company, Inc. in Cleveland, Ohio in order to complete the testing at torques greater than 600 ft-lbs (813 N-m). Here, the samples were fixed between a torque transducer and pneumatic torque generator. Torque was increased until movement was detected. The average torque at which movement was detected for the three test specimens of each size was then recorded.

**Results-** All samples passed torque tests up to 600 ft-lbs (813 N-m) conducted by Lokring Corporation. In torque tests conducted by E.J. Daiber Company, Inc., all samples exceeded the minimum torque requirements before movement of the pipe in the coupling was detected. The average torque size is shown in Table 3. The 3" was also tested by Lokring Corporation and passed the 600 ft-lbs (813 N-m) requirement.

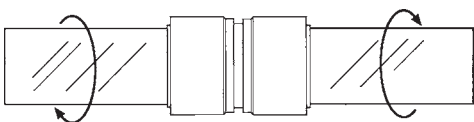


Table 3 - Torsion Test Results

Pipe Size in. (mm)	Minimum Torque Requirement ft-lbs (N-m)	Average Torque Test Results ft-lbs (N-m)	Result
1 (25)	450 (610)	848 (1150)	Pass
1 1/2 (40)	750 (1017)	942 (1277)	Pass
2 (50)	1,000 (1356)	1,159 (1571)	Pass

For 3" the coupling withstood in excess of 2,000 ft-lbs of torque.

### Testing of the Liner Butt Weld

To test the integrity of the liner butt weld, it was subjected to tests in two separate categories: burst and pressure fatigue. Testing was performed on Resistoflex pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. These tests were conducted three sets of plastic-lined pipe. The first set was lined in polypropylene (PP), the second in polyvinylidene (PVDF), and lastly in perfluoroalkoxy (PFA).

All test samples were 24" (610 mm) long and were butt welded at their mid-point. The ends of each sample were flanged and blanked, and equipped with connections that permitted internal hydraulic pressure to be applied. Three steel bars were then welded to the steel shell spanning the exposed liner in the area that contained the butt weld. This prevented the butt weld from being subjected to tensile stress produced by the internal pressure on the flanged ends. The liners and butt-welds were visually monitored throughout the testing.

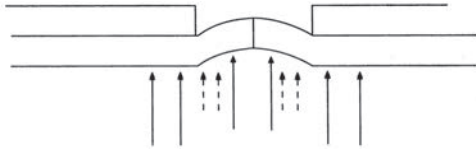
#### A. Liner Butt Weld Burst Test

**Test Procedure** Liner butt welds were fabricated using standard fabrication techniques described in Resistoflex's Technical Data Sheet "Joint Fabrication Procedures for CONQUEST Flangeless Piping Systems with PP, PVDF/HFP, and PFA-Liners". Three samples of each size and liner type were produced. Samples were filled with water and connected to a hand pump with a 10,000 psi (690 bar) capability. A 5,000 psi (345 bar) pressure gauge was attached to the pump outlet. The requirement to pass the test was set at a minimum of 1,100 psi (76 bar). Samples were pressurized to 500 psi (34.5 bar) and held there for three minutes, then increased in 1,000 psi (69 bar) increments and held at each increment for a minimum of three minutes. The burst pressure range in which failure occurred for the three test specimens of each size was recorded.

**Results-** All samples exceeded the minimum burst pressure requirement of 1,100 psi (76 bar). Failures ultimately occurred in the burst pressure range given in Table 4. However, it should be noted that all failures occurred in the exposed portion of the liner and not at the butt weld faces.



## CONQUEST® Flangeless Piping for PP and PVDF



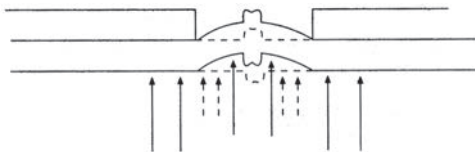
Pipe Size (in. mm)	Liner Type	Min. Burst Pressure Requirement psi (bar)	Burst Pressure Range psi (bar)
(1) 25 - 4 (100)	PP	1,100 (76)	3,500 - 4,400 (241 - 303)
	PVDF	1,100 (76)	4,500 - 5,000 (311 - 345)

†The test was discontinued after the pressure exceeded 5,000 PSI (345 Bar), the maximum pressure gauge reading.

### B. Liner Butt Weld Pressure Fatigue Test

**Test Procedure** - Test samples were 2" (50 mm) spools of pipe lined with PP and PVDF, each 24" (610 mm) long and containing a butt weld at their mid-point. The samples were connected to a high-pressure piston pump capable of producing 1,400 psi (97 bar). Description of pressure fatigue test cycle: increase internal pressure to 1,000 psi (69 bar), hold for 10 seconds, reduce pressure to 50 psi (3.4 bar), hold for 10 seconds, then increase to 1,000 psi (69 bar) to repeat the cycle. The minimum requirement to pass the test was set at 7,000 cycles.

**Results** - All samples withstood the minimum 7,000 cycles without displaying any evidence of failure. All tests were allowed to continue in order to determine approximately how many pressure fatigue cycles the butt weld could actually withstand. The test was terminated after 50,115 cycles and still no failure was observed.



Pipe Size in. (mm)	Liner Type	Minimum Number of Cycles Required	Actual Number of Cycles Achieved
2 (50)	PP	7,000	50,115
2 (50)	PVDF	7,000	50,115

### Testing of CONQUEST Connection

To test the integrity of the CONQUEST connection, it was subjected to tests in two separate categories: ASTM Steam/Cold Water and Cold Temperature.

#### A. ASTM Steam/Cold Water

**Test Procedure** - Testing was performed on RESISTOFLEX Plastic-Lined Pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. Tests were conducted on one set of 1"(25 mm) 1-1/2" (40 mm) 2" (50 mm) pipe lined with polyvinylidene fluoride (PVDF) and two 2" (50mm) sections of pipe, one lined with polypropylene (PP) and the other with perfluoroalkoxy (PFA). Plastic-lined pipe spools were subjected to the appropriate ASTM Steam/Cold Water test for lined pipe. Each spool was 40 feet (12.2 m) long, consisting of two 20-foot (6.1 m) lengths joined by a CONQUEST flangeless connection at the mid-point. The test spools contained the standard flanged connection at each end. The test involved subjecting the spool to 100 alternating cycles of heating with steam, then cooling with water

**Results** - All spools passed the requirements of the ASTM Steam/Cold Water test.

#### B. Cold Temperature Test

**Test Procedure** - Testing was performed on RESISTOFLEX Plastic-Lined Pipe in a test lab by RESISTOFLEX Plastic-Lined Piping Products at their Bay City, Michigan facility. The 2" (50 mm) spools were fabricated by joining two 10-foot (3 m) sections with a CONQUEST flangeless connection at the mid-point. One pipe section was lined with polyvinylidene (PVDF), the other with polypropylene (PP). The test involved inserting a sample into a freezer with a -40°F (-40°C) capability and cooling it until either the liner failed or the maximum low temperature was reached. Description of test procedure: Insert sample into freezer with temperature set at 20°F (-7°C) and hold for a minimum of 8 hours. Visually inspect each sample and, if no liner failure has occurred, reduce the temperature in 10°F (6°C) increments and hold at each increment for a minimum of 8 hours. Visually inspect each sample after each 8-hour interval.

**Results** - All spools withstood a low freezer temperature of -40°F (-40°C).

## Joint Reduction Technologies - Life Cycle Cost Estimating

Many specifiers of piping systems limit their economic analysis to piping material costs only, because they are relatively simple to estimate. Yet this approach creates some pitfalls when selecting either an installation of conventional flanged plastic-lined piping (PLP) or an installation that fully incorporates Resistoflex's Joint Reduction Technologies (JRT), consisting of CONQUEST® flangeless connections and MULTI-AXIS® precision bent piping. An evaluation that considers only the cost of pipe, fittings, flanges and connectors may result in specification of a system with the higher life cycle cost.

### Life Cycle Cost Considers All Cost Factors

Life cycle cost (LCC) analysis includes all costs of system ownership and permits selection of the less expensive system. Costs can be divided into the following categories:

- Initial acquisition costs
- Initial acquisition labor
- Operating, maintenance, and flange leak costs

When deciding to utilize JRT, it's often helpful to perform the evaluation based on the LCC of current practice (i.e., the use of flanged PLP) and then consider which costs would change if the system were designed and installed using the various Joint Reduction Technologies. Different alternatives can be evaluated with the judicious use of JRT and elimination of many, but not all, flanged connections resulting in the most economical PLP installation.

### Cost Elements to Consider When Evaluating JRT vs. Conventional PLP

#### • **Initial Acquisition Costs**

**- Pipe, fittings, flanges, venting & locking collars and CONQUEST® connectors.** These are the items that are purchased from the supplier of PLP. Pipe can be supplied already flanged, or spooled, ready for installation. If the pipe will be fabricated on-site, then a sufficient number of flanges and/or CONQUEST® connectors should be purchased. Don't overlook venting collars for PTFE (polytetrafluoroethylene) or PFA (perfluoroalkoxy) lined pipe if flanged pipe ends will be fabricated onsite. These collars are not needed if the pipe is joined with a CONQUEST® flangeless connection.

**- Nuts, bolts or studs needed to join flanged connections.**

**- Flange protectors or spray shields.** Many corporate or government regulations require that flanged connections be covered or protected so that if a leak occurs, it is either contained or flows in a controlled, predictable pattern instead of spraying at the flanged connection.

**- Registration of flanged connections in a corporate database.** Often the location of a flanged connection must be noted in records so that its location, maintenance and inspection can be reported. One common technique is to attach a bar code label to the flanged connection, input location and chemical service information into a database. Registration is essential if the service is covered by the 1990 Clean Air Act Amendments (CAAA) or other similar laws governing chemical processes. Many companies register all flanged connections in critical or hazardous services, even if the service isn't currently included in regulations. This is often done either for safety reasons or in anticipation of changes in regulations. Registration usually occurs at the time of installation and is in addition to the recurrent costs of periodic inspection.

**- Items that are less costly when flanged connections are eliminated because the piping system is lighter in weight and has a more streamlined profile. These could include:**

- number and type of hangers
- support structure
- diameter or configuration of insulation
- complexity of heat tracing around connections

**- Diameter of the piping system and size of pumps.** Don't overlook the improved flow characteristics of JRT, especially of MULTI-AXIS® precision bent piping. The 3-D bends of MULTI-AXIS® create less pressure drop than the standard 1.5-D bends of conventional PLP. It may be possible to specify a smaller diameter piping system and/or smaller pumps if JRT is specified instead of conventional PLP.

### Initial Acquisition Labor

**- Design and design review.** Usually PLP systems are designed with all piping spool lengths calculated and shown on detailed isometric drawings. This level of detail is often not needed if CONQUEST® flangeless connections are used in piping runs since the pipe can be field routed.

**- Material acquisition cost.** The cost of specifying, ordering and receiving materials can be reduced if the piping is bought as bulk quantities of unflanged, standard length pipe instead of numerous flanged spools with different custom lengths. Also the material acquisition costs for some items (like nuts, bolts, studs, flange protectors and spray shields) are reduced in direct portion to the number of flanged connections eliminated by the use of JRT.

## Joint Reduction Technologies - Life Cycle Cost Estimating

**- Field fabrication of custom length pipe.** The process of PLP custom spool fabrication includes cutting and threading the pipe, installing and aligning the flange, installing the venting or locking collar, heating the plastic stub, flaring the plastic face, cooling and removing the flaring die and installing a protective wooden cover over the flared face. This process can be time-consuming and quality difficult to control if performed on-site by personnel who fabricate PLP on an infrequent basis. Often custom spools are fabricated at the factory or by nearby stocking distributors who have fully equipped shops and certified personnel that fabricate PLP routinely. If conventional PLP is fabricated at the factory or by a distributor, then the cost will be part of the purchase price quoted by the supplier of the fabricated pipe. Understandably, flanged and fabricated spools are more expensive than plain-end PLP.

**- Cost of installation.** This includes the cost of installing the piping system and the associated nuts, bolts, studs, flange protectors and spray shields with conventional PLP or the cost of fabricating a CONQUEST® connection when the method is used to create a joint.

**- Miscellaneous labor cost savings.** Be sure to include labor cost savings if the use of lighter weight, streamlined JRT piping permits a reduction in the number of hangers and supports and if the elimination of flanged connections speeds up the installation of insulation and heat tracing. Also, the time required for painting can be reduced when flanged connections are eliminated. If installation time is reduced, then it's often possible to reduce the time required for rental or recharge of equipment like man-lifts.

**- Start-up costs.** This includes the time to hydrotest the piping system and perform the recommended retorquing of bolts after 24 hours of operation. When flanged connections are eliminated, the start-up time can be substantially reduced. This means that the system is operational sooner and the process is out of commission for a shorter period of time.

### Operating and maintenance costs

**- Monitoring and associated paperwork.** Government or corporate regulations may require the periodic monitoring of flanged connection for leaks and records of that monitoring activity. If a service is listed in the 1990 CAAA, then the connection must be "sniffed" for fugitive emissions and detailed records maintained for submittal to the government. The monitoring frequency ranges from every six months to biannually, depending upon the service and history of the site. Even if regulations don't require monitoring, it's still good chemical plant operations practice to visually inspect flanged connections periodically for signs of leaks or emissions.

**- Periodic retorquing of flange bolts.** It's common for flange bolt torques to be checked and bolts tightened, if needed, on a periodic basis. Often this is done semi-annually or annually depending upon the thermal cycling history of the piping. This retorquing isn't needed when flanged connections are eliminated through installation of JRT.

**- Cleaning costs.** Consider the cost difference in batch-to-batch cleaning of conventional PLP vs. JRT. In some batch processes this can be a savings, particularly when directional changes in the piping are created with MULTI-AXIS® piping instead of with conventional flanged elbows, which have a discontinuity or crevice at the flanged connection.

### Costs associated with flanged leaks

**- Unused capacity.** Consider the likelihood of plant outages due to flange leaks and the cost of production that is lost when the plant isn't operating.

**- Out-of-spec product.** Flange leaks can create a sudden and unexpected plant outage resulting in the production of out-of-spec product.

**- Safety issues.** The "cost" is difficult to estimate but can be a tangible concern for some chemical services and/or some piping system locations. This could include direct injury to workers and passers-by and indirect issues such as evacuation of the process site and adjacent areas.

**- Reporting requirements.** Government or corporate regulations can require lengthy and time-consuming reports and investigations in the event of flange leaks. The direct and indirect costs of these reports shouldn't be overlooked.

### Example of Life Cycle Cost Estimating Analysis

Consider a piping system that was recently installed with extensive use of JRT. The system consists of 2-in diameter (50 mm N.B.) PVDF-lined piping that was installed in an existing, overhead pipe rack to replace a conventional PLP system that had reached the end of its useful life of several decades. The conventional system consists of 670 ft (204 m) of piping, ten directional changes for routing the thermal expansion purposes and two tees installed as "stand-pipes" to reduce the effect of water hammer. By specifying JRT, all the flange connections, except for the first and last connections. In JRT, the system consists of 620 ft of straight-run piping, three pieces of MULTI-AXIS® precision-bent piping, two CONQUEST® flangeless tees and thirty-seven CONQUEST® connections. The system is depicted in the isometric drawing. Costs are estimated using 1995 data for the upper mid-west and listed in U.S. dollars.

## Joint Reduction Technologies - Life Cycle Cost Estimating

### Initial Acquisition Labor Savings

**- Design, design review and material acquisition costs.**

Since this system represents an initial JRT installation at this location, the specifiers decided that the design, review and acquisition of the system would be no different with either design. After the installation, they report that the project went very “smoothly” and they can anticipate savings in design, review and acquisition of future JRT installations.

**- Elimination of field fabrication of flanged custom length pipe.**

It takes about 1.15 hr to completely cut, thread, flange, flare and block the two ends of a 2" PVDF-lined spool. There are thirty-seven spools in the conventional flanged system design, representing a total fabrication time of 42.55 hours. It takes about 0.6 hours to cut, align, trim, butt-fusion weld and install a CONQUEST® connection. There are thirty-seven CONQUEST® connections in the system, with a total installation time of 22.2 hours.

**- Cost of installation.** It takes about 0.4 hr to install the nuts, bolts and flange shield of a 2" diameter connection. There are forty-nine flanged connections in the conventional design, for a total installation labor of 9.80 hours. The CONQUEST® connections are installed during the fabrication process outlined above, so there is no additional installation time since there are no nuts, bolts or spray shields used.

**- Start-up costs.** It's assumed that the cost to hydrotest the system would be identical for conventional piping and for a JRT system. However, the costs for hydrotesting of the conventional system would be higher if leaks occurred at the flanged connections and had to be corrected during the hydrotest. A leak occurring in a CONQUEST® connection during hydrotest would not be likely. These costs could be included based on previous experience at the site. However, the cost of the 24-hr retorquing of the flanged connections is tangible, at 0.2 hr per connection. With forty-nine flanged connections, there's an additional 9.8 hrs needed to start up the conventional system. The conventional PLP system takes nearly fifty hours more to fabricate, install and start-up than the same system that fully incorporates JRT to eliminate flanged connections. At \$50.00 per hour, the seemingly “less expensive” system is nearly \$2500 more expensive to install and commission.

So, if both the initial acquisition costs and the initial acquisition labor is considered, the total installed cost of the system that incorporates CONQUEST® flangeless joints and MULTI-AXIS® precision-bent piping is \$3,800 less than the same system installed with conventional flanged plastic-lined piping. This savings increases if the operating and maintenance costs are also considered.

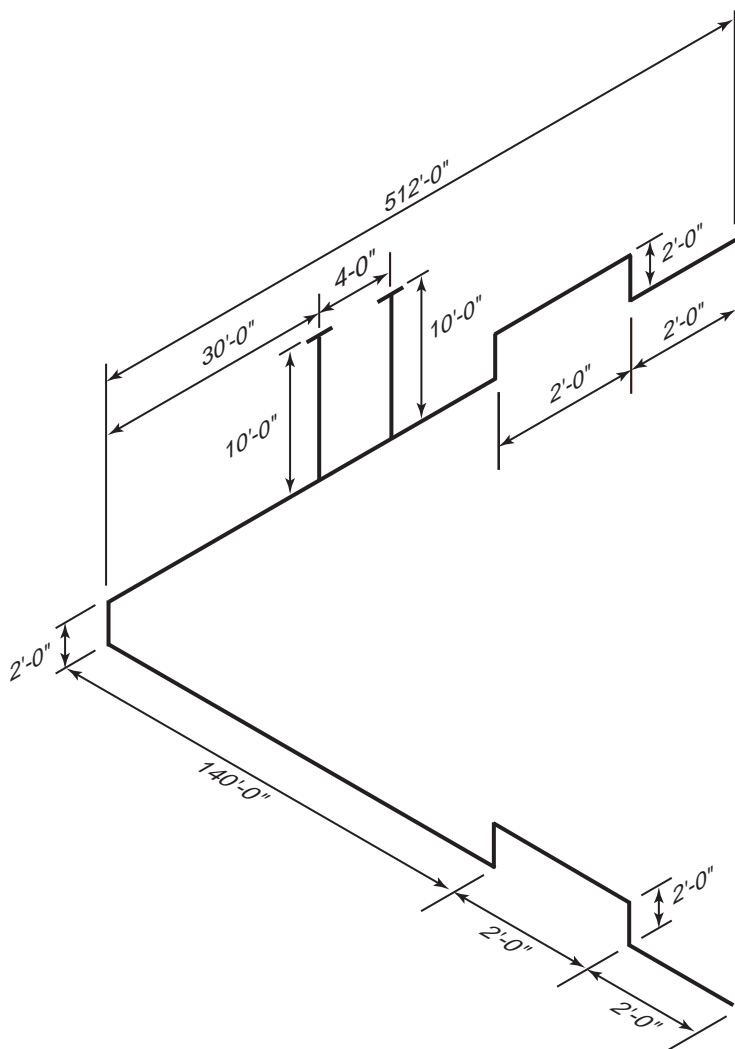
### Operating and maintenance costs

**- Annual monitoring and record keeping.** It costs about \$75.00 annually to monitor and record the testing of each flanged connection in a conventional PLP system. With forty-nine flanged connections, the system will cost an additional \$3,675 per year to maintain.

**- Annual retorquing.** The cost to retorque each connection is about \$10.00 per year, creating an additional \$490 in annual operating costs not required to maintain a JRT system. In certain critical services, retorquing is required semi-annually or quarterly.

**- Other costs.** Leaks and shut-downs can be very expensive, yet each location will have to evaluate their annual cost potential based upon system configuration, location, process conditions and history. These costs should not be overlooked, but are beyond the scope of this study.

## Joint Reduction Technologies - Life Cycle Cost Estimating



### Initial Acquisition Costs

#### - Pipe, fittings, flanges, locking collars and CONQUEST® connections.

The conventional flanged system consists of: ten 90° elbows; two standard tees; thirty-three plain end pieces of pipe, 20 ft (6.1 m) long; one plain-end piece of pipe, 10 ft (3 m) long; seventy-four threaded flanges; and, seventy-four locking collars. The net price is \$17,032. If the system is designed with JRT, then it consists of: two MULTI-AXIS® four-bend pieces, 20 ft (6.1 m) long, plain one end, flanged the other; one MULTI-AXIS® two-bend piece, 20 ft (6.1 m) long, plain both ends; two CONQUEST® tees; thirty-one plain-end pieces of pipe, 20 ft (6.1 m) long; and, thirty-seven CONQUEST® connectors. It has a net price of \$20,073. Thus the system that utilized JRT has a piping material cost premium of \$3,041 (the difference between \$20,073 and \$17,073). If the economic study ended at this point, then the conventional, flanged PLP system would be specified. However, complete life cycle cost analysis reveals that it is the most expensive of the two alternatives.

For the other initial costs (nuts, bolts, flange protectors, and registration of connections) consider the relative cost differences between the two systems.

**- Nuts and bolts.** A set of four bolts or studs and nuts cost about \$3.00 to \$5.00 for a 2", four bolt flanged connection. The specification of fluorocarbon-coated studs or bolts can increase the cost of the hardware to \$10.00 to \$12.00 for the connection.

In this example, uncoated bolts and nuts, with a cost of \$4.00 per set, are used on the forty-nine flanged connections. Total nut and bolt cost is \$196.

**- Flange protectors or spray shields.** Simple polyethylene spray shields cost about \$5.00 each, and shields of PVDF (the same material at the pipe liner) cost about \$10.00 each. Sometimes, fluorocarbon drain guards are specified for especially critical areas to permit collection of any leaks or drips. These deluxe guards can cost up to \$25.00 per connection. In this system, PVDF spray shields, at \$10.00 each are used on each of the forty-nine flanged connections with a total shield cost of \$490.

**- Registration of connectors.** Each flanged connection is labeled with a bar code and its location and chemical service is recorded on a corporate database system at a unit cost of \$75.00 per connection. The total cost for the forty-nine flanged connections is \$3,675. Many connections are totally eliminated through the use of MULTI-AXIS® in the JRT alternative and the remaining CONQUEST® connections are considered to be permanent connections and thus are not subject to periodic monitoring and record-keeping.

**- Other possible savings.** In this example, an existing pipe rack is used and the piping system isn't insulated or heat traced. However, in other installations where this isn't the case, these savings should be considered. For example the cost to insulate a 2" (50 mm) flange set is \$75-90 if common calcium silicate insulation is used.

## Joint Reduction Technologies - Life Cycle Cost Estimating

	Conventional Flanged PLPP			Joint Reduction Technologies			JRT vs. Flanged	
	Qty.	Unit Price \$	Ext. Price \$	Qty.	Unit Price \$	Ext. Price \$		
Initial Acquisition Costs								
Pipe, fittings, flanges, collars and connectors			17,031.60			20,072.55	3,040.95	
Nut & bolts for connection	49	4.00	196.00				-196.00	credit
Flange protectors	49	10.00	490.00				-490.00	credit
Registration of connection	49	75.00	3,675.00				-3,675.00	credit
	Qty.	Unit Hours	Ext. Hours	Qty.	Unit Hours	Ext. Hours		
Initial Acquisition Labor, hours								
Field fabrication 1.15 hr for flanged pipe spool	37	1.15	42.55					
Field fabrication 0.6 hr for CONQUEST connection				37	0.60	22.2		
Install nuts, bolts, shields 0.4 hr per connection	49	0.40	19.60					
24 hr retorque, 0.2 hr per connection	49	0.20	9.80					
Total Hours			71.95			22.2		
Extra Hours for Conventional PLP			45.75					
	Conventional Flanged PLPP			Joint Reduction Technologies			JRT vs. Flanged	
	Qty.	Unit Price \$	Ext. Price \$	Qty.	Unit Price \$	Ext. Price \$		
Initial Acquisition Labor Extra hours @ \$50/hr	49.75	50.00	2,487.50				-2,487.50	credit
Difference in Cost of Initial Acquisition Materials and Labor							-3,807.55	credit
Annual Operating and Maintenance Costs								
Monitor & record connection	49	75.00	3,675.00				-3,675.00	credit
Retorque connection	49	10.00	490.00				-490.00	credit
Annual Operating Cost Difference							-4,165.00	credit

### Discussion of results

The recurring annual cost savings realized by elimination of bolting hardware, monitoring, retorquing, and record-keeping make the JRT system \$4,165 less expensive to operate each year. This can create a cost savings of tens of thousands of dollars over the life of the system, more than paying for the initial investment.

Obviously, each piping system is different and operating conditions are sometimes difficult to predict. As this study shows, there's no quick answer to the question, "How much more will it cost me to use JRT?" The answer is, "It depends.", and it's usually less expensive to use JRT instead of conventional PLP when all costs associated with installation and maintenance are considered.

# Pressure Drop

## Pressure drop per 100 Feet of Straight Resistoflex Plastic-Lined Pipe

### INSTRUCTIONS FOR USE

1) You must know the flowrate in gallons per minute (gpm), or the velocity in feet per second (fps).

2) If you know the velocity in fps, go directly to the charts and locate the pressure drop for the velocity and line size you are working with.

3) If you don't know the velocity, but know the flowrate in gpm, follow the example below to determine velocity in fps:

Size*	CF
1"	.6933
1.5"	.2433
2"	.1322
3"	.0543
4"	.0300
6"	.0132
8"	.0073
10"	.0045
12"	.0031

Note: CF factors were determined using the average ID's of Resistoflex lined pipe for PTFE, PP, and PVDF liners.

#### Example:

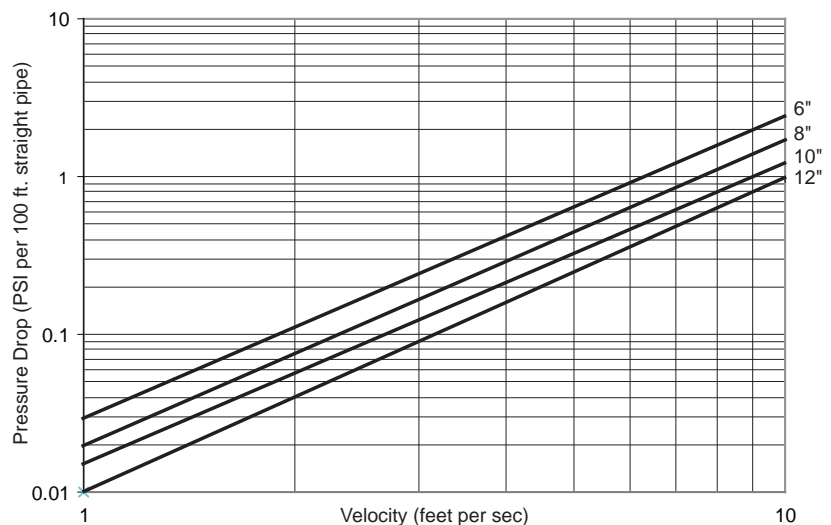
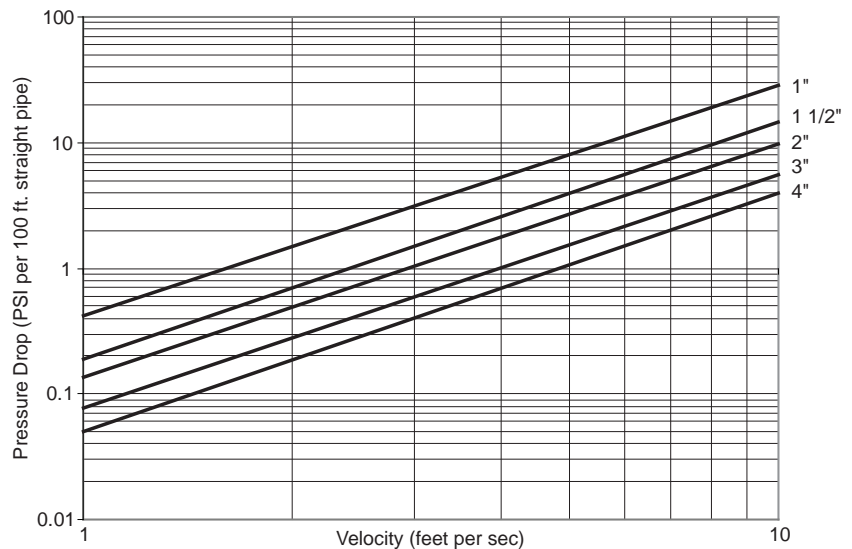
What is the pressure drop in 2" pipe at 60 gpm? First multiply 60 gpm x 0.1322 (CF factor for 2") to get a velocity of 7.93 feet per second. Look up the pressure drop for that velocity and line size in the charts. The pressure drop is approx. 4.5 psi per 100 ft. of straight pipe.

If the resultant pressure drop is too high for your needs, repeat the procedure for the next higher line size, until you get a pressure drop that is suitable. Conversely, a smaller line size will result in higher pressure drop for a given flowrate.

Pressure drops were determined using the Chen equation. Average lined pipe I.D.'s were used together with friction factors obtained from the Moody Diagram. Per a study made for Resistoflex by Battelle Institute, the friction factors were derived using relative roughness factors for smooth pipes.

\* For data for 14" - 48" sizes, consult factory.

### PTFE Lined Pipe Pressure Drop Water at 60°F



### FITTINGS

For pressure drops in fittings, please refer to a Piping Handbook giving that information for unlined components in equivalent feet of pipe. Then use the pressure drop chart for PTFE lined pipe.

Note: The information on this page is intended to give a general idea of pressure drop for plastic-lined pipe. For actual pressure drop calculations used to size pumps or piping, use published formulas from recognized sources, such as Crane Technical Paper 410.

## Flange Bolt Torquing

### Torquing

When assembling flange connections, always use a full complement of clean, new high strength A193-B7 bolting. If using stainless steel bolting, the bolts should be A320/A320M Class 2 B8 (304 SS) or Class 2 B8M (316 SS) with A 94/A194M Grade 8 or 8A Nuts (for 304 SS) or Grade 8M or 8MA (for 316 SS). If other bolting materials are used, the end user must ensure that the new bolting material strength properties exceed the calculated bolt stress values to be generated in making the piping connection.

- 1) Always use flat washers on both sides of the connection.
- 2) Tighten the flange bolts with a calibrated torque wrench. The recommended bolt torque values are shown in the tables on next pages. Note: For zinc-plated bolts, or with anti-seize compounds, the torque values will be different. Please contact Resistoflex for more information
- 3) Tighten the flange bolts with a torque wrench, using a "crisscross" pattern that alternately tightens the bolts located 180 degrees apart.
- 4) Using this pattern, tighten the bolts in 20% increments of the final bolt torque until 80% of final bolt torque has been achieved.
- 5) For tightening to the final torque values, tighten bolts sequentially clockwise once around the flange. This will help ensure that the bolts are evenly stressed.
- 6) Care should be taken to avoid over-torquing, which can cause damage to the plastic sealing surfaces.

#### NOTES:

Gaskets: Not required for 1/2" NPS - 12" NPS lined pipe. For large diameter (>12" NPS) PP, ETFE or HDPE-lined flange connections, gaskets are required for sealability and long term joint performance. These stiff plastic liners have minimal resilience and are sensitive to installer technique and support imperfections. Properly selected and installed gaskets add resilience and can help accommodate for these variables. We do not recommend the use of gaskets that contain non-resilient components such as metal inserts, as these can increase seating stress by concentrating force over a reduced area.

When bolting together dissimilar materials, always tighten to the lowest recommended torque of the components in the joint. Using higher torques may cause excessive deformation of the "softer" material in the joint.

Install a 1/2" thick spacer between Resistoflex plastic-lined pipe or fittings and other plastic-lined components, if the diameters of the raised plastic faces are different, as is often the case with plastic-lined valves. Spacers or gaskets should also be used when mating plastic-lined piping to unlined pipe, fittings, valves, pumps, etc.

### Retorquing

A retorque should be applied within 24 hours of the initial torque or after the first thermal cycle. This allows for seating of the plastic and for relaxation of the bolts. If the system is to perform at elevated temperatures, it is recommended that hot water be circulated at the maximum operating temperature of the process (if possible) for a minimum of 24 hours. This allows for the pipe system to experience one thermal cycle. After cool-down, retorquing of the system should be done. Torquing should only be done on the system in the ambient, cooled state, never while the process is at elevated temperature, or excessive force could be applied to the plastic faces. Never disassemble a flange joint in a hot system. Wait until the system has cooled to ambient temperature.

### Hydrostatic Testing

Normally, after initial torque and retorque, a hydrostatic test should be performed following ANSI requirements. Experience has shown that if the above procedure has been followed very few, if any, of the flange joints may fail the hydrostatic test. If a flange joint does leak, first check the torque values, then tighten in 10% increments over the specified bolt torques until sealed. However, if 150% of the specified torque value is reached and the flange joint still leaks, stop and disassemble the flange joint. Something else is probably wrong such as a scratched plastic face. Only after the hydrostatic test has been successfully completed and any leaks corrected, can the pipeline be signed off and commissioned.

### Annual retorquing

Retorquing should be considered at least annually thereafter, especially if the process line experiences elevated temperatures or extreme ambient temperature situations. Torquing should only be done on the system in the ambient, cooled state, never while the process is at elevated temperature or excessive force could be applied to the plastic faces.

**Note:** Resistoflex recommends the use of flat washers on both flanges.

**Note:** Lightly oiled is considered lubrication with WD-40\* or equivalent.

Please contact us for guidance on torques for other bolting/lubrication systems, such as zinc-plated bolts, or bolts with anti-seize lubricants.

**Note:** The maximum recommended torque values are suggested for lined systems operating at or near the maximum recommended pressures and temperatures. Systems operating under less severe conditions can, in general, experience leak-free performance using lower torque values. Additionally, when gaskets are used, we suggest comparing the torque values of the plastic-lined piping and the gasket, and using the lower torque value. For systems that will require frequent disassembly, we suggest using the minimum recommended torque value initially to avoid distortion of the plastic face.

\*WD-40 is a trademark of WD-40 Company, San Diego, CA USA



# 1/2" (DN 15) - 12" (DN 300) Bolt Torque Chart

ANSI Class 150 Systems - Lightly Oiled A193 Gr. B7 Bolts and A194 2H Nuts									
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)								
	PP		PVDF/ETFE		PTFE		PFA		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
1/2 (15)	--	--	--	--	6 (9)	11 (15)	9 (13)	14 (19)	
3/4 (20)	--	--	--	--	9 (13)	16 (22)	14 (19)	20 (28)	
1 (25)	13 (18)	17 (24)	17 (24)	21 (29)	8 (11)	13 (18)	12 (17)	17 (24)	
1 (40)	31 (43)	41 (56)	41 (56)	50 (68)	19 (26)	31 (43)	28 (38)	41 (56)	
2 (50)	65 (89)	85 (116)	85 (116)	104 (142)	39 (53)	65 (89)	59 (81)	85 (116)	
3 (80)	103 (140)	134 (182)	134 (182)	165 (224)	62 (85)	103 (140)	93 (127)	134 (182)	
4 (100)	67 (91)	88 (120)	88 (120)	108 (147)	40 (55)	67 (91)	61 (83)	88 (120)	
6 (150)	124 (169)	161 (219)	161 (219)	199 (270)	75 (102)	124 (169)	112 (152)	161 (219)	
8 (200)	167 (227)	217 (295)	217 (295)	267 (363)	100 (136)	167 (227)	--	--	
10 (250)	157 (213)	204 (277)	205 (277)	252 (342)	157 (213)	204 (277)	--	--	
12 (300)	193 (262)	251 (341)	251 (341)	308 (419)	193 (262)	251 (341)	--	--	

ANSI Class 300 Systems - Lightly Oiled A193 Gr. B7 Bolts and A194 2H Nuts									
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)								
	PP		PVDF		PTFE		PFA		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
1/2 (15)	--	--	--	--	6 (9)	11 (15)	9 (13)	14 (19)	
3/4 (20)	--	--	--	--	6 (9)	10 (14)	9 (13)	13 (18)	
1 (25)	17 (24)	22 (24)	22 (30)	27 (37)	10 (14)	17 (24)	15 (21)	22 (30)	
1 (40)	47 (64)	61 (64)	61 (83)	75 (102)	28 (38)	47 (64)	42 (57)	61 (83)	
2 (50)	33 (45)	42 (45)	42 (57)	52 (71)	20 (28)	33 (45)	29 (40)	42 (57)	
3 (80)	62 (85)	80 (85)	80 (109)	99 (135)	37 (51)	62 (85)	56 (76)	80 (109)	
4 (100)	81 (110)	105 (110)	105 (143)	130 (177)	49 (67)	81 (110)	73 (99)	105 (143)	
6 (150)	83 (113)	108 (113)	108 (147)	132 (179)	50 (68)	83 (113)	75 (102)	108 (147)	
8 (200)	130 (177)	169 (177)	169 (230)	207 (281)	78 (106)	130 (177)	--	--	
10 (250)	135 (184)	175 (184)	176 (239)	216 (293)	135 (184)	175 (238)	--	--	
12 (300)	186 (253)	242 (253)	--	--	186 (253)	242 (329)	--	--	

Note: These maximum torques are valid only for LIGHTLY OILED A193 Gr. B7 bolts. Lightly oiled is considered lubrication with WD-40® or equivalent. Contact the factory for bolt torque values when using anti-seize compounds. WD-40 is a trademark of WD-40 Company.

# 1/2" (DN 15) - 12" (DN 300) Bolt Torque Chart

ASME B16.5 Class 150 - PTFE-Coated A193 Gr. B7 Bolts and A194 2H Nuts									
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)								
	PP		PVDF		PTFE		PFA		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
1/2 (15)	--	--	--	--	4 (6)	6 (9)	6 (9)	8 (11)	
3/4 (20)	--	--	--	--	6 (9)	9 (13)	9 (13)	12 (17)	
1 (25)	8 (11)	10 (14)	10 (14)	13 (18)	5 (7)	8 (11)	7 (10)	10 (14)	
1 (40)	19 (26)	25 (34)	25 (34)	30 (41)	11 (15)	19 (26)	17 (24)	25 (34)	
2 (50)	39 (53)	51 (70)	51 (70)	62 (85)	23 (32)	39 (53)	35 (48)	51 (70)	
3 (80)	62 (85)	80 (109)	80 (109)	99 (135)	37 (51)	62 (85)	56 (76)	80 (109)	
4 (100)	40 (55)	53 (72)	53 (72)	65 (89)	24 (33)	40 (55)	36 (49)	53 (72)	
6 (150)	75 (102)	97 (132)	97 (132)	119 (162)	45 (62)	75 (102)	67 (91)	97 (132)	
8 (200)	100 (136)	130 (177)	130 (177)	160 (217)	60 (82)	100 (136)	--	--	
10 (250)	94 (128)	123 (167)	123 (167)	151 (205)	94 (128)	123 (167)	--	--	
12 (300)	116 (158)	150 (204)	--	--	116 (158)	150 (204)	--	--	
ASME B16.5 Class - PTFE-Coated A193 Gr. B7 Bolts and A194 2H Nuts									
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)								
	PP		PVDF		PTFE		PFA		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
1/2 (15)	--	--	--	--			6 (9)	8 (11)	
3/4 (20)	--	--	--	--			5 (7)	8 (11)	
1 (25)	10 (14)	13 (18)	13 (18)	16 (22)	6 (9)	10 (14)	9 (13)	13 (18)	
1 (40)	28 (38)	37 (51)	37 (51)	45 (62)	17 (24)	28 (38)	25 (34)	37 (51)	
2 (50)	20 (28)	25 (34)	25 (34)	31 (43)	12 (17)	20 (28)	18 (25)	25 (34)	
3 (80)	37 (51)	48 (66)	48 (66)	59 (81)	22 (30)	37 (51)	33 (45)	48 (66)	
4 (100)	49 (67)	63 (86)	63 (86)	78 (106)	29 (40)	49 (67)	44 (60)	63 (86)	
6 (150)	50 (68)	65 (89)	65 (89)	79 (108)	30 (41)	50 (68)	45 (62)	65 (89)	
8 (200)	78 (106)	101 (137)	101 (137)	124 (169)	47 (64)	78 (106)	--	--	
10 (250)	81 (110)	105 (143)	114 (155)	140 (190)	81 (110)	105 (143)	--	--	
12 (300)	112 (152)	145 (197)	--	--	112 (152)	145 (197)	--	--	

# 1/2" (DN 15) - 12" (DN 300) Bolt and Stud Lengths

ASME B16.5 Class 150									
Pipe Size NPS (DN)	Bolt Size	Qty	Bolt Length, in. (mm)			Stud Length, in. (mm)			
			F x F	F x R	R x R	F x F	F x R	R x R	
1/2 (15)	1/2	4	1 (20)	1 (20)	1 (20)	1 3/4 (39)	1 3/4 (39)	1 3/4 (39)	
3/4 (20)	1/2	4	1 (24)	1 (24)	1 (24)	2 (46)	2 (46)	2 (46)	
1 (25)	1/2	4	2 1/4 (56)	2 1/2 (60)	2 1/2 (63)	3 1/4 (81)	3 1/2 (81)	3 1/2 (88)	
1 (40)	1/2	4	2 1/2 (63)	2 3/4 (66)	2 3/4 (70)	3 1/2 (87)	3 3/4 (87)	3 3/4 (95)	
2 (50)	5/8	4	2 3/4 (70)	3 (74)	3 (78)	4 (99)	4 (99)	4 1/4 (107)	
3 (80)	5/8	4	3 1/4 (81)	3 1/2 (86)	3 3/4 (92)	4 1/2 (109)	4 3/4 (109)	4 3/4 (120)	
4 (100)	5/8	8	3 1/4 (83)	3 1/2 (89)	3 3/4 (95)	4 1/2 (111)	4 1/2 (111)	5 (123)	
6 (150)	3/4	8	3 3/4 (93)	4 (100)	4 1/4 (107)	5 (128)	5 (128)	5 1/4 (142)	
8 (200)	3/4	8	4 (101)	4 1/2 (110)	4 3/4 (118)	5 1/2 (136)	4 1/2 (136)	6 (153)	
10 (250)	7/8	12	4 1/2 (110)	4 3/4 (118)	5 (125)	6 (149)	6 (149)	6 1/2 (164)	
12 (300)	7/8	12	4 1/2 (115)	5 (122)	5 (128)	6 1/4 (154)	6 1/4 (154)	6 3/4 (167)	
Class 300									
Pipe Size NPS (DN)	Bolt Size	Qty	Bolt Length, in. (mm)			Stud Length, in. (mm)			
			F x F	F x R	R x R	F x F	F x R	R x R	
1/2 (15)	1/2	4	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	
3/4 (20)	5/8	4	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 3/4 (70)	
1 (25)	5/8	4	2 1/2 (64)	2 3/4 (70)	2 3/4 (70)	3 1/4 (83)	3 1/2 (89)	3 1/2 (89)	
1 (40)	3/4	4	2 3/4 (70)	3 (76)	3 (76)	3 3/4 (95)	4 (102)	4 1/4 (108)	
2 (50)	5/8	8	3 (76)	3 1/4 (83)	3 1/2 (89)	3 3/4 (95)	3 3/4 (95)	4 (102)	
3 (80)	3/4	8	3 1/2 (89)	3 3/4 (95)	3 3/4 (95)	4 1/2 (114)	4 3/4 (121)	5 (127)	
4 (100)	3/4	8	3 1/2 (89)	3 3/4 (95)	4 (102)	4 3/4 (121)	5 (127)	5 1/4 (133)	
6 (150)	3/4	12	4 (102)	4 1/4 (108)	4 1/2 (114)	5 1/4 (133)	5 1/2 (140)	5 3/4 (146)	
8 (200)	7/8	12	4 1/4 (108)	4 1/2 (114)	4 3/4 (121)	6 (152)	6 1/4 (159)	6 1/2 (165)	
10 (250)	1	16	4 1/2 (114)	5 (127)	5 1/4 (133)	6 3/4 (171)	7 (178)	7 1/2 (191)	
12 (300)	1 1/8	16	4 3/4 (121)	5 (127)	5 1/4 (133)	7 1/2 (191)	7 3/4 (197)	8 (203)	

## 1/2" (DN 15) - 12" (DN 300) Bolt and Stud Lengths

ASME B16.5 Class 150									
Pipe Size NPS (DN)	Bolt Size	Qty	Bolt Length, in. (mm)			Stud Length, in. (mm)			
			F x F	F x R	R x R	F x F	F x R	R x R	
1/2 (15)	1/2	4	1 (20)	1 (20)	1 (20)	1 3/4 (39)	1 3/4 (39)	1 3/4 (39)	
3/4 (20)	1/2	4	1 (24)	1 (24)	1 (24)	2 (46)	2 (46)	2 (46)	
1 (25)	1/2	4	2 1/4 (56)	2 1/2 (60)	2 1/2 (63)	3 1/4 (81)	3 1/2 (81)	3 1/2 (88)	
1 (40)	1/2	4	2 1/2 (63)	2 3/4 (66)	2 3/4 (70)	3 1/2 (87)	3 3/4 (87)	3 3/4 (95)	
2 (50)	5/8	4	2 3/4 (70)	3 (74)	3 (78)	4 (99)	4 (99)	4 1/4 (107)	
3 (80)	5/8	4	3 1/4 (81)	3 1/2 (86)	3 3/4 (92)	4 1/2 (109)	4 3/4 (109)	4 3/4 (120)	
4 (100)	5/8	8	3 1/4 (83)	3 1/2 (89)	3 3/4 (95)	4 1/2 (111)	4 1/2 (111)	5 (123)	
6 (150)	3/4	8	3 3/4 (93)	4 (100)	4 1/4 (107)	5 (128)	5 (128)	5 1/4 (142)	
8 (200)	3/4	8	4 (101)	4 1/2 (110)	4 3/4 (118)	5 1/2 (136)	4 1/2 (136)	6 (153)	
10 (250)	7/8	12	4 1/2 (110)	4 3/4 (118)	5 (125)	6 (149)	6 (149)	6 1/2 (164)	
12 (300)	7/8	12	4 1/2 (115)	5 (122)	5 (128)	6 1/4 (154)	6 1/4 (154)	6 3/4 (167)	
ASME B16.5 Class 300									
Pipe Size NPS (DN)	Bolt Size	Qty	Bolt Length, in. (mm)			Stud Length, in. (mm)			
			F x F	F x R	R x R	F x F	F x R	R x R	
1/2 (15)	1/2	4	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	
3/4 (20)	5/8	4	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 1/2 (64)	2 3/4 (70)	
1 (25)	5/8	4	2 1/2 (64)	2 3/4 (70)	2 3/4 (70)	3 1/4 (83)	3 1/2 (89)	3 1/2 (89)	
1 (40)	3/4	4	2 3/4 (70)	3 (76)	3 (76)	3 3/4 (95)	4 (102)	4 1/4 (108)	
2 (50)	5/8	8	3 (76)	3 1/4 (83)	3 1/2 (89)	3 3/4 (95)	3 3/4 (95)	4 (102)	
3 (80)	3/4	8	3 1/2 (89)	3 3/4 (95)	3 3/4 (95)	4 1/2 (114)	4 3/4 (121)	5 (127)	
4 (100)	3/4	8	3 1/2 (89)	3 3/4 (95)	4 (102)	4 3/4 (121)	5 (127)	5 1/4 (133)	
6 (150)	3/4	12	4 (102)	4 1/4 (108)	4 1/2 (114)	5 1/4 (133)	5 1/2 (140)	5 3/4 (146)	
8 (200)	7/8	12	4 1/4 (108)	4 1/2 (114)	4 3/4 (121)	6 (152)	6 1/4 (159)	6 1/2 (165)	
10 (250)	1	16	4 1/2 (114)	5 (127)	5 1/4 (133)	6 3/4 (171)	7 (178)	7 1/2 (191)	
12 (300)	1 1/8	16	4 3/4 (121)	5 (127)	5 1/4 (133)	7 1/2 (191)	7 3/4 (197)	8 (203)	

## 14" (DN 350) - 48" (DN 1200) Bolt Torque Chart

ASME B16.5 Class 150 ASME B16.47 Series A Class 150 Lightly Oiled A193 Gr. B7 Bolts and A194 2H Nuts										
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)									
	PP		ETFE		HDPE		PTFE			
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
14 (350)	198 (268)	257 (348)	257 (349)	317 (429)	46 (63)	69 (95)	119 (161)	198 (268)		
16 (400)	184 (250)	239 (324)	239 (325)	295 (400)	44 (60)	66 (90)	111 (150)	184 (250)		
18 (450)	268 (364)	349 (473)	349 (473)	429 (582)	64 (88)	97 (131)	161 (218)	268 (364)		
20 (500)	243 (329)	316 (428)	316 (428)	389 (527)	58 (80)	87 (119)	146 (198)	243 (329)		
24 (600)	320 (434)	416 (564)	416 (564)	512 (695)	77 (105)	115 (157)	192 (261)	320 (434)		
26 (650)	370 (501)	481 (652)	481 (652)	592 (802)	89 (121)	133 (181)	--	--		
28 (700)	339 (460)	441 (598)	441 (598)	543 (736)	81 (111)	122 (166)	--	--		
30 (750)	376 (510)	489 (663)	489 (663)	602 (816)	90 (123)	135 (184)	--	--		
32 (800)	497 (674)	647 (877)	647 (877)	796 (1079)	119 (162)	179 (243)	--	--		
34 (850)	460 (624)	598 (811)	598 (811)	736 (998)	110 (150)	166 (225)	--	--		
36 (900)	502 (681)	653 (885)	653 (885)	804 (1090)	121 (164)	181 (246)	--	--		
38 (950)	528 (716)	686 (930)	686 (931)	845 (1145)	127 (172)	190 (258)	--	--		
40 (1000)	492 (667)	640 (868)	640 (867)	787 (1067)	118 (161)	177 (241)	--	--		
42 (1050)	566 (767)	735 (997)	735 (997)	905 (1227)	136 (185)	204 (277)	--	--		
44 (1100)	531 (720)	691 (937)	691 (936)	850 (1152)	127 (173)	191 (260)	--	--		
46 (1150)	553 (750)	719 (975)	719 (975)	885 (1200)	133 (181)	199 (271)	--	--		
48 (1200)	553 (750)	719 (975)	719 (975)	885 (1200)	133 (181)	199 (271)	--	--		

For torque values for Class 300 flanges, consult factory.  
Consult factory for custom torque table when using anti-seize compound.

## 14" (DN 350) - 48" (DN 1200) Bolt Torque Chart

ASME B16.5 Class 150 ASME B16.47 Series A Class 150 PTFE Coated A193 Gr. B7 Bolts and A194 2H Nuts									
Pipe Size NPS (DN)	Bolt Torque, ft-lb per Bolt (Nm per bolt)								
	PP		ETFE		HDPE		PTFE		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
14 (350)	119 (161)	154 (209)	154 (209)	190 (258)	28 (39)	42 (58)	97 (97)	161 (161)	
16 (400)	111 (150)	144 (195)	144 (195)	177 (240)	27 (37)	40 (55)	90 (90)	150 (150)	
18 (450)	161 (218)	209 (284)	209 (284)	258 (349)	39 (53)	58 (79)	131 (131)	218 (218)	
20 (500)	146 (198)	190 (257)	190 (257)	233 (316)	35 (48)	53 (72)	119 (119)	198 (198)	
24 (600)	192 (261)	250 (339)	250 (339)	307 (417)	47 (64)	70 (96)	156 (156)	261 (261)	
26 (650)	222 (301)	288 (391)	288 (391)	355 (481)	54 (74)	80 (109)	--	--	
28 (700)	204 (276)	265 (359)	265 (359)	326 (441)	49 (67)	74 (101)	--	--	
30 (750)	226 (306)	293 (398)	293 (398)	361 (490)	55 (75)	82 (112)	--	--	
32 (800)	298 (405)	388 (526)	388 (526)	477 (647)	72 (98)	108 (147)	--	--	
34 (850)	276 (374)	359 (487)	359 (487)	442 (599)	67 (91)	100 (136)	--	--	
36 (900)	301 (409)	392 (531)	392 (531)	482 (654)	73 (100)	109 (149)	--	--	
38 (950)	317 (429)	412 (558)	412 (558)	507 (687)	77 (105)	115 (157)	--	--	
40 (1000)	295 (400)	384 (520)	384 (520)	472 (640)	71 (97)	107 (146)	--	--	
42 (1050)	339 (460)	441 (598)	441 (598)	543 (736)	82 (112)	123 (168)	--	--	
44 (1100)	319 (432)	414 (562)	414 (562)	510 (691)	77 (105)	115 (157)	--	--	
46 (1150)	332 (450)	432 (585)	432 (585)	531 (720)	80 (109)	120 (163)	--	--	
48 (1200)	332 (450)	431 (585)	431 (585)	531 (720)	80 (109)	120 (163)	--	--	

For torque values for Class 300 flanges, consult factory.

## 14" (DN 350) - 48" (DN 1200) Bolt and Stud Lengths

F = Fixed Flange  
R = Rotating Flange

ASME B16.5 Class 150											
Pipe Size NPS (DN)	Bolt Size	Qty	Bolt Length, in. (mm)						Stud Length, in. (mm)		
			F x F		F x R (PTFE, only)		R x R (PTFE, only)		F x F		F x R (PTFE, only)
14 (350)	1	12	4 3/4 (121)	5 3/4 (147)	6 1/2 (166)	6 1/2 (166)	7 1/2 (191)	8 1/4 (210)			
16 (400)	1	16	5 (127)	6 (153)	6 3/4 (172)	6 1/2 (166)	7 1/2 (191)	8 1/2 (216)			
18 (450)	1 1/8	16	5 1/2 (140)	6 1/4 (159)	7 1/4 (185)	7 1/4 (185)	8 (204)	9.00 (229)			
20 (500)	1 1/8	20	5 1/2 (140)	6 1/2 (166)	7 1/2 (191)	7 1/2 (191)	8 1/2 (216)	9 1/2 (242)			
24 (600)	1 1/4	20	6 1/4 (159)	7 1/4 (185)	8 1/4 (210)	8 1/4 (210)	9 1/4 (235)	10 1/4 (261)			
26 (650)	1 1/2	24	7 3/4 (197)	--	--	9 3/4 (248)	--	--			
28 (700)	1 1/4	28	8 (204)	--	--	10 (254)	--	--			
30 (750)	1 1/4	28	8 1/4 (210)	--	--	10 1/4 (261)	--	--			
32 (800)	1 1/2	28	9 (229)	--	--	11 1/4 (286)	--	--			
34 (850)	1 1/2	32	9 (229)	--	--	11 1/2 (293)	--	--			
36 (900)	1 1/2	32	9 3/4 (248)	--	--	12 (305)	--	--			
38 (950)	1 1/2	32	9 1/2 (242)	--	--	12 (305)	--	--			
40 (1000)	1 1/2	36	9 3/4 (248)	--	--	12 (305)	--	--			
42 (1050)	1 1/2	36	10 1/4 (261)	--	--	12 1/2 (318)	--	--			
44 (1100)	1 1/2	40	10 1/2 (267)	--	--	13 (331)	--	--			
46 (1150)	1 1/2	40	10 3/4 (274)	--	--	13 (331)	--	--			
48 (1200)	1 1/2	44	11 (280)	--	--	13 1/2 (343)	--	--			

Class 300 flanges, consult factory.

FxR and RxR available for ETFE/PP/HDPE on request.

## Pressure Testing Plastic-Lined Pipe

### Hydrostatic Test

Resistoflex pipe and fittings can be tested at the pressures recommended by ASME B31.3. The fluid used for the hydrostatic test is typically water. Another suitable non-toxic liquid can be substituted if there is the risk of damage due to the adverse effects of having water in the system. The system should be tested at a pressure not less than 1.5 times the design pressure. If the design temperature is above the test temperature then the required test pressure is calculated by the following equation:

$$P_t = (1.5 P_d) / S_t$$

Where:

$P_t$  = minimum hydrostatic test gauge pressure  
 $P$  = internal design gauge pressure  
 $S_t$  = allowable pipe stress value at test temperature  
 $S$  = allowable pipe stress value at design temperature

Typically, for the pressures and temperatures in which plastic-lined pipe is used, the above calculation reduces to:

$$P_t = 1.5 P$$

We recommend that the system be retorqued after the first thermocycle. If the hydrostatic test is performed at the expected operating temperature (a "hot hydrotest") then the hydrotest can constitute the first thermocycle and the recommended retorquing can occur after the pressure test.

### Pneumatic Leak Test

This pressure test is performed in some situations where the presence of any water in the system is forbidden. The test is very dangerous due to the stored energy of the compressed gas. ASME B31.3 refers to the dangers of performing this test and provides safety considerations in the standard.

Test procedures should follow the requirements of ASME B31.3 Para 345.8 Sensitive Leak Test.

### Alternative Leak Test

If a hydrostatic pressure test is undesirable due to the possible chemical reactions with water and a pneumatic test is undesirable due to the potential hazards, then an alternative leak test can be used. This test is not applicable to plastic lined pipe because it relates to welded systems.

### Initial Service Leak Test

This test is applicable only to systems, which meet the following requirements:

- The fluid handled is nonflammable, non-toxic, and not damaging to human tissues.
- The design gauge pressure does not exceed 150 psig.
- The design temperature is between -20°F and 366°F.

In this test, the test fluid is the service fluid. It is rare that this test is used with plastic-lined pipe. ASME B31.3 should be considered if more information concerning this test is required.

The above is a description of some pressure test methods. In general, most systems are hydrostatically tested as described in ASME B31.3. If the hydrostatic test is impractical, then the pneumatic test can be substituted, however, extreme caution must be observed during this potentially hazardous test.



## Storage and Maintenance

To obtain maximum performance from Plastic-Lined Piping Products, it is important that the flared or molded end faces of the plastic are protected from damage during storage, handling and installation. The following should be considered when handling Plastic-Lined Piping Products:

- Store indoors or under cover.
- Never put the lifts of a forklift inside of the pipe to transport. This can damage the plastic liner.
- Products are shipped with a high performance, two component, epoxy primer protective coating.
- Protective end caps are not designed for prolonged outdoor exposure.
- Protective end caps on all pipe and fittings should be left in place until the pipe is ready to be installed.
- Do not damage the plastic sealing faces when removing the end caps.
- If end caps are removed for painting, they must be re-installed with bolting as soon as possible.
- Avoid rough handling of plastic-lined pipe in temperatures below 40°F. Plastic becomes brittle in low temperatures, and is more susceptible to cracking during rough handling.
- Avoid mechanical or thermal shock to piping that is stored in cold temperatures.
- Avoid storing plastic-lined piping products where they will be exposed to ultraviolet light for long periods of time.
- The center of gravity of MULTI-AXIS® pipe may not be readily apparent. Be sure to handle carefully.

### Safety Precautions for Field fabricating Plastic-Lined Pipe

Plastic-lined pipe can be fabricated on-site, and should only be fabricated by properly certified personnel. Please contact your Resistoflex representative for more information on certification training. When field fabricating plastic-lined pipe, adequate ventilation (such as exhaust fans) should be used. Overheating of the plastic can cause it to degrade and generate vapors. Avoid breathing vapors. Vapors can cause severe irritation to skin, eyes, and respiratory tract. When field fabricating, never heat the plastic with a torch or open flame.

### Welding Plastic-Lined Piping Products During Field Fabrication

Welding should not be performed on Swaged plastic-lined pipe and fittings. Heat generated from welding will cause extensive damage to the plastic liners. If welding is necessary, use THERMALOK® plastic-lined pipe, since the liner can be moved back and out of the way from the heat source during welding. Any welding should be performed by a welder who is trained and certified to ASME Boiler and Vessel Code, Section IX. Plastic-lined pipe and fittings should not be used as a ground for electric welders or other equipment. NOTE: NEVER WELD ON FINISHED FLANGED PLASTIC LINED PIPE OR FITTINGS - LINER DAMAGE WILL RESULT.

### Painting Plastic-Lined Piping Products

All pipe, fittings, and valves supplied by Resistoflex have a gray protective coating applied to minimize oxidation during shipping and handling. Refer to NACE guidelines and recommendations for sandblasting and selection of an appropriate primer and topcoat suitable for your plant environmental conditions.

It is important that the raised plastic face on all plastic-lined piping components is protected from damage during sandblasting and painting. Make sure that the protective end caps remain in place at all times during these operations, and direct the sandblasting away from the face of the flange. As an extra precaution, you may want to remove the protective end cap, apply protective tape over the plastic face, and then replace the cap before sandblasting and painting. If the exterior of the pipe is to be treated with a heat-curable protective coating, exercise caution during the heating process. Never apply heat in excess of the liner's maximum temperature rating.

PTFE venting collars on swaged pipe and vent holes on PTFE THERMALOK® pipe and PTFE-lined fittings should not be plugged with paint. The collars and holes are part of the venting system needed to prevent possible gas buildup behind the liner and possible liner collapse. Pipe, fittings, and valves can also be special ordered without paint, but longer lead times may result.

All paint systems have a poor resistance to handling and transit damage. This fact should be considered when evaluating pre-erection shop painting versus in-place painting. If shop painting is selected, touch-up will be required after job-site receipt. Touch-up costs are for Buyer's account.

## Heat Tracing

Many products freeze or become viscous when exposed to ambient temperatures. Other polymerize, react, or become corrosive when exposed to ambient temperatures (e.g., condensation of a permeating vapor through a PTFE liner). Successful storage and transfer of such products, in most cases, requires that the piping and associated equipment be heat traced. Throughout the industry, steam, fluid, and electric heat tracing systems are widely used. All are intended for the same purpose of pipe heating, but each has its own design considerations and limitations.

The potential problem with heat tracing plastic lined pipe is overheating of the plastic liner. In PTFE lined pipe, localized heating can cause increased permeation, resulting in a single lobe collapse of the liner. Each liner has a maximum service temperature; however, some aggressive chemicals can reduce the temperature limits of the plastic. The following outlines the maximum service temperatures for the liners, recommended heat tracing methods for each liner, design considerations for each heat tracing method, and relative strengths and limitations for each heating system.

Available Liners	Maximum Temperature °F (°C)	Recommended Heat Tracing
Polypropylene (PP)	225 (107)	steam**, fluid, electric
Polyvinylidene Fluoride (PVDF)	275 (135)	steam, fluid, electric
Polytetrafluoroethylene (PTFE)	450 (232)	steam, fluid, electric
Perfluoroalkoxyfluorocarbon (PFA)	450 (232)	steam, fluid, electric

\*\*Since useful steam temperatures are above the recommended temperature for PP, a special designed isolated tracing system must be used to limit the tracer temperature to prevent overheating of the liner.

Note: Maximum Liner Service Temperature can decrease because of the service application; check Chemical Resistance Section for recommended temperature of each liner for the application in question.

### General Design Consideration for Heat Tracing Plastic-Lined Pipe

1. Pipe Size
2. Liner Type
  - a. Maximum Liner Temperature
  - b. Decrease of Liner Service Temperature Due to Service

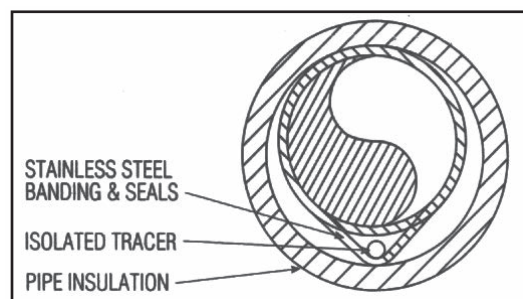
### Application (per Chemical Resistance Guide)

1. Insulation Type
2. Insulation Thickness
3. Temperature to be Maintained
4. Ambient Conditions
  - a. High and Low Temperatures
  - b. Wind Speed

### Steam Tracing : Special Design Considerations

1. Steam Pressure and Temperature
2. Since useful steam temperatures are above the recommended temperature for PP, a specially designed isolated tracking system must be designed to limit the tracer temperature to prevent overheating of the liner.
3. Advantages
  - a. Often available as surplus in plant operations
  - b. Good for heat up and temperature maintenance
  - c. Can be used in explosive risk areas
4. Disadvantages
  - a. Temperature range: 200 °F (93 °C) - 350 °F (177 °C)
  - b. Temperature control difficult
  - c. High installation and day-to-day maintenance

### Recommended steam tracing technique



## Insulation and Venting

Plastic-lined pipe is often insulated to prevent freezing, save energy or maintain a certain process temperature. Some operating experience has shown that heat tracing and insulating can also reduce permeation rates by lowering the temperature differential across the pipe wall.

If installed improperly, however, insulation may block the paths for venting permeants on most PTFE-lined components. Under conditions which favor high permeation rates, blockage of the vent path can lead to high exterior steel shell corrosion rates, liner collapse and ultimately to premature failure of the lined components.

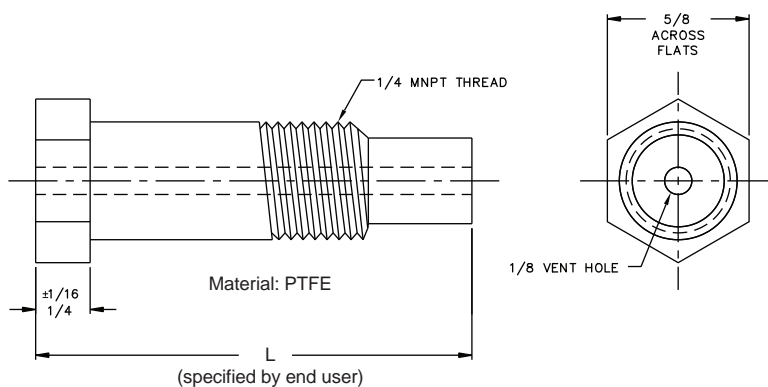
Swaged PTFE-lined pipe spools are designed to vent at the flange. Spiral grooves on the interior of the steel shell transport permeated vapors to the flange area, whereby they exit the annulus along a patented vent collar.

When insulating swaged PTFE-lined pipe spools and flange connections, care must be taken to extend the vent path through the insulation. One simple way is to drill a hole through the bottom of the insulation and insert a piece of 1/4" flexible tubing into a position between the flanges. This is shown in Illustration A.

THERMALOK® PTFE-lined pipe and PTFE-lined fittings are vented via vent holes in the pipe, casting or fabricated steel shell. Welded half couplings and vent extenders can be used to extend the vent path through insulation on pipe or around fittings, as shown in Illustration B & C. Couplings are available as 3000lb. 1/8" or 1/4" sizes.

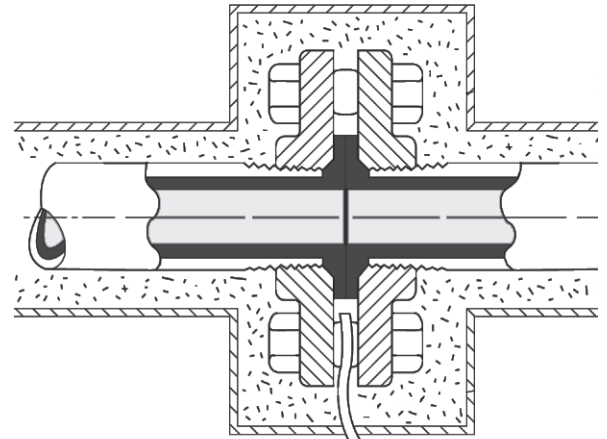
Vent extenders can be metal or plastic. A PTFE hex plug design is increasingly being specified for insulated and uninsulated services. The end of the plug seats on the pipe OD concentric with the vent hole, providing a corrosion-resistant path for venting.

Example is shown below:

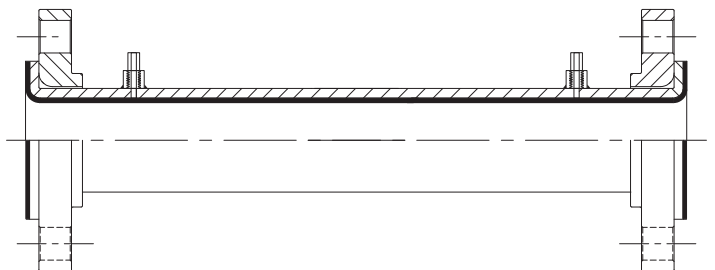


Venting Resistoflex plastic-lined pipe with Swaged pipe

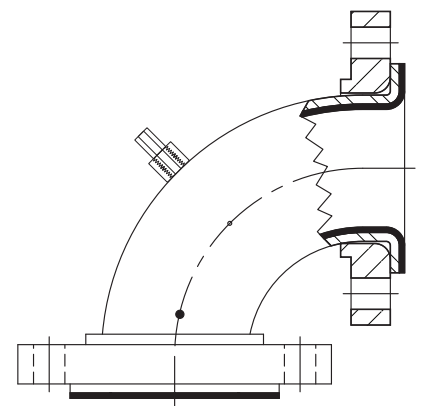
A. Vent extender at insulated pipe joint



B. Vent holes and couplings on THERMALOK® pipe



C. Vent extender for fittings



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Per the Pressure Equipment Directive 97/23/EC Essential Safety Requirements Annex I Checklist, the following Essential Requirements are within the customer scope for all products: Wind, Earthquake, Reaction forces and Moments, Fire, Safety devices, permeation, temperature and pressure spikes. For all products, it is recommended that customer remove representative sample for examination of internal corrosion every 2 years.

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