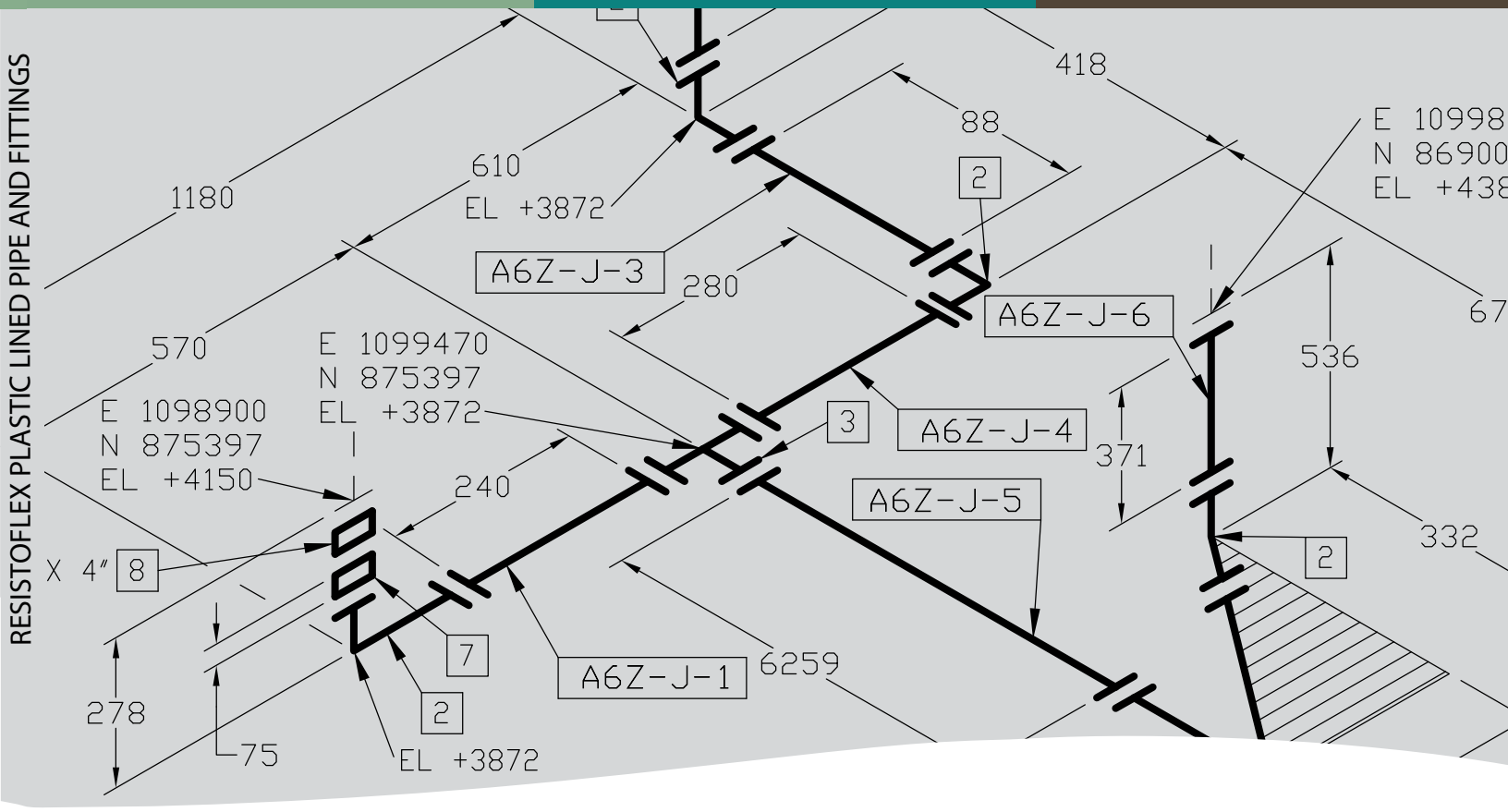
RESISTOFLEX®

Design Manual 2013



Plastic Lined Pipe and Fittings

CRANE

www.cranechempharma.com
www.craneenergy.com






Crane Co. is a diversified manufacturer of highly engineered industrial products with a substantial presence in a number of focused niche markets. With approximately 10,000 employees working together in five business segments across 25 countries, Crane generated 2011 net sales of $2.5 billion.

Resistoflex®, a CRANE ChemPharma business wihthin 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 MANUFACTURING PLANT
IN MARION, USA320,000 SQ

SUZHOU, CHINA
60,000 SQ FT

SINGAPORE
10,000 SQFT

About CRANE

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.

RESISTOFLEX

Resistoflex® offers corrosion-resistant plastic lined pipe, fittings, and Teflon® lined chemical hoses.

ResistoPure™ is a brand of products offered by Resistoflex for the Biotech, Pharmaceutical, Food & Beverage, and Cosmetics industries.

® Teflon is a registered trademark of E. I. du Pont de Nemours Company

www.cranechempharma.com
www.craneenergy.com

Table of Contents

Terminology & Standards

LINER MATERIALS

PTFE	Polytetrafluoroethylene, manufactured by DuPont under the trade name Teflon®, is the only PTFE used by Resistoflex.
PFA	Perfluoroalkoxy, manufactured by DuPont under the trade name of Teflon®.
PVDF	Polyvinylidene Fluoride, manufactured by Arkema under the name Kynar® and Kynar Flex®
PP	Polypropylene
FEP	Perfluoro (Ethylene - Propylene) Copolymer
ETFE	Ethylenetetrafluoroethylene, manufactured by DuPont under the trade name Tefzel®, is the only ETFE used by Resistoflex

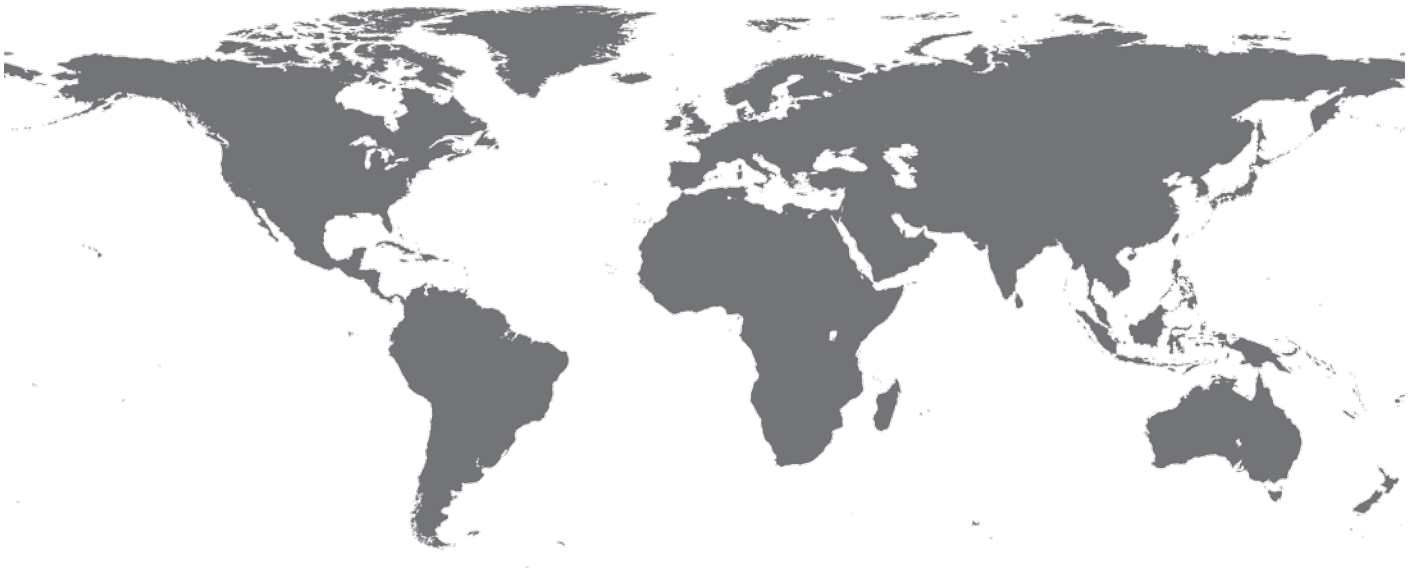
INDUSTRY STANDARDS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASTM F1545	Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges Resistoflex fully complies with ASTM F1545, including all qualification testing on representative pipe/fittings. This qualification testing includes high/low temperature aging, steam/cold water temperature cycling, and vacuum testing. All finished lined piping components are electrostatically tested at 18 KV. Hydrostatic testing is available on request, at an additional charge.
A395	ASTM standard pertaining to ferritic ductile iron for flanges and fittings.
A105	ASTM standard pertaining to forged steel used for flanges
A216	ASTM standard pertaining to cast steel (grade WCB)
A587	ASTM standard pertaining to electric-resistance-welded low-carbon steel pipe for use as process lines in chemical industries.
A53	ASTM standard pertaining to steel pipe, seamless or welded.
A513	ASTM standard pertaining to electric-resistance-welded carbon and alloy steel mechanical tubing

INDUSTRY STANDARD LINER COLORATION

PTFE	White
PVDF	Black
PP	Orange or milky white
FEP	Natural - clear
PFA	Natural - off white
ETFE	Natural - shiny, milky white

Global Support



Crane Resistoflex has a well-established network of distributors and ChemPharma 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 sales offices in the Americas, Europe, Asia, Australia, and the Middle East.

Our distributors are not just order takers. Many of them share over 40 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 sales office, visit www.cranechempharma.com or contact our Customer Service Center at (828) 724-4000.

The Thermalok® Process

Resistoflex Thermalok steel pipe and PTFE liner act as one integral piece. Combining dissimilar materials with very different coefficients of thermal expansion, our precision Thermalok Process locks the isostatically molded PTFE liner into the pipe housing, making it full vacuum rated from -20°F to 450°F. 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.

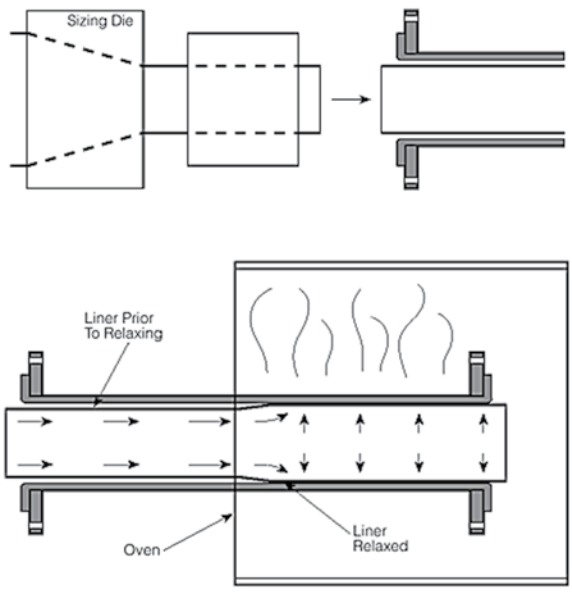
The Thermalok process positively locks the plastic liner in the metal pipe housing while effectively relieving stresses that could cause unwanted liner movement in service.

Thermalok Process

- Incoming lots of resin are analyzed in our Quality Assurance laboratory for conformance to established raw material specifications.
- The liner is processed 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 PTFE 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 oustide 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 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[1] with the following features:

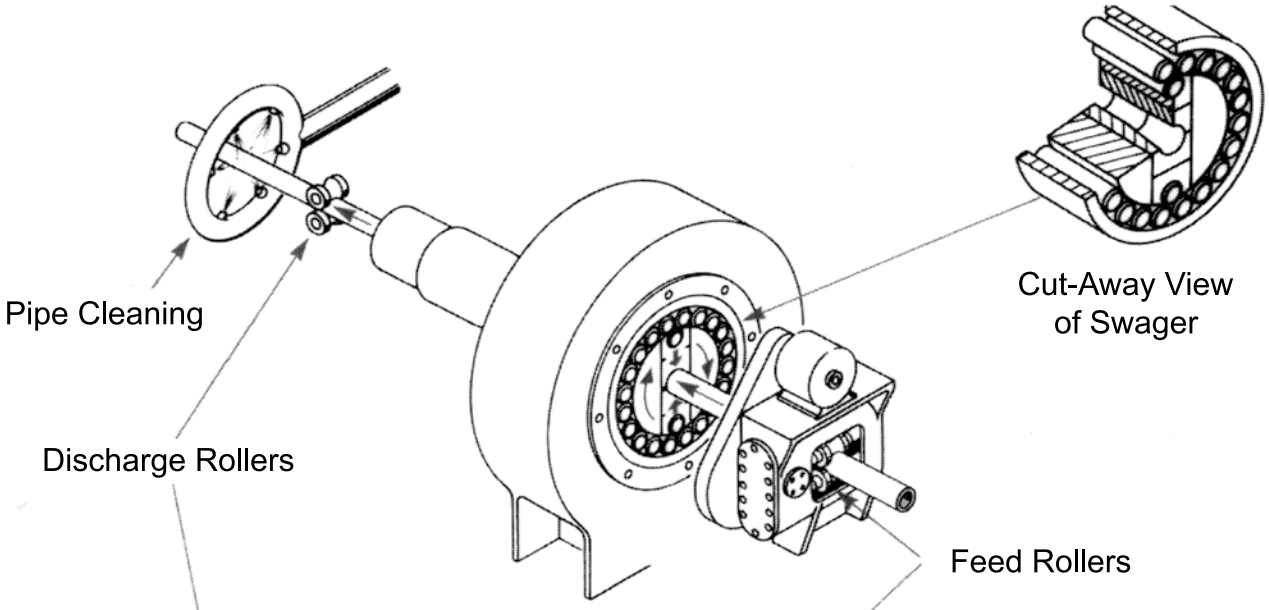
- Resistoflex manufactures Field Flare pipe utilizing the the same Thermalok Process as factory-finished pipe, but the process is modified to result in a movable liner.
- The liner can be removed from the pipe, allowing the fabricator a wide variety of flange options, including the Resistoflex field 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.
- Housings are available in CS or SS.

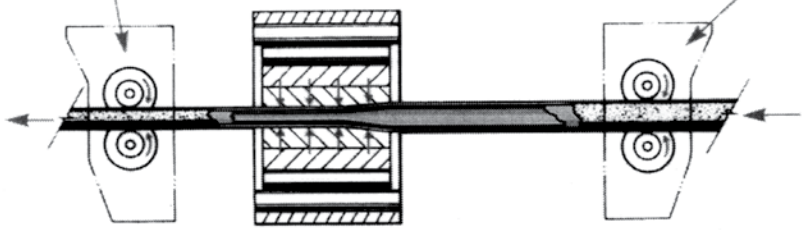
1 - Special fabrication tooling and training required.

The Swaging Process

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

Abbey Etna has built what is probably the largest swager of its type— The 916 machine designed to accommodate 8" O.D. pipe. It is used by Resistoflex at its Bay City, Michigan plant to reduce pipe around a plastic liner. The largest lined pipe, until this machine was developed, was 6".





Cross-Section
of Swager

SPECIFICATIONS:

Overall Height	116"
Horsepower	75
Tube Capacity	8"
Roll Diameter	4.8"
Number of Rolls	20
RPM	120
Blows Per Minute	2400

Standard Materials Specifications

Pipe and fittings manufactured by Resistoflex are in full compliance with:

ASTM F1545, 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 housings and flanges
- Resistoflex meets or exceeds minimum dimensional requirements
- Resistoflex meets qualification testing requirements, including steam/cold water, temperature aging, and vacuum testing
- Resistoflex performs 30KV electrostatic test on 100% of finished product. Hydrostatic test is available on request.

Resistoflex products also meet the following specifications/requirements:

Liners:	PTFE — Polytetrafluoroethylene, ASTM D4894 and D4895 PFA — Perfluoroalkoxy, ASTM D3307 PVDF — Polyvinylidene Fluoride, ASTM D3222 and D5575 PP — Polypropylene, ASTM D4101
Pipe:	*Thermalok (Carbon Steel):* 1" through 4" size, Sch. 40 Carbon Steel per ASTM A53 ERW, Grade B Type E or A587 Sch. 40 ERW 6" - 8" size, Sch. 40 Carbon Steel per ASTM A53 ERW, Grade B Type E 10" size = Sch. 30 Carbon Steel per ASTM A53 ERW, Grade B Type E 12" size = Sch. 20 Carbon Steel per ASTM A53 ERW, Grade B Type E *Thermalok (Stainless Steel) 304LSS or 316LSS:* 1" through 8" size, Sch. 40 Stainless Steel per ASTM A312 Sch. 40 ERW 10" size = Sch. 30 Stainless Steel per ASTM A312 Sch. 40 ERW 12" size = Sch. 20 Stainless Steel per ASTM A312 Sch. 40 ERW *Swaged:* 1" through 6" size, Sch. 40 Carbon Steel per ASTM A513 ERW 8" size, Sch. 30 Carbon Steel per ASTM A513 ERW
Flanges:	Lap-joint, 1" through 12" size, Ductile Iron ASTM A395, dimensions per ANSI B16.42 Class 150 Lap-joint, 1" through 12" size, Forged Carbon Steel, ASTM A105, dimensions per ANSI B16.5 Class 150 Lap-joint, 1" through 12" size, Forged Stainless Steel, ASTM A182, dimensions per ANSI B16.5 Class 150 Threaded (for Swaged pipe), 1" - 8" size, Forged Steel ASTM A105, dimensions per ANSI B16.5 Class 150 Note: Standard flange configuration for Thermalok pipe spools and most fabricated fittings is rotating lap joint. The lap is a "flared" lap. Fixed flanges are available, including slip-on and welding neck.
Fittings:	Fabricated Carbon Steel: Components per ASTM A587, ASTM A53 and/or ASTM A234 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. Fittings flanges are rotating lap joint or fixed as specified in the Design Guide. Standard fittings dimensions per ANSI B16.5 Class 150.
Fabrication:	Pipe and Fittings Tolerances:

Dimension	**Tolerance, in.**
Length and Centerline Dimensions	± 1/8"
Fixed Flange Bolt Hole Alignment	± 1/16"
Flange Perpendicularity (with Pipe Centerline)	3/32 in/ft of nom. pipe diameter

Standard and Custom Coatings

Standard Coating

All pipe and fittings are coated with a high-solids polyamide epoxy primer. Color is gray. Surface preparation is SSPC-SP5 White Metal Blast.

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 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:	Polyamide Epoxy
International Coatings Interthane 990:	Acrylic 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.

High Performance System No.	Application	Paint System Description	Supplier	Designation	DFT, mils (µm)	Color
S1	Above ground Indoor < 250° F Ease of recoat Not insulated	Primer: Organic zinc-rich epoxy per SSPC Paint 20 Topcoat: Polyamide epoxy	International Coatings International Coatings	Interzinc 52 Intergard 345	2 - 3 (50 - 75) 4 - 6 (100 - 150)	Green Custom
S2	Above ground Outdoor < 250° F Not insulated Resists UV Fading	Primer: Organic zinc-rich epoxy per SSPC Paint 20 Topcoat: Acrylic Polyurethane	International Coatings International Coatings	Interzinc 52 Interthane 990	2 - 3 (50 - 75) 2 - 3 (50 - 75)	Green Custom
S3	Above ground Outdoor < 250° F Not insulated Resists UV Fading Corrosion Resistance	Primer: Organic zinc-rich epoxy per SSPC Paint 20 Intermediate Coat: Polyamide epoxy Topcoat: Acrylic Polyurethane	International Coatings International Coatings International Coatings	Interzinc 52 Intergard 345 Interthane 990	2 - 3 (50 - 75) 4 - 6 (100 - 150) 2 - 3 (50 - 75)	Green Gray Custom
S4	Special Applications Insulated Pipe Wet/dry to 450°F , or Acid/alkali splash	Topcoat: Glass Flake-Filled Amine-Cured Epoxy Novalac Topcoat: Glass Flake-Filled Amine-Cured Epoxy Novalac	Carboline Carboline	Thermaline 450 Thermaline 450	4 - 5 (100 - 125) 4 - 5 (100 - 125)	Red or Gray

Note: Other customer-specified coatings are available. 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 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.

Flange Dimensions

Flange Dimensions, in. (nominal)								
Size (NPS)	Class 150				Class 300			
	OD	Thickness	(No.) and Dia. of Bolt Holes	Bolt Circle Diameter	OD	Thickness	(No.) and Dia. of Bolt Holes	Bolt Circle Diameter
.5	3 1/2	7/16	(4) 5/8	2 3/8	3 3/4	9/16	(4) 5/8	2 5/8
.75	3 7/8	1/2	(4) 5/8	2 3/4	4 5/8	5/8	(4) 3/4	3 1/4
1	4 1/4	9/16	(4) 5/8	3 1/8	4 7/8	11/16	(4) 3/4	3 1/2
1.5	5	11/16	(4) 5/8	3 7/8	6 1/8	13/16	(4) 7/8	4 1/2
2	6	3/4	(4) 3/4	4 3/4	6 1/2	7/8	(8) 3/4	5
2.5	7	7/8	(4) 3/4	5 1/2	7 1/2	1	(8) 7/8	5 7/8
3	7 1/2	15/16	(4) 3/4	6	8 1/4	1 1/8	(8) 7/8	6 5/8
4	9	15/16	(8) 3/4	7 1/2	10	1 1/4	(8) 7/8	7 7/8
6	11	1	(8) 7/8	9 1/2	12 1/2	1 7/16	(12) 7/8	10 5/8
8	13 1/2	1 1/8	(8) 7/8	11 3/4	15	1 5/8	(12) 1	13
10	16	1 3/16	(12) 1	14 1/4	17 1/2	1 7/8	(16) 1 1/8	15 1/4
12	19	1 1/4	(12) 1	17	20 1/2	2	(16) 1 1/4	17 3/4

Pipe Dimensions

Pipe Dimensions, in. (nominal)				
Size (NPS)	OD	Wall Thickness		
		Sch. 40	Sch. 30	Sch. 20
.5	0.840	0.109		
.75	1.050	0.113		
1	1.315	0.133		
1.5	1.900	0.145		
2	2.375	0.154	--	
2.5	2.875	0.203		--
3	3.500	0.216		
4	4.500	0.237		
6	6.625	0.280		
8	8.625	0.322	0.277	
10	10.750	--	0.307	
12	12.750		0.330	0.250

Plastic-Liner Data

Liner Characteristics	PTFE	PFA	PP	PVDF (homopolymer)	PVDF (copolymer)	ETFE
Service Temperature Range, °F[1]	-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[3]	Black[3]	Black[3]	Natural
Color of Liner Identification Band	White with Black Lettering[2]	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	5.5×10^{-5}	7.8×10^{-5}	4.8×10^{-5}	6.6×10^{-5}	7.8×10^{-5}	7.4×10^{-5}
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 PP = polypropylene ETFE = ethylene tetrafluoroethylene
PFA = perfluoroalkoxy PVDF = polyvinylidene fluoride

[1]Max. allowable temperature depend on the specific contact chemicals. Refer to the Chemical Resistance guide on page 227.
[2]10" - 12" non-vacuum pipe and fittings band is red with black letters.
[3]Available unpigmented as a special option.

Pressure and Vacuum Capabilities of Lined Pipe & Fittings

The pressure/temperature ratings of 1" to 12" RESISTOFLEX Plastic-Lined Piping Products conform to standard ANSI codes and specifications per the appropriate flange metallurgy. See Figure 1. The pressure/temperature ratings for lined piping with ANSI B16.5 Class 300 flanges are adjusted to account for plastic raised faces on pipe and fittings, and are lower than actual ANSI B16.5 Class 300 pressure/temperature ratings.

PVDF (1" - 8") and PP (1" - 12") pipe and fittings have been full vacuum rated at their maximum service temperature and can be used at full vacuum within their operating temperature ranges. Standard 1" - 12" PTFE pipe and fittings are available to provide full vacuum / 450°F performance, in general. However, a few fittings are not rated to full vacuum / 450°F. Actual vacuum ratings are shown on the individual fittings dimensional pages in this manual.

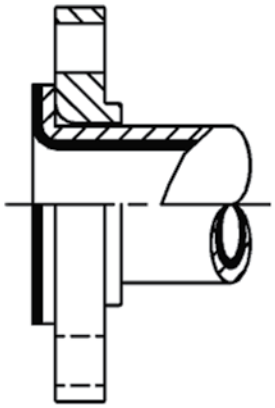
Figure 1: Working pressures for Resistoflex plastic-lined pipe and fittings

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)	285	(19.7)	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)
350	(177)	207	(14.3)	215	(14.8)	167	(11.5)	440	(30.3)
400	(204)	200	(13.8)	200	(13.8)	160	(11)	425	(29.3)
450	(232)	185	(12.8)	185	(12.8)	155	(10.7)	405	(27.9)

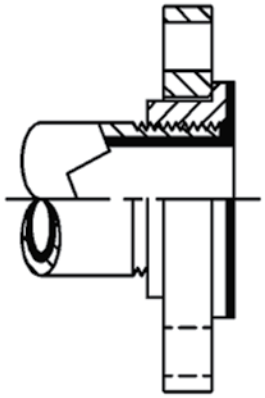
* Pipe and fittings with Class 300 flanges cannot operate at the full ANSI B16.5 Class 300 pressure ratings, as the plastic flares acting as the gasket sealing faces are the limiting factor.

Maximum service temperatures may be reduced by the chemical being handled. Please contact our Technical Service Department at 828-724-4000 for more information.

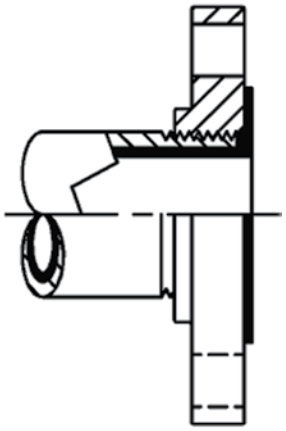
Pipe Spool Dimensions
PTFE / Polypropylene / PVDF / PFA-Lined



Van Stone Flange
(Thermalok)



Threaded Rotatable
Flange (Swaged)



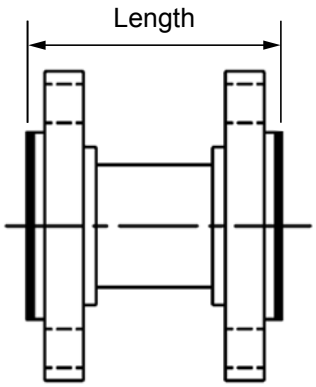
Threaded Chamfered
Flange (Swaged)

Thermalok Pipe					
Size (NPS)	Nominal Liner Thickness (in.)				Max. Length (ft.)
	PTFE	PFA	PP	PVDF	
1/2	0.054	N/A			10
3/4	0.062				10
1	0.130	0.113	0.135	0.125	20
1.5	0.150	0.114	0.160	0.125	20
2	0.155	0.114	0.175	0.125	20
3	0.155	0.130	0.175	0.125	20
4	0.160	0.150	0.210	0.145	20
6	0.255	0.145*	0.220	0.160	20
8	0.310	N/A	0.220	0.185	20
10	0.350	N/A	0.320	0.220	PTFE - 15 PP/PVDF - 20
12	0.450		0.380	N/A	PTFE - 15 PP - 20

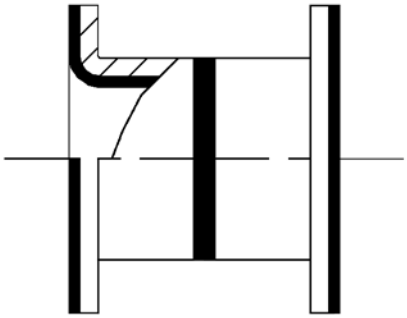
Swaged Pipe							
Size (NPS)	Nominal Liner Thickness (in.)			Max. Length (ft.)			
	PTFE	PFA	PP/PVDF	PTFE	PFA	PP	PVDF
1	0.130	0.113	0.150	20	20	20	20
1.5	0.130	0.114	0.160	40	40	40	40
2	0.130	0.114	0.172	40	40	40	40
3	0.130	0.130	0.175	40	20	40	40
4	0.160	0.150	0.207	40	20	40	40
6	0.225	N/A	0.218	20	N/A	40	40
8	0.300		0.218	20		20	20

Thermalok Pipe Housings Available in Stainless Steel and Other Alloys. Swaged pipe is available in carbon steel, only.
* 6" PFA-lined pipe is non-vacuum rated.

Minimum Flanged Pipe Spool Lengths



Distance Piece



For filling spaces greater in length than the maximum spacer (3") but less than the minimum flanged pipe spool, a distance piece is used. A distance piece does not have flanges, but is held in place by using long bolts or studs between the adjacent flanges.

Swaged Minimum Pipe Spool Lengths in Inches					
Size (NPS)	Standard		Special[1]		Field[2]
	Class 150	Class 300	Class 150	Class 300	
1	4	4	2 1/2	2 1/2	7
1 1/2	4	4	2 3/4	2 3/4	7
2	4 1/2	4 1/2	3 1/8	3 1/8	7
3	5	5	3 1/2	3 1/2	8
4	5 1/2	5 1/2	3 3/4	3 3/4	8
6	5 1/2	5 1/2	4 1/8	4 1/8	10
8	7	7	4 1/2	4 1/2	12

Thermalok Minimum Pipe Spool Length in inches[3]					Class 150
Size (NPS)	No Options		With Vent Couplings or Grounding Studs		Field Flare [4]
	Class 150	Class 300	Class 150	Class 300	
1/2	3	3 1/4	3 7/8	4 3/8	N/A
3/4	3	3 3/8	3 7/8	4 1/2	N/A
1	3	3 5/8	4 1/8	4 7/8	5 1/2
1 1/2	3 3/8	4	4 5/8	5 1/8	7
2	3 1/2	4 1/4	4 7/8	5 1/2	8
3	4	5 1/8	5 3/8	6 3/8	10 5/8
4	4 3/8	5 1/2	5 5/8	6 3/4	11
6	5 1/2	6 3/8	6 1/2	7 1/2	16 1/2
8	6 1/2	7 1/2	7	8 3/8	16 1/2
10	8 1/2	9 7/8	8 1/2	11	Consult Factory
12 (PTFE, PP, only)	8 1/2	10 3/8	8 1/2	11 5/8	Consult Factory

[1] Available only as fixed flange spools.
[2] Capability of field threaders, such as Wheeler Rex or equal, 8" size requires alternate method of threading.

Wheeler Rex will only thread up through 6". Minimum spool lengths for flange one end piping is 3 ft. when using a Wheeler Rex machine.

[3] Thermalok minimum lengths can be reduced by using fixed flanges at one or both ends at an additional cost.

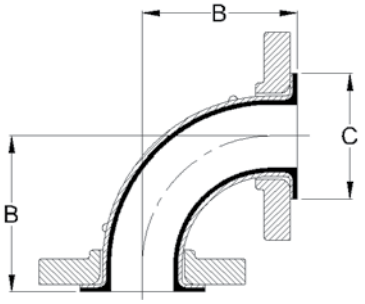
[4] When using a pipe end forming machine such as a Conrac by PHI. Min. length assumes no welding of stubends. Consult factory for details.

90° Elbows
PTFE-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105
CAST STEEL = ASTM A216
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum



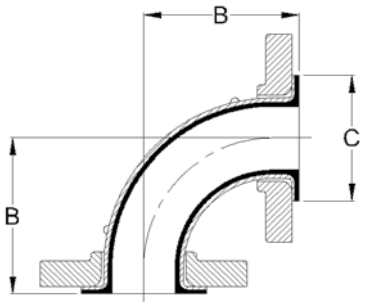
150lb. Flanged							
Size	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		B	C		Material	R = Rotating F = Fixed	
1	E900M3VV0V100	3 1/2	2	FAB STEEL	DI	R	FV/450
	E900M3ZZ0V100				CS		
1.5	E900M3VV0VB00	4	2 7/8		DI		
	E900M3ZZ0VB00				CS		
2	E900M3VV0V200	4 1/2	3 5/8		DI		
	E900M3ZZ0V200				CS		
3	E900M3VV0V300	5 1/2	5		DI		
	E900M3ZZ0V300				CS		
4	E900M3VV0V400	6 1/2	6 3/16		DI		
	E900M3ZZ0V400				CS		
6	E900M1VV0N600	8	8 1/2	DI	DI	F	
	E900M3ZZ0V600			FAB STEEL	CS	R	
	E900M3VV0V600			FAB STEEL	DI	R	
8	E900M1VV0N800	9	10 5/8	DI	DI	F	
	E900M3ZZ0V800			FAB STEEL	CS	R	
	E900M3VV0V800			FAB STEEL	DI	R	
10	E900M1VV0NE00	11	12 3/4	DI	DI	F	
	E900M3ZZ0VE00			FAB STEEL	CS	R	
	E900M3VV0VE00			FAB STEEL	DI	R	
12	E900M1VV0NF00	12	15	DI	DI	F	
	E900M2ZZ0NF00			CAST STEEL	CAST STEEL		

90° Elbows
PTFE-Lined

Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105

FV = Full Vacuum

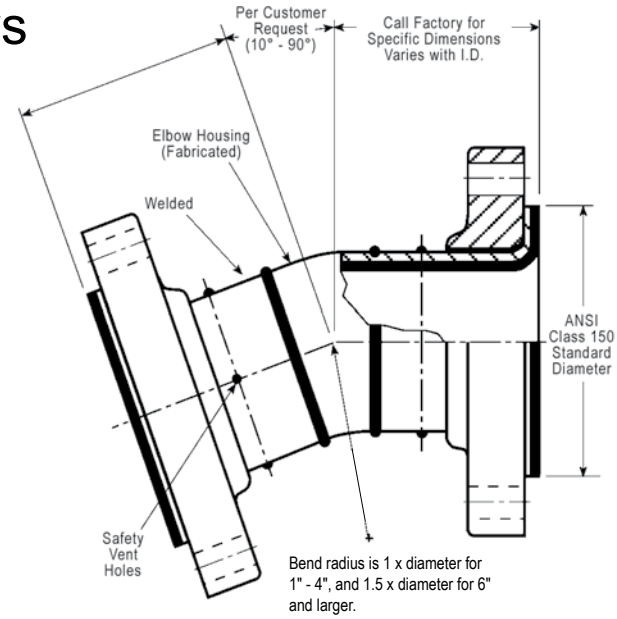


300lb. Flanged - Fab Steel Body Only							
Size (NPS)	Part Numbers	Dimension (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/°F)
		B	C		Material	R = Rotating F = Fixed	
1	R6390YY-016	4	2	FAB STEEL	CS	R	FV/450
	E900M3YY0V100	3 1/2					
1.5	R6390YY-024	4 1/2	2 7/8				
	E900M3YY0VB00	4					
2	R6390YY-032	5	3 5/8				
	E900M3YY0V200	4 1/2					
3	R6390YY-048	6	5				
	E900M3YY0V300	5 1/2					
4	R6390YY-064	7	6 3/16				
	E900M3YY0V400	6 1/2					
6	R6390YY-096	8 1/2	8 1/2				
	E900M3YY0V600	8					
8	E900MAYY0V800	10	10 5/8				

Fabricated Special Angle Elbows
Lined with PTFE or ETFE (Tefzel®)

Resistoflex can provide special angle elbows in various sizes and many configurations. These are custom fabrications to accommodate non-standard applications that may occur in piping design. When need for a special angle elbow arises, a rough sketch or description giving the pipe size, angle required and desired face-to-centerline dimension should be submitted to the Resistoflex factory. Fabricated Special Angle Elbows are not rated for vacuum service.

As a guide, when centerline to face dimensions are not provided, special angle elbows less than 45° have standard 45° elbow centerline to face dimensions. Special angle elbows greater than 45° have standard 90° centerline to face dimensions. Dimensions are for correspoinding sizes.



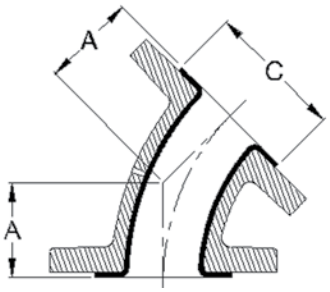
Tefzel® is a trademark of Dupont.

45° Elbows
PTFE-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105
CAST STEEL = ASTM A216
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum
*This part number is special order



150lb. Flanged							
Size (NPS)	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/°F)
		A	C		Material	R = Rotating F = Fixed	
1	*E500M3VV0V100	1 3/4	2	FAB STEEL	DI	R	FV/450
	E500M1VV0N100			DI	DI	F	
	E500M3ZZ0S100			FAB STEEL	CS		
1.5	E500M1VV0NB00	2 1/4	2 7/8	DI	DI	F	
	E500M3ZZ0VB00			FAB STEEL	CS	R	
2	E500M3VV0V200	2 1/2	3 5/8	FAB STEEL	DI	R	
	E500M3ZZ0V200				CS		
3	E500M3VV0V300	3	5		DI		
	E500M3ZZ0V300				CS		
4	E500M3VV0V400	4	6 3/16		DI		
	E500M3ZZ0V400				CS		
6	E500M1VV0N600	5	8 1/2	DI	DI	F	
	E500M3ZZ0V600			FAB STEEL	CS	R	
	E500M3VV0V600			FAB STEEL	DI	R	
8	E500M1VV0N800	5 1/2	10 5/8	DI	DI	F	
	E500M3ZZ0S800			FAB STEEL	CS	F	
	E500M3VV0V800			FAB STEEL	DI	R	
10	E500M1VV0NE00	6 1/2	12 3/4	DI	DI	F	
	E500M3ZZ0VE00			FAB STEEL	CS	R	
	E500M3VV0V800			FAB STEEL	DI	R	
12	E500M1VV0NF00	7 1/2	15	DI	DI	F	
	E500M3ZZ0VF00			FAB STEEL	CS	R	

300lb. Flanged							
Size (NPS)	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		A	C		Material	R = Rotating F = Fixed	
1	E500MAYY0V100	2 1/4	2	FAB STEEL	CS	F	FV/450
1.5	E500MAYY0VB00	2 3/4	2 7/8			R	
2	E500MAYY0V200	3	3 5/8				
3	E500MAYY0V300	3 1/2	5				
4	E500MAYY0V400	4 1/2	6 3/16				
6	E500MAYY0V600	5 1/2	8 1/2				
8	E500MAYY0V800	6	10 5/8				

Equal Tees
PTFE-Lined

Housing Materials

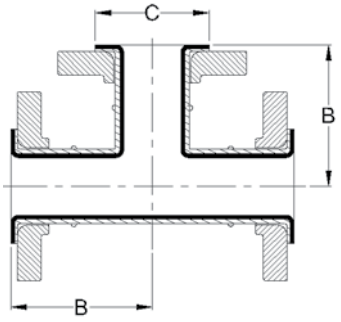
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials

CS = ASTM A105

DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

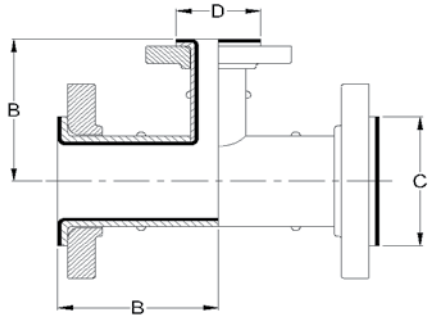


150lb. Flanged							
Size (NPS)	Part Number	Dimension (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		B	C		Material	R = Rotating F = Fixed	
1	TN00M3VVVV100	3 1/2	2	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV100				CS		
1.5	TN00M3VVVVB00	4	2 7/8	FAB STEEL	DI	R	FV/450
	TN00M3ZZZVB00				CS		
2	TN00M3VVVV200	4 1/2	3 5/8	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV200				CS		
3	TN00M3VVVV300	5 1/2	5	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV300				CS		
4	TN00M3VVVV400	6 1/2	6 3/16	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV400				CS		
6	TN00M3VVVV600	8	8 1/2	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV600				CS		
8	TN00M3VVVV800	9	10 5/8	FAB STEEL	DI	R	FV/450
	TN00M3ZZZV800				CS		FV/375
10	TN00M3VVVVE00	11	12 3/4	FAB STEEL	DI	R	FV/450
	TN00M3ZZZVE00				CS		
12	TN00M3VVVVF00	12	15	FAB STEEL	DI	R	FV/375
	TN00M3ZZZVF00				CS		

300lb. Flanged - Fab Steel Body Only							
Size (NPS)	Part Number	Dimension (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/°F)
		B	C		Material	R = Rotating F = Fixed	
1	TN00M3YYYV100	3 1/2	2	FAB STEEL	CS	R	FV/450
1.5	TN00M3YYYVB00	4	2 7/8				
2	TN00M3YYYV200	4 1/2	3 5/8				
3	TN00M3YYYV300	5 1/2	5				
4	TN00M3YYYV400	6 1/2	6 3/16				
6	TN00M3YYYV600	8	8 1/2				
8	TN00MAYYYV800	10	10 5/8				

300 lb. flanged tees have ANSI 150 center-face dimensions, except 8" size which has ANSI 300 dimensions.

Reducing Tees
PTFE-Lined



Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105 DI = ASTM A395 Cast Ductile Iron FV = Full Vacuum

150lb. Flanged									
Major Size (NPS)	Minor Size (NPS)	Part Numbers	Dimensions (in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
			B	C	D		Material	R=Rotating F=Fixed	
1.5	1	TR00M3VVVVB10	4	2 7/8	2	FAB STEEL	DI	R	FV/450
		TR00M3ZZZVB10					CS		
2	1	TR00M3VVVV210	4 1/2	3 5/8	2		DI		
		TR00M3ZZZV210					CS		
	1.5	TR00M3VVVV2B0			2 7/8		DI		
		TR00M3ZZZV2B0					CS		
3	1	TR00M3VVVV310	5 1/2	5	2		DI		
		TR00M3ZZZV310					CS		
	1.5	TR00M3VVVV3B0			2 7/8		DI		
		TR00M3ZZZV3B0					CS		
	2	TR00M3VVVV320			3 5/8		DI		
		TR00M3ZZZV320					CS		
4	1	TR00M3ZZZR410	6 1/2	6 3/16	2		CS		FV/325
	1.5	TR00M3VVVV4B0			2 7/8		DI		FV/450
		TR00M3ZZZV4B0					CS		FV/325
	2	TR00M3VVVV420			3 5/8		DI		FV/450
		TR00M3ZZZV420					CS		FV/325
	3	TR00M3VVVV430			5		DI		FV/450
		TR00M3ZZZV430					CS		FV/325
6	2	TR00M3VVVV620	8	8 1/2	3 5/8		DI		FV/450
		TR00M3ZZZV620					CS		23/200
	3	TR00M3VVVV630			5		DI		FV/450
		TR00M3ZZZV630					CS		23/200
	4	TR00M3VVVV640			6 3/16		DI		FV/450
		TR00M3ZZZV640					CS		23/200
8	3	TR00M3VVVV830	9	10 5/8	5		DI		FV/450
		TR00M3ZZZV830					CS		
	4	TR00M3VVVV840			6 3/16		DI		
		TR00M3ZZZV840					CS		FV/150
	6	TR00M3VVVV860			8 1/2		DI		FV/450
		TR00M3ZZZV860					CS		FV/150
10	6	TR00M3VVVVE60	11	12 3/4	8 1/2		DI		FV/450
		TR00M3ZZZVE60					CS		
	8	TR00M3VVVVE80			10 5/8		DI		
		TR00M3ZZZVE80					CS		
12	4	TR00M3VVVVF40	12	15	6 3/16	FAB STEEL	DI	R	FV/375
		TR00M3ZZZVF40					CS		
	6	TR00M3VVVVF60			8 1/2		DI		
		TR00M3ZZZVF60					CS		
	8	TR00M3VVVVF80			10 5/8		DI		
		TR00M3ZZZZF80					CS		
	10	TR00M3VVVVFE0			12 3/4		DI		
		TR00M3ZZZVFE0					CS		

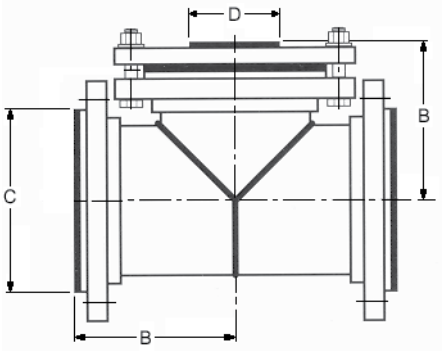
Reducing Tees
PTFE-Lined

300lb. Flanged - Fab Steel Body Only									
Major Size (NPS)	Minor Size (NPS)	Part Number	Dimensions (in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
			B	C	D		Material	R = Rotating F = Fixed	
1.5	1	TR00M3YYYVB10	4	2 7/8	2	FAB STEEL	CS	R	FV/450
2	1	TR00M3YYYV210	4 1/2	3 5/8	2				
	1.5	TR00M3YYYV2B0			2 7/8				
3	1	TR00M3YYYV310	5 1/2	5	2				
	1.5	TR00M3YYYV3B0			2 7/8				
	2	TR00M3YYYV320			3 5/8				
4	1.5	TR00M3YYYV4B0	6 1/2	6 3/16	2 7/8				FV/325
	2	TR00M3YYYV420			3 5/8				
	3	TR00M3YYYV430			5				
6	2	TR00M3YYYV620	8	8 1/2	3 5/8				23/200
	3	TR00M3YYYV630			5				
	4	TR00M3YYYV640			6 3/16				
8	3	TR00M3YYYV830	9	10 5/8	5				FV/450
	4	TR00M3YYYV840			6 3/16				
	6	TR00M3YYYV860			8 1/2				

300 lb. flanged reducing tees have ANSI 150 center-face dimensions.

Fabricated Two-Piece Reducing Tees
PTFE-Lined

Construction is an equal tee with a shortened stack and a reducing filler flange bolted together



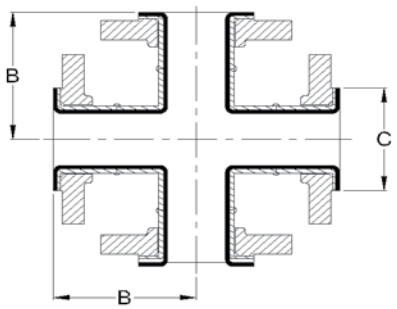
150lb. Flanged									
Major Size (NPS)	Minor Size (NPS)	Part Number	Dimensions (in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
			B	C	D		Material	R = Rotating F = Fixed	
6	1	TR00M3VVVV610	8	8	2	FAB STEEL	CS	R	FV/450
	1 1/2	TR00M3VVVV6B0			2 7/8				
8	1	TR00M3VVVV810	9	10 1/4	2				
	1 1/2	TR00M3VVVV8B0			2 7/8				
	2	TR00M3VVVV820			3 5/8				
10	1	TR00M3VVVVE10	11	12 3/4	2				
	1 1/2	TR00M3VVVVEB0			2 7/8				
	2	TR00M3VVVVE20			3 5/8				
	3	TR00M3VVVVE30			5				
	4	TR00M3VVVVE40			6 3/16				
12	1	TR00M3VVVVF10	12	15	2				
	1 1/2	TR00M3VVVVFB0			2 7/8				
	2	TR00M3VVVVF20			3 5/8				
	3	TR00M3VVVVF30			5				

Crosses
PTFE-Lined

Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum



150lb. Flanged							
Size (NPS)	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		B	C		Material	R = Rotating F = Fixed	
1	CN00M3VVVV100	3 1/2	2	FAB STEEL	DI	R	FV/450
	CN00M3ZZZV100				CS		
1.5	CN00M3VVVVB00	4	2 7/8		DI		
	CN00M3ZZZVB00				CS		
2	CN00M3VVVV200	4 1/2	3 5/8		DI		
	CN00M3ZZZV200				CS		
3	CN00M3VVVV300	5 1/2	5		DI		
	CN00M3ZZZV300				CS		
4	CN00M3VVVV400	6 1/2	6 3/16		DI		
	CN00M3ZZZV400				CS		
6	CN00M3VVVV600	8	8 1/2		DI		
	CN00M3ZZZV600				CS		
8	CN00M3VVVV800	9	10 5/8		DI		
	CN00M3ZZZV800				CS		

300lb. Flanged							
Size (NPS)	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		B	C		Material	R = Rotating F = Fixed	
1	CN00M3YYYR100	3 1/2	2	FAB STEEL	CS	R	No Vacuum
1.5	CN00M3YYYRB00	4	2 7/8				
2	CN00M3YYYR200	4 1/2	3 5/8				
3	CN00M3YYYR300	5 1/2	5				
4	CN00M3YYYR400	6 1/2	6 3/16				
6	CN00M3YYYR600	8	8 1/2				
8	CN00MAYYYR800	10	10 5/8				

300 lb. flanged crosses have ANSI 150 center-face dimensions, except 8" size which has ANSI 300 dimension.

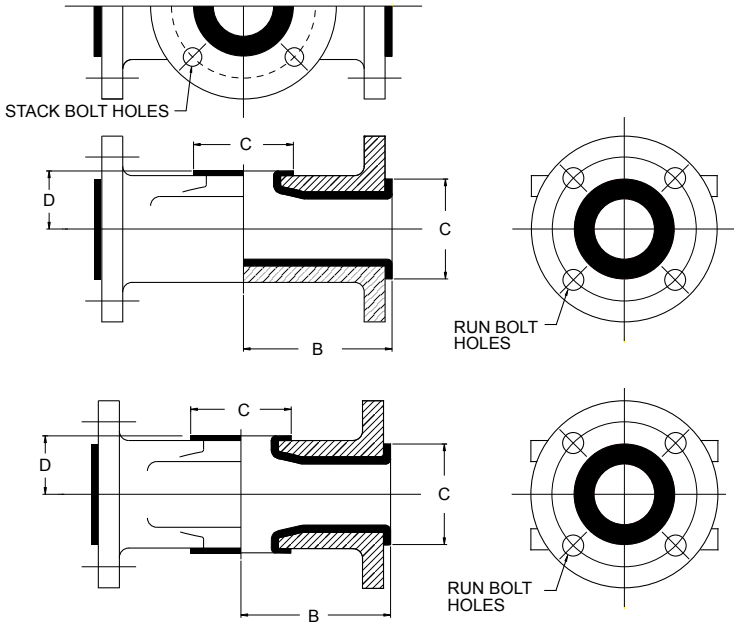
DI Short Stack Tees & Crosses
PTFE-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron

Flange Materials
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

Note: Vacuum ratings for this product are for steady-state vacuum, only. Frequent vacuum cycling may reduce service life.



Short Stack Tees

150 lb. Flanged									
Size (NPS)	Part Numbers	Dimensions (in.)			Housing Material	Flanges			Vacuum Rating (in. Hg/ F)
		B	C	D		Material	Stack Bolt Hole	Run Bolt Hole	
1	TH00B1VVVN100	3 1/2	2	1 3/16	DI	DI	1/2-13*	1/2-13	FV/450
1.5	TH00B1VVVNB00	4	2 7/8	1 15/32			1/2-13*	1/2-13	FV/450
2	TH00B1VVVN200	4 1/2	3 5/8	1 11/16			5/8-11*	3/4	FV/450
3	TH00B1VVVN300	5 1/2	5	2 3/16			5/8-11*	3/4	FV/350
4	TH00B1VVVN400	6 1/2	6 3/16	2 11/16			5/8-11*	3/4	FV/210
6	TH00B1VVVN600	8	8 1/2	3 11/16			3/4-10**	7/8	11/210
8	TH00B1VVVN800	9	10 5/8	4 15/16			3/4-10**	7/8	No Vacuum
10	TH00B1VVVNE00	11	12 3/4	6			7/8-9**	1	
12	TH00B1VVVNF00	12	15	7 1/32			7/8-9**	1	

Short Stack Crosses

150 lb. Flanged									
Size (NPS)	Part Numbers	Dimensions (in.)			Housing Material	Flanges			Vacuum Rating (in. Hg/ F)
		B	C	D		Material	Stack Bolt Hole	Run Bolt Hole	
1	CH00B1VVVN100	3 1/2	2	1 3/16	DI	DI	1/2-13*	1/2-13	FV/300
1.5	CH00B1VVVNB00	4	2 7/8	1 15/32			1/2-13*	1/2-13	FV/250
2	CH00B1VVVN200	4 1/2	3 5/8	1 11/16			5/8-11*	3/4	FV/250
3	CH00B1VVVN300	5 1/2	5	2 3/16			5/8-11*	3/4	FV/200
4	CH00B1VVVN400	6 1/2	6 3/16	2 11/16			5/8-11**	3/4	25/200
6	CH00B1VVVN600	8	8 1/2	3 11/16			3/4-10**	7/8	No Vacuum
8	CH00B1VVVN800	9	10 5/8	4 15/16			3/4-10**	7/8	
10	CH00B1VVVNE00	11	12 3/4	6			7/8-9**	1	
12	CH00B1VVVNF00	12	15	7 1/32			7/8-9**	1	

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

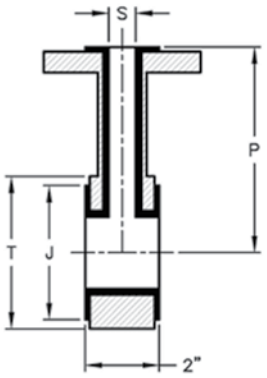
Instrument Tees with 1" Branch
PTFE-Lined

Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings
DI = ASTM A395 Cast Ductile Iron

Flange Materials
CS = ASTM A105
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

*Nominal ID. For exact ID to determine if an instrument will fit in the bore, field measurement is necessary.



150 lb. Flanged									
Size (NPS)	Part Numbers	Dimensions (in.)				Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		P	T	J	S*		Material	R = Rotating F = Fixed	
1	T400M100VN110	3 1/2	2 5/8	2	25/32	DI	DI	F	FV/450
	T400M300ZR110				5/8	Cast Steel	CS	R	
1.5	T400M100VNB10	4	3 3/8	2 7/8	25/32	DI	DI	F	
	T400M300ZRB10				5/8	Cast Steel	CS	R	
2	T400M100VN210	5 9/16	4 1/8	3 5/8	25/32	DI	DI	F	
	T400M300ZR210	4 1/2			5/8	Cast Steel	CS	R	
3	T400M100VN310	6 5/16	5 3/8	5	25/32	DI	DI	F	
	T400M300ZR310	5 1/2			5/8	Cast Steel	CS	R	
4	T400M100VN410	7 1/16	6 7/8	6 3/16	25/32	DI	DI	F	
	T400M300ZR410	6 1/2			5/8	Cast Steel	CS	R	
6	T400M100VN610	8 1/16	8 3/4	8 1/2	25/32	DI	DI	F	
	T400M300ZR610	8			5/8	FAB STEEL	CS	R	
8	T400M300ZM810	9 5/16	11	10 5/8	25/32	FAB STEEL	CS	F	
	T400M300ZR810	9			5/8			R	
10	T400M300ZME10	10 3/8	13 3/8	12 3/4	25/32	FAB STEEL	CS	F	FV/450
	T400B300ZRE10	11	13 1/4		5/8			R	No Vacuum
12	T400M300ZMF10	11 7/8	16 1/8	15	25/32	FAB STEEL	CS	F	FV/450
	T400B300ZRF10	12	16		5/8			R	No Vacuum

300lb. Flanged									
Size (NPS)	Part Numbers	Dimensions (in.)				Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		P	T	J	S*		Material	R = Rotating F = Fixed	
1	T400MA00YM110	4	2 7/8	2	25/32	FAB STEEL	CS	F	FV/450
1.5	T400MA00YMB10	4 1/2	3 3/4	2 7/8	25/32				
2	T400MA00YM210	5 9/16	4 3/8	3 5/8	5/8				
3	T400MA00YM310	6 5/16	5 7/8	5	5/8				
4	T400MA00YM410	7 1/16	7 1/8	6 3/16	5/8				
6	T400MA00YM610	8 1/16	9 7/8	8 1/2	5/8				
8	T400MA00YM810	9 5/16	12 1/8	10 5/8	5/8				

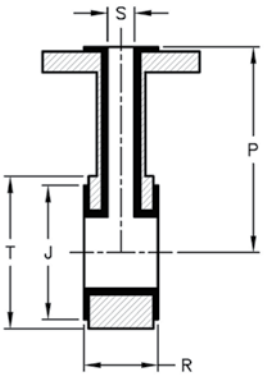
Instrument Tees with 1.5" Branch
PTFE-Lined

Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings
DI = ASTM A395 Cast Ductile Iron

Flange Materials
CS = ASTM A105
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

*Nominal ID. For exact ID to determine if an instrument will fit in the bore, field measurement is necessary.



150lb. Flanged										
Size (NPS)	Part Numbers	Dimensions (in.)					Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		P	R	T	J	S*		Material	R=Rotating F=Fixed	
1.5	T400M300ZSBB0	4	3	3 3/8	2 7/8	1 5/16	FAB STEEL	CS	F	FV/450
	T400M300ZRBB0		4			1 1/8			R	
2	T400M300ZS2B0	5 9/16	3	4 1/8	3 5/8	1 5/16			F	
	T400M300ZR2B0	4 1/2	4			1 1/8			R	
3	T400M100VN3B0	6 5/16	3	5 3/8	5	1 5/16	DI	DI	F	
	T400M300ZR3B0	5 1/2	4			1 1/8	FAB STEEL	CS	R	
4	T400M300ZS4B0	7 1/16	3	6 7/8	6 3/16	1 5/16			F	
	T400M300ZR4B0	6 1/2	4			1 1/8			R	
6	T400M300ZS6B0	8 1/16	3	8 3/4	8 1/2	1 5/16			F	FV/450
	T400M300ZR6B0	8	4			1 1/8			R	27/400
8	T400M300ZS8B0	9 5/16	3	11	10 5/8	1 5/16			F	FV/450
	T400M300ZR8B0	9	4			1 1/8			R	No Vacuum
10	T400M300ZSEB0	10 3/8	3	13 3/8	12 3/4	1 5/16			F	FV/450
	T400B300ZREB0	11	4	13 1/4		1 1/8			R	No Vacuum
12	T400M300ZSFB0	11 7/8	3	16 1/8	15	1 5/16			F	FV/450
	T400B300ZRFB0	12	4	16		1 1/8			R	No Vacuum

300lb. Flanged										
Size (NPS)	Part Numbers	Dimensions (in.)					Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		P	R	T	J	S*		Material	R = Rotating F = Fixed	
1.5	T400MA00YSBB0	4 1/2	3	3 3/4	2 7/8	1 11/32	FAB STEEL	CS	F	FV/450
3	T400MA00YS3B0	6 5/16	3	5 7/8	5	1 11/32				
4	T400MA00YS4B0	7 1/16	3	7 1/8	6 3/16	1 11/32				
6	T400MA00YS6B0	8 1/16	3	9 7/8	8 1/2	1 11/32				
8	T400MA00YS8B0	9 5/16	3	12 1/8	10 5/8	1 11/32				

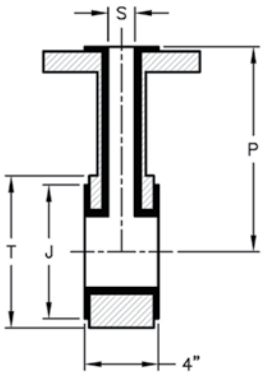
Instrument Tees With 2" Branch
PTFE-Lined

Housing Materials
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105

FV = Full Vacuum

*Nominal ID. For exact ID to determine if an instrument will fit in the bore, field measurement is necessary.



150lb. Flanged									
Size (NPS)	Part Numbers	Dimensions (in.)				Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		P	T	J	S*		Material	R=Rotating F=Fixed	
2	T400M300ZM220	5 9/16	4 1/8	3 5/8	1 25/32	FAB STEEL	CS	F	FV/450
	T400M300ZR220	4 1/2			1 5/8			R	
3	T400M300ZS320	6 5/16	5 3/8	5	1 7/8			F	
	T400M300ZR320	5 1/2			1 5/8			R	
4	T400M300ZM420	7 1/16	6 7/8	6 3/16	1 25/32			F	
	T400M300ZR420	6 1/2			1 5/8			R	
6	T400M300ZS620	8 1/16	8 3/4	8 1/2	1 7/8			F	FV/450
	T400B300ZR620	8			1 5/8			R	28/450
8	T400M300ZS820	9 5/16	11	10 5/8	1 7/8			F	FV/450
	T400B300ZR820	9			1 5/8			R	No Vacuum
10	T400M300ZSE20	10 3/8	13 3/8	12 3/4	1 7/8			F	FV/450
	T400B300ZRE20	11	13 1/4		1 5/8			R	No Vacuum
12	T400M300ZSF20	11 7/8	16 1/8	15	1 7/8			F	FV/450
	T400B300ZRF20	12	16		1 5/8			R	No Vacuum

Strainer Tee Assembly
PTFE-Lined, 150 lb. Flanged

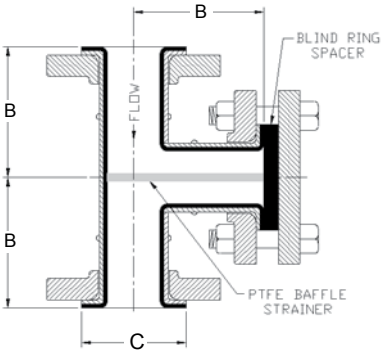
Housing Material
FAB STEEL = Housing fabricated from carbon steel pipe and/or weld fittings.

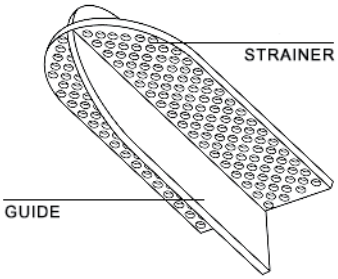
Flange Material
CS = ASTM A105
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

Note: 12th character in the part number indicates the size of the holes in the strainer. All part numbers in the table are shown with an “R”, which indicates 1/8” holes. The following are the available hole sizes and their corresponding character: Q = 1/16”; R = 1/8”; S = 3/16”; T = 1/4”; U = 5/16”; V = 3/8”

If other hole sizes are required, please contact the factory.





Size (NPS)	Part Number	Dimensions (in.)		Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		B	C		Material	R = Rotating F = Fixed	
1	T807M3VVVV1R0	3 1/2	2	FAB STEEL	DI	R	FV/450
	T807M3ZZZV1R0				CS		
1 1/2	T807M3VVVVBR0	4	2 7/8		DI		
	T807M3ZZZVBR0				CS		
2	T807M3VVVV2R0	4 1/2	3 5/8		DI		
	T807M3ZZZV2R0				CS		
3	T807M3VVVV3R0	5 1/2	5		DI		
	T807M3ZZZV3R0				CS		
4	T807M3VVVV4R0	6 1/2	6 3/16		DI		
	T807M3ZZZV4R0				CS		
6	T807M3VVVV6R0	8	8 1/2		DI		
	T807M3ZZZV6R0				CS		
8	T807M3VVVV8R0	9	10 5/8		DI		
	T807M3ZZZV8R0				CS		
10	T807M3VVVVER0	11	12 3/4		DI		
	T807M3ZZZVER0				CS		
12	T807M3VVVVFR0	12	15		DI		FV/375
	T807M3ZZZVFR0				CS		

Note: Plastic-lined baffle tee strainers are designed to prevent relatively large particles from passing. These are not designed to be fine particulate screens or filters.

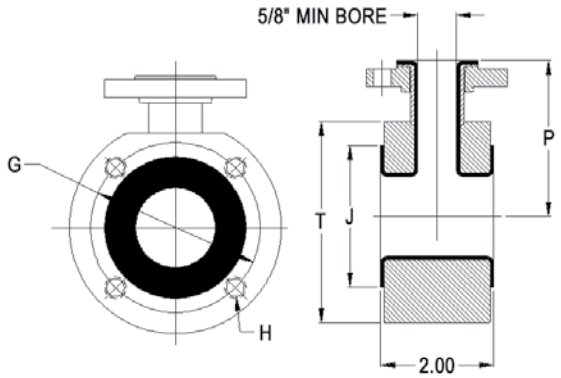
Lugged Body Instrument Tees with 1" Branch
PTFE / Polypropylene / PVDF-Lined, 150 lb. Flanged

Housing Materials
Fabricated Steel

Flange Material
ASTM A105 Forged Steel

Vacuum Ratings
All 1” - 8” lugged body instrument tees are rated for full vacuum at maximum operating temperature.
10” - 12” sizes are not rated for vacuum service.

Actual branch inside diameter may vary. If ID of branch is critical, consult the factory.



Note: Lugged Body Instrument Tees cannot be installed side by side, they need to have a flanged spool installed between them.

Size (NPS)	Liner	Part Numbers	Dimensions (in.)				
			P	T	J	H Holes No. & Size	G
1	PTFE	T400M3ZZZL110	3 1/2	4 1/4	2	(4) 1/2-13	3 1/8
	PP	T400P3ZZZL110					
	PVDF	T400K3ZZZL110					
1 1/2	PTFE	T400M3ZZZLB10	4	5	2 7/8	(4) 1/2-13	3 7/8
	PP	T400P3ZZZLB10					
	PVDF	T400K3ZZZLB10					
2	PTFE	T400M3ZZZL210	4 1/2	6	3 5/8	(4) 5/8-11	4 3/4
	PP	T400P3ZZZL210					
	PVDF	T400K3ZZZL210					
3	PTFE	T400M3ZZZL310	5 1/2	7 1/2	5	(4) 5/8-11	6
	PP	T400P3ZZZL310					
	PVDF	T400K3ZZZL310					
4	PTFE	T400M3ZZZL410	6 1/2	9	6 3/16	(8) 5/8-11	7 1/2
	PP	T400P3ZZZL410					
	PVDF	T400K3ZZZL410					
6	PTFE	T400M3ZZZL610	8	11	8 1/2	(8) 3/4-10	9 1/2
	PP	T400P3ZZZL610					
	PVDF	T400K3ZZZL610					
8	PTFE	T400M3ZZZL810	9	13 1/2	10 5/8	(8) 3/4-10	11 3/4
	PP	T400P3ZZZL810					
	PVDF	T400K3ZZZL810					
10	PTFE	T400B3ZZZLE10	11	16	12 3/4	(12) 7/8-9	14 1/4
12	PTFE	T400B3ZZZLF10	12	19	15	(12) 7/8-9	17

PTFE lined lugged body instrument tees are supplied with a rotating flange on the branch.
PP & PVDF lined lugged body instrument tees are supplied with a fixed flange on the branch.

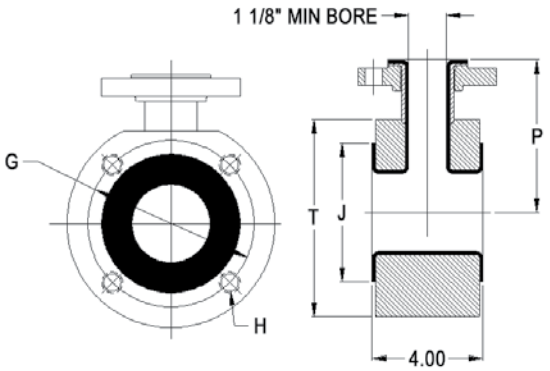
Lugged Body Instrument Tees with 1.5" Branch
PTFE / Polypropylene / PVDF-Lined, 150 lb. Flanged

Housing Materials
Fabricated Steel

Flange Material
ASTM A105 Forged Steel

Vacuum Ratings
All 1 1/2” - 8” lugged body instrument tees are rated for full vacuum at maximum operating temperature.
10” - 12” sizes are not rated for vacuum service.

Actual branch inside diameter may vary. If ID of branch is critical, consult the factory.



Note: Lugged Body Instrument Tees cannot be installed side by side, they need to have a flanged spool installed between them.

Size (NPS)	Liner	Part Numbers	Dimensions (in.)				
			P	T	J	H Holes No. & Size	G
1 1/2	PTFE	T400M3ZZZLBB0	4	5	2 7/8	(4) 1/2-13	3 7/8
	PP	T400P3ZZZLBB0					
	PVDF	T400K3ZZZLBB0					
2	PTFE	T400M3ZZZL2B0	4 1/2	6	3 5/8	(4) 5/8-11	4 3/4
	PP	T400P3ZZZL2B0					
	PVDF	T400K3ZZZL2B0					
3	PTFE	T400M3ZZZL3B0	5 1/2	7 1/2	5	(4) 5/8-11	6
	PP	T400P3ZZZL3B0					
	PVDF	T400K3ZZZL3B0					
4	PTFE	T400M3ZZZL4B0	6 1/2	9	6 3/16	(8) 5/8-11	7 1/2
	PP	T400P3ZZZL4B0					
	PVDF	T400K3ZZZL4B0					
6	PTFE	T400M3ZZZL6B0	8	11	8 1/2	(8) 3/4-10	9 1/2
	PP	T400P3ZZZL6B0					
	PVDF	T400K3ZZZL6B0					
8	PTFE	T400M3ZZZL8B0	9	13 1/2	10 5/8	(8) 3/4-10	11 3/4
	PP	T400P3ZZZL8B0					
	PVDF	T400K3ZZZL8B0					
10	PTFE	T400B3ZZZLEB0	11	16	12 3/4	(12) 7/8-9	14 1/4
12	PTFE	T400B3ZZZLFB0	12	19	15	(12) 7/8-9	17

PTFE lined lugged body instrument tees are supplied with a rotating flange on the branch.
PP & PVDF lined lugged body instrument tees are supplied with a fixed flange on the branch.

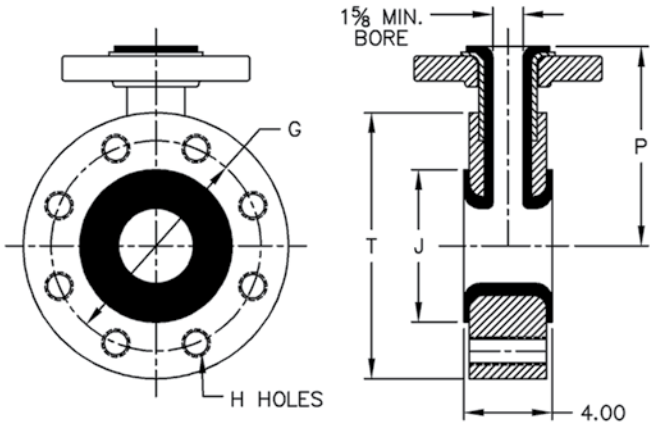
Lugged Body Instrument Tees with 2" Branch
PTFE / Polypropylene / PVDF-Lined, 150 lb. Flanged

Housing Materials
Fabricated Steel

Flange Material
ASTM A105 Forged Steel

Vacuum Ratings
All 2” - 8” lugged body instrument tees are rated for full vacuum at maximum operating temperature.
10” - 12” sizes are not rated for vacuum service.

Actual branch inside diameter may vary. If ID of branch is critical, consult the factory.



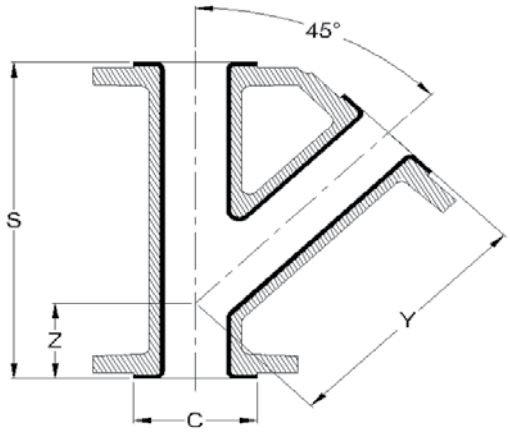
Note: Lugged Body Instrument Tees cannot be installed side by side, they need to have a flanged spool installed between them.

Size (NPS)	Liner	Part Numbers	Dimensions (in.)				
			P	T	J	H Holes No. & Size	G
2	PTFE	T400M3ZZZL220	4 1/2	6	3 5/8	(4) 5/8-11	4 3/4
	PP	T400P3ZZZL220					
	PVDF	T400K3ZZZL220					
3	PTFE	T400M3ZZZL320	5 1/2	7 1/2	5	(4) 5/8-11	6
	PP	T400P3ZZZL320					
	PVDF	T400K3ZZZL320					
4	PTFE	T400M3ZZZL420	6 1/2	9	6 3/16	(8) 5/8-11	7 1/2
	PP	T400P3ZZZL420					
	PVDF	T400K3ZZZL420					
6	PTFE	T400M3ZZZL620	8	11	8 1/2	(8) 3/4-10	9 1/2
	PP	T400P3ZZZL620					
	PVDF	T400K3ZZZL620					
8	PTFE	T400M3ZZZL820	9	13 1/2	10 5/8	(8) 3/4-10	11 3/4
	PP	T400P3ZZZL820					
	PVDF	T400K3ZZZL820					
10	PTFE	T400B3ZZZLE20	11	16	12 3/4	(12) 7/8-9	14 1/4
12	PTFE	T400B3ZZZLF20	12	19	15	(12) 7/8-9	17

PTFE lined lugged body instrument tees are supplied with a rotating flange on the branch.
PP & PVDF lined lugged body instrument tees are supplied with a fixed flange on the branch.

45° Laterals

PTFE-Lined, 150lb. Flanged



Housing Materials
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

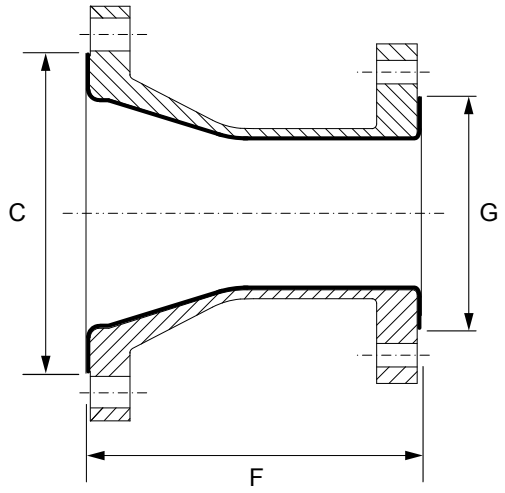
Flange Materials
CAST STEEL = ASTM A105
CAST STEEL = ASTM A216
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

Size (NPS)	Part Numbers	Dimensions (in.)				Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
		Y	Z	S	C		Material	R=Rotating F=Fixed	
1	LN00M3VVVV100	5 3/4	1 3/4	7 1/2	2	FAB STEEL	DI	R	FV/450
	LN00B2ZZZN100					CAST STEEL	CAST STEEL	F	No Vacuum
1.5	LN00M3VVVVB00	7	2	9	2 7/8	FAB STEEL	DI	R	FV/450
	LN00B2ZZZNB00					CAST STEEL	CAST STEEL	F	No Vacuum
2	LN00M3VVVV200	8	2 1/2	10 1/2	3 5/8	FAB STEEL	DI	R	FV/450
	LN00B2ZZZN200					CAST STEEL	CAST STEEL	F	No Vacuum
3	LN00M3VVVV300	10	3	13	5	FAB STEEL	DI	R	FV/450
	LN00B2ZZZN300					CAST STEEL	CAST STEEL	F	No Vacuum
4	LN00M3VVVV400	12	3	15	6 3/16	FAB STEEL	DI	R	FV/450
	LN00B2ZZZN400					CAST STEEL	CAST STEEL	F	No Vacuum
6	LN00M3VVVV600	14 1/2	3 1/2	18	8 1/2	FAB STEEL	DI	R	FV/450
	LN00B2ZZZN600					CAST STEEL	CAST STEEL	F	No Vacuum
8	LN00B3VVVV800	17 1/2	4 1/2	22	10 5/8	FAB STEEL	DI	R	FV/210, 15/450
	LN00B2ZZZN800					CAST STEEL	CAST STEEL	F	No Vacuum

Laterals with rotating carbon steel flanges are available. These have the same vacuum ratings as the DI flanged models.

Concentric Reducers
PTFE-Lined



Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105 for Rotating and A216 for Fixed
DI = ASTM A395 Cast Ductile Iron

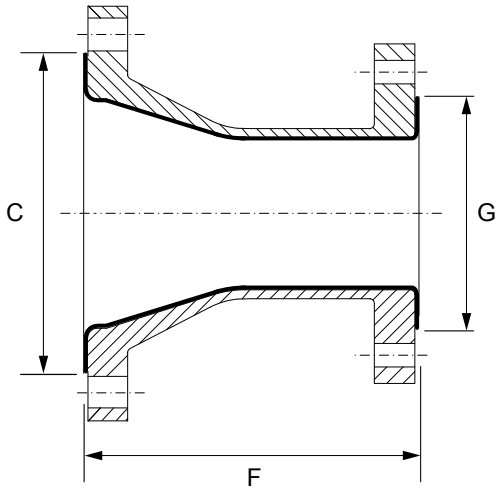
FV = Full Vacuum

150lb. Flanged									
Major Size (NPS)	Minor Size (NPS)	Part Number	Dimensions (in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/ F)
			C	F	G		Material	R = Rotating F = Fixed	
1	.5	6000M1VV0N170	2	4 1/2	1 5/16	DI	DI	F/F	FV/450
1.5	1	6000M1VV0NB10	2 7/8	4 1/2	2	DI	DI	F/F	
		6000M3ZZ0VB10				Fab Steel	CS	R/R	
2	1	6000M1VV0N210	3 5/8	5	2	DI	DI	F/F	
		6000M3ZZ0V210				Fab Steel	CS	R/R	
	1.5	6000M1VV0N2B0			2 7/8	DI	DI	F/F	
		6000M3ZZ0V2B0				Fab Steel	CS	R/R	
3	1	6000M1VV0N310*	5	6	2	DI	DI	F/F	
		6000M3ZZ0R310				Fab Steel	CS	F/R**	
	1.5	6000M1VV0N3B0			2 7/8	DI	DI	F/F	
		6000M3ZZ0R3B0				Fab Steel	CS	F/R**	
	2	6000M1VV0N320			3 5/8	DI	DI	F/F	
		6000M3ZZ0R320				Fab Steel	CS	F/R**	
4	1	6000M1VV0N410*	6 3/16	7	2	DI	DI	F/F	
		6000M3ZZ0R410				Fab Steel	CS	F/R**	
	1.5	6000M1VV0N4B0			2 7/8	DI	DI	F/F	
		6000M3ZZ0R4B0				Fab Steel	CS	F/R**	
	2	6000M1VV0N420			3 5/8	DI	DI	F/F	
		6000M3ZZ0R3B0				Fab Steel	CS	F/R**	
	3	6000M1VV0N430			5	DI	DI	F/F	
		6000M3ZZ0R430				Fab Steel	CS	F/R**	
6	2	6000M1VV0N620	8 1/2	9	3 5/8	DI	DI	F/F	
		6000M3ZZ0R620				Fab Steel	CS	F/R**	
	3	6000M1VV0N630			5	DI	DI	F/F	
		6000M3ZZ0R630				Fab Steel	CS	F/R**	
	4	6000M1VV0N640			6 3/16	DI	DI	F/F	
		6000M3ZZ0R640				Fab Steel	CS	F/R**	
8	4	6000M1VV0N840	10 5/8	11	6 3/16	DI	DI	F/F	
		6000M2ZZ0N840				Cast Steel	CS	F/F	
	6	6000M1VV0N860			8 1/2	DI	DI	F/F	
		6000M2ZZ0N860				Cast Steel	CS	F/F	

* Small side bolt holes are tapped with 1/2-13 UNC 2B threads

** Major size is fixed, minor size is rotating

Concentric Reducers
PTFE-Lined



Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

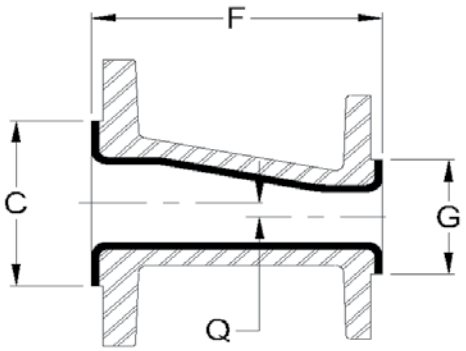
Flange Materials
CS = ASTM A105 for Rotating and A216 for Fixed
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

150lb. Flanged, cont'd									
Major Size (NPS)	Minor Size (NPS)	PartNumber	Dimensions(in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/ºF)
			C	F	G		Material	R = Rotating F = Fixed	
10	6	6000M1VV0NE60	12 3/4	12	8 1/2	DI	DI	F	FV/240 , 18/450
	8	6000M1VV0NE80			10 5/8				FV/450
12	6	6000M3ZZ0WF60	15	14	8 1/2	FAB STEEL	CS	F	FV/450
	8	6000M3ZZ0WF80			10 5/8				
	10	6000M3ZZ0WFE0			12 3/4				

300lb. Flanged - Fab Steel Body Only									
Major Size (NPS)	Minor Size (NPS)	Part Number	Dimensions (in.)			Housing Material	Flanges		Vacuum Rating (in. Hg/°F)
			C	F	G		Material	R = Rotating F = Fixed	
1	.5	6000MAYY0V170	2	4 1/2	1 5/16	FAB STEEL	CS	R/R	FV/450
1.5	1	6000MAYY0RB10	2 7/8	4 1/2	2	FAB STEEL	CS	F/R	FV/450
2	1	6000MAYY0R210	3 5/8	5	2				
	1.5	6000MAYY0R2B0			2 7/8				
3	1	6000MAYY0R310	5	6	2				
	1.5	6000MAYY0R3B0			2 7/8				
	2	6000MAYY0R320			3 5/8				
4	1.5	6000MAYY0R4B0	6 3/16	7	2 7/8				
	2	6000MAYY0R420			3 5/8				
	3	6000MAYY0R430			5				
6	2	6000MAYY0R620	8 1/2	9	3 5/8				
	3	6000MAYY0R630			5				
	4	6000MAYY0R640			6 3/16				
8	4	6000MAYY0R840	10 5/8	11	6 3/16				
	6	6000MAYY0R860			8 1/2				

Eccentric Reducers
PTFE-Lined, 150 lb. Flanged



Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216
FAB STEEL = Housing fabricated from pipe and/or weld fittings

Flange Materials
CS = ASTM A105
CAST STEEL = ASTM A216
DI = ASTM A395 Cast Ductile Iron

FV = Full Vacuum

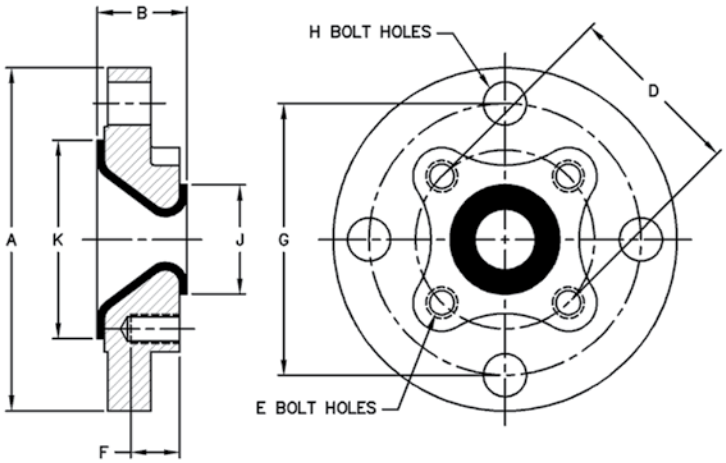
Major Size (NPS)	Minor Size (NPS)	Part Numbers	Dimensions				Housing Material	Flanges		Vacuum Rating (in. Hg / °F
			C	F	G	Q		Material	R=Rotating F=Fixed	
1.5	1	8000M3ZZ0SB10	2 7/8	4 1/2	2	1/4	FAB STEEL	CS	F	FV/450
		8000M2ZZ0NB10					CAST STEEL	CAST STEEL		
2	1	8000M2ZZ0N210	3 5/8	5	2	1/2	CAST STEEL	CAST STEEL	F	FV/450
	1.5	8000M2ZZ0N2B0			2 7/8	1/4	CAST STEEL	CAST STEEL		
3	1.5	8000M1VV0N3B0	5	6	2 7/8	3/4	DI	DI	F	FV/450
		8000M2ZZ0N3B0					CAST STEEL	CAST STEEL		
	2	8000M1VV0N320			3 5/8	1/2	DI	DI		
		8000M2ZZ0N320					CAST STEEL	CAST STEEL		
4	1.5	8000M2ZZ0N4B0*	6 3/16	7	2 7/8	1 1/4	CAST STEEL	CAST STEEL	F	FV/450
	2	8000M1VV0N420			3 5/8	1	DI	DI		
		8000M2ZZ0N420					CAST STEEL	CAST STEEL		
	3	8000M1VV0N430			5	1/2	DI	DI		
		8000M2ZZ0N430					CAST STEEL	CAST STEEL		
6	3	8000M1VV0N630	8 1/2	9	5	1 1/2	DI	DI	F	FV/450
		8000M2ZZ0N630					CAST STEEL	CAST STEEL		
	4	8000M1VV0N640			6 3/16	1	DI	DI		
		8000M2ZZ0N640					CAST STEEL	CAST STEEL		28/450
8	4	8000M1VV0N840	10 5/8	11	6 3/19	2	DI	DI	F	FV/450
		8000M2ZZ0N840					CAST STEEL	CAST STEEL		NO VACUUM
	6	8000M1VV0N860			8 1/2	1	DI	DI		FV/450
		8000M2ZZ0N860					CAST STEEL	CAST STEEL		NO VACUUM

* 4" x 1.5" size: minor size flange bolt holes are tapped to 1/2-13.

Ductile Iron Reducing Filler Flanges
PTFE-Lined, 150 lb. Flanged

Ductile Iron conforms to ASTM A395

All sizes are Full-Vacuum rated to 450 ºF

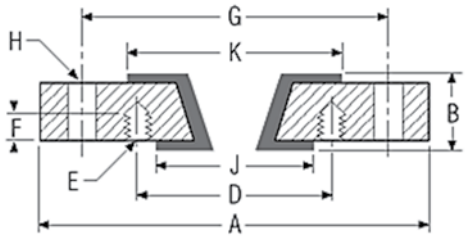


Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	K	J	
1	.5	3T00M0VV0C170	1 5/8	4 1/4	4	5/8	3 1/8	4	1/2-13	2 3/8	7/8	2	1 3/8	45
	.75	3T00M0VV0C190								2 3/4			1 11/16	
1.5	1	3T00M0VV0CB10	1 9/16	5	4	5/8	3 7/8	4	1/2-13	3 1/8	7/8	2 7/8	2	45
2	1	3T00M0VV0C210	1 9/16	6	4	3/4	4 3/4	4	1/2-13	3 1/8	7/8	3 5/8	2	45
	1.5	3T00M0VV0C2B0								3 7/8			2 7/8	
2.5	2	3T00M0VV0CC20	1 9/16	7	4	3/4	5 1/2	4	5/8-11	4 3/4	7/8	4 1/4	3 5/8	45
3	1	3T00M0VV0C310	1 5/8	7 1/2	4	3/4	6	4	1/2-13	3 1/8	3/4	5	2	45
	1.5	3T00M0VV0C3B0								3 7/8	7/8		2 7/8	
	2	3T00M0VV0C320	1 3/4						5/8-11	4 3/4			3 5/8	
	2.5	3T00M0VV0C3C0	1 5/8							5 1/2			4 1/8	
4	1	3T00M0VV0C410	1 7/8	9	8	3/4	7 1/2	4	1/2-13	3 1/8	11/16	6 3/16	2	None
	1.5	3T00M0VV0C4B0	1 5/8							3 7/8	7/8		2 7/8	
	2	3T00M0VV0C420	2						5/8-11	4 3/4			3 5/8	
	3	3T00M0VV0C430	1 3/4							6			5	
5	4	3T00M0VV0C540	1 5/8	10	8	7/8	8 1/2	8	5/8-11	4	1	7 5/16	6 3/16	22 1/2
6	1.5	3T00M0VV0C6B0	1 7/8	11	8	7/8	9 1/2	4	1/2-13	3 7/8	11/16	8 1/2	2 7/8	None
	2	3T00M0VV0C620							5/8-11	5	3/4		3 5/8	
	3	3T00M0VV0C630	1 3/4							6	1		5	
	4	3T00M0VV0C640	2 1/8					8		7 1/2	7/8		6 3/16	22 1/2
	5	3T00M0VV0C650	1 3/4						3/4-10	8 1/2	1		7 5/16	
8	4	3T00M0VV0C840	2	13 1/2	8	7/8	11 3/4	8	5/8-11	7 1/2	7/8	10 5/8	6 3/16	22 1/2
	6	3T00M0VV0C860							3/4-10	9 1/2	1 1/8		8 1/2	None
10	4	3T00M0VV0CE40	2 7/16	16	12	1	14 1/4	8	5/8-11	7 1/2	7/8	12 3/4	6 3/16	None
	6	3T00M0VV0CE60							3/4-10	9 1/2	1		8 1/2	
	8	3T00M0VV0CE80								11 3/4			10 5/8	

Carbon Steel Reducing Filler Flanges
PTFE-Lined, 150 lb. Flanged

Carbon Steel conforms to ASTM A516 GR 70 or SAE 1010-1030.

1" – 8" is Full Vacuum rated to 450°F.
10" & 12" are not vacuum rated.



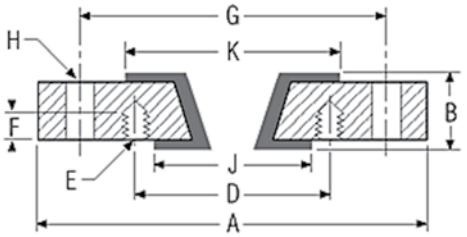
Note: The minor size bolt holes on reducing filler flanges are always threaded. Also, many sizes of this style of reducing filler flange are constructed with both the major size and minor size bolt holes as threaded. This is to prevent interference between bolt heads and nuts of the two connecting flanges. Please be aware of what these will be connected to - if connecting to other flanges that have threaded holes, a concentric reducer (through holes on both flanges) may be required. The PTFE-lined ductile iron reducing flanges are constructed with the major holes as through holes in all sizes. The thickness dimension may be different than the carbon steel reducing flange.

150lb. Flanged														
Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation (degrees)
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	K	J	
1	.5	3T00M0ZZ00170	1 1/2	4 1/4	4	1/2-13	3 1/8	4	1/2-13	2 3/8	11/16	2	1 3/8	45
	.75	3T00M0ZZ00190								2 3/4			1 11/16	
1.5	1	3T00M0ZZ00B10	1 1/2	5	4	1/2-13	3 7/8	4	1/2-13	3 1/8	9/16	2 7/8	2	45
2	1	3T00M0ZZ00210	1 1/2	6	4	5/8-11	4 3/4	4	1/2-13	3 1/8	9/16	3 5/8	2	None
	1.5	3T00M0ZZ002B0								3 7/8	5/8		2 7/8	45
3	1	3T00M0ZZ00310	1 1/2	7 1/2	4	5/8-11	6	4	1/2-13	3 1/8	9/16	5	2	None
	1.5	3T00M0ZZ003B0								3 7/8	5/8		2 7/8	
	2	3T00M0ZZ00320							5/8-11	4 3/4	3/4		3 5/8	45
4	1	3T00M0ZZ00410	2	9	8	3/4	7 1/2	4	1/2-13	3 1/8	9/16	6 3/16	2	None
	1.5	3T00M0ZZ004B0								3 7/8	5/8		2 7/8	
	2	3T00M0ZZ00420	1 1/2						5/8-11		3/4		3 5/8	
	3	3T00M0ZZ00430				5/8-11				6			5	
6	1	3T00M0ZZ00610	2	11	8	7/8	9 1/2	4	1/2-13	3 1/8	9/16	8 1/2	2	None
	1.5	3T00M0ZZ006B0								3 7/8	5/8		2 7/8	
	2	3T00M0ZZ00620							5/8-11	4 3/4	3/4		3 5/8	
	3	3T00M0ZZ00630								6			5	
	4	3T00M0ZZ00640	1 1/2			3/4-10		8		7 1/2			6 3/16	
8	3	3T00M0ZZ00830	2	13 1/2	8	7/8	11 3/4	4	5/8-11	6	3/4	10 5/8	5	None
	4	3T00M0ZZ00840						8		7 1/2			6 3/16	
	6	3T00M0ZZ00860	1 1/2			3/4-10			3/4-10	9 1/2	13/16		8 1/2	
10	3	3T00B0ZZ00E30	2	16	12	1	14 1/4	4	3/4-10	6	5/8	12 3/4	5	None
	4	3T00B0ZZ00E40						8			3/4		6 3/16	
	6	3T00B0ZZ00E60								9 1/2	13/16		8 1/2	
	8	3T00B0ZZ00E80				7/8-9				11 3/4			10 5/8	
12	6	3T00B0ZZ00F60	2	19	12	1	17	8	3/4-10	9 1/2	13/16	15	8 1/2	None
	8	3T00B0ZZ00F80								11 3/4			10 5/8	
	10	3T00B0ZZ00FE0				7/8-9		12	7/8-9	14 1/4	1 1/4		12 3/4	

Carbon Steel Reducing Filler Flanges
PTFE-Lined, 300 lb. Flanged

Carbon Steel conforms to ASTM A516 GR 70 or SAE 1010-1030.

1" – 8" is Full Vacuum rated to 450°F.
10" & 12" are not vacuum rated.



Note: The minor size bolt holes on reducing filler flanges are always threaded. Also, many sizes of this style of reducing filler flange are constructed with both the major size and minor size bolt holes as threaded. This is to prevent interference between bolt heads and nuts of the two connecting flanges. Please be aware of what these will be connected to - if connecting to other flanges that have threaded holes, a concentric reducer (through holes on both flanges) may be required. The PTFE-lined ductile iron reducing flanges are constructed with the major holes as through holes in all sizes. The thickness dimension may be different than the carbon steel reducing flange.

300 lb. Flanged															
Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation	Vacuum Rating (in. Hg/°F)
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth				
			B	A			G			D	F	K	J		
1	.5	3T00B0YY0M170	15/16	4 7/8	4	5/8-11	3 1/2	4	1/2-13	2 5/8	9/16	2	1 3/4	45°	See Note
	.75	3T00B0YY0M190							5/8-11	3 1/4			1 11/16		
1.5	.5	3T00B0YY0MB70	1 1/16	6 1/8	4	3/4-10	4 1/2	4	1/2-13	2 5/8	9/16	2 7/8	1 3/8	45°	See Note
	1	3T00M0YY00B10	1 1/2						5/8-11	3 1/2	5/8		2		FV/450
2	1	3T00M0YY00210	1 1/2	6 1/2	8	5/8-11	5	4	5/8-11	3 1/2	5/8	3 5/8	2	---	FV/450
	1.5	3T00M0YY002B0							3/4-10	4			2 7/8		
3	1	3T00M0YY00310	1 1/2	8 1/4	8	3/4-10	6 5/8	4	5/8-11	3 1/2	5/8	5	2	---	FV/450
	1.5	3T00M0YY003B0							3/4-10	4 1/2			2 7/8		
	2	3T00M0YY00320						8	5/8-11	5	3/4		3 5/8	22.5°	
	2.5	3T00B0YY0M3C0	1 3/8						3/4-10	5 7/8			4 1/8		See Note
4	1	3T00M0YY00410	2	10	8	7/8	7 7/8	4	5/8-11	3 1/2	5/8	6 3/16	2	---	FV/450
	1.5	3T00M0YY004B0							3/4-10	4 1/2			2 7/8		
	2	3T00M0YY00420	1 1/2			3/4-10		8	5/8-11	5	3/4		3 5/8	22.5°	
	3	3T00M0YY00430							3/4-10	6 5/8			5		
5	4	3T00B0YY0M540	1 5/8	11	8	3/4-10	9 1/4	8	3/4-10	7 7/8	1	7 5/16	6 3/16	22.5°	See Note
6	1	3T00M0YY00610	2	12 1/2	12	7/8	10 5/8	4	5/8-11	3 1/2	5/8	8 1/2	2	---	FV/450
	1.5	3T00B0YY0M6B0							3/4-10	4 1/2	1		2 7/8		See Note
	2	3T00M0YY00620						8	5/8-11	5	3/4		3 5/8		FV/450
	3	3T00M0YY00630							3/4-10	6 5/8			5		
	4	3T00M0YY00640	1 1/2			3/4-10				7 7/8			6 3/16	7.5°	
8	1	3T00B0YY0M810	1 7/8	15	12	1	13	4	5/8-11	3 1/2	11/16	10 5/8	2	---	See Note
	1.5	3T00B0YY0M8B0							3/4-10	4 1/2	1		2 7/8		
	2	3T00B0YY0M820						8	5/8-11	5	3/4		3 5/8		
	3	3T00M0YY00830	2						3/4-10	6 5/8			5		FV/450
	4	3T00M0YY00840								7 7/8			6 3/16		
	6	3T00M0YY00860	1 1/2			7/8-9		12		10 5/8	13/16		8 1/2	15°	

Other sizes through 36" are available on request.
Straight-through (non-tapered) bore available on request.

Carbon Steel Reducing Filler Flanges

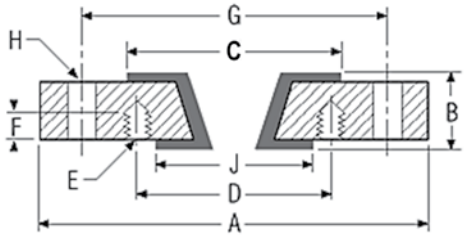
Non-Standard Sizes

PTFE-Lined, 150 lb. Flanged

Items below are available in stainless steel 304 or 316.

Vacuum Rating
Although the liner cannot collapse and block flow due to vacuum, these items are technically not vacuum rated.
Repeated flexing due to vacuum cycling may reduce service life.

Sizes not shown may be available - contact factory.

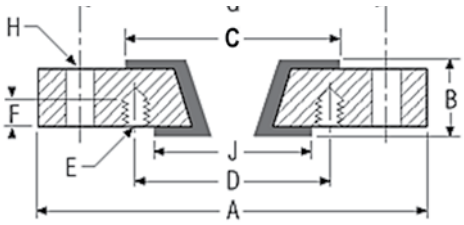


Major Size (NPS	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	C	J	
1.5	.5	3T00B0ZZ0MB70	13/16	5	4	1/2-13	3 7/8	4	1/2-13	2 3/8	7/16	2 7/8	1 3/8	45
	.75	3T00B0ZZ0MB90								2 3/4	1/2		1 11/16	
	1.25	3T00B0ZZ0MBA0								3 1/2			2 1/2	
2	.5	3T00B0ZZ0M270	7/8	6	4	5/8-11	4 3/4	4	1/2-13	2 3/8	1/2	3 5/8	1 3/8	45
	.75	3T00B0ZZ0M290								2 3/4			1 11/16	
	1.25	3T00B0ZZ0M2A0								3 1/2			2 1/2	
2.5	1	3T00B0ZZ0MC10	1	7	4	3/4	5 1/2	4	1/2-13	3 1/8	5/8	4 1/8	2	---
	1.5	3T00B0ZZ0MCB0				5/8-11				3 7/8			2 7/8	45
	2	3T00B0ZZ0MC20				3/4			5/8-11	4 3/4	9/16		3 5/8	
3	1.25	3T00B0ZZ0M3A0	1 3/16	7 1/2	4	5/8-11	6	4	1/2-13	3 1/2	1/2	5	2 1/2	45
	2.5	3T00B0ZZ0M3C0							5/8-11	5 1/2	11/16		4 1/8	
5	2	3T00B0ZZ0M520	1 3/16	10	8	7/8	8 1/2	4	5/8-11	4 3/4	11/16	7 5/16	3 5/8	---
	3	3T00B0ZZ0M530				3/4-10				6			5	
6	.75	3T00B0ZZ0M690	1 1/4	11	8	7/8	9 1/2	4	1/2-13	2 3/4	11/16	8 1/2	1 11/16	---
8	1	3T00B0ZZ0M810	1 3/8	13 1/2	8	7/8	11 3/4	4	1/2-13	3 1/8	11/16	10 5/8	2	----
	1.5	3T00B0ZZ0M8B0								3 7/8	5/8		2 7/8	
	2	3T00B0ZZ0M820							5/8-11	4 3/4	11/16		3 5/8	
10	1	3T00B0ZZ0ME10	1 7/16	16	12	1	14 1/4	4	1/2-13	3 1/8	3/4	12 3/4	2	---
	1.5	3T00B0ZZ0MEB0								3 7/8	11/16		2 7/8	
	2	3T00B0ZZ0ME20							5/8-11	4 3/4	3/4		3 5/8	
	4	3T00B0ZZ0ME40						8		7 1/2			6 3/16	
12	1	3T00B0ZZ0MF10	1 1/2	19	12	1	17	4	1/2-13	3 1/8	7/8	15	2	---
	1.5	3T00B0ZZ0MFB0								3 7/8	3/4		2 7/8	
	2	3T00B0ZZ0MF20							5/8-11	4 3/4			3 5/8	
	3	3T00B0ZZ0MF30								6			5	
	4	3T00B0ZZ0MF40						8		7 1/2			6 3/16	
14	2	3T00B0ZZ0MG20	1 5/8	21	12	1 1/8	18 3/4	4	5/8-11	4 3/4	11/16	16 1/4	3 5/8	---
	4	3T00B0ZZ0MG40						8		7 1/2	3/4		6 3/16	
	6	3T00B0ZZ0MG60							3/4-10	9 1/2	1		8 1/2	
	8	3T00B0ZZ0MG80								11 3/4			10 5/8	
	10	3T00B0ZZ0MGE0						12	7/8-9	14 1/4	7/8		12 3/4	
	12	3T00B0ZZ0MGF0				1-8				17			15	15

Carbon Steel Reducing Filler Flanges

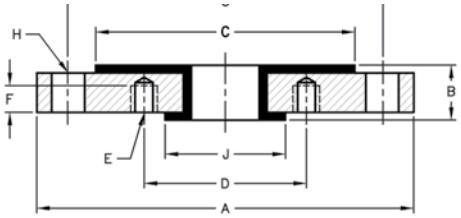
Non-Standard Sizes

PTFE-Lined, 150 lb. Flanged



Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	C	J	
16	3	3T00B0ZZ0MH30	1 11/16	23 1/2	16	1 1/8	21 1/4	4	5/8-11	6	3/4	18 1/2	5	---
	4	3T00B0ZZ0MH40						8		7 1/2			6 3/16	
	6	3T00B0ZZ0MH60							3/4-10	9 1/2	1		8 1/2	
	8	3T00B0ZZ0MH80								11 3/4			10 5/8	
	10	3T00B0ZZ0MHE0						12	7/8-9	14 1/4	7/8		12 3/4	
	12	3T00B0ZZ0MHF0								17			15	
18	3	3T00B0ZZ0MJ30	1 13/16	25	16	1 1/8	21 1/4	4	5/8-11	6	3/4	18 1/2	5	---
	4	3T00B0ZZ0MJ40						8		7 1/2			6 3/16	
	6	3T00B0ZZ0MJ60							3/4-10	9 1/2	1		8 1/2	
	8	3T00B0ZZ0MJ80								11 3/4			10 5/8	
	10	3T00B0ZZ0MJE0						12	7/8-9	14 1/4	7/8		12 3/4	
	12	3T00B0ZZ0MJF0								17			15	
20	8	3T00B0ZZ0MK80	1 15/16	27 1/2	20	1 1/4	25	8	3/4-10	11 3/4	1	23	10 5/8	---
	12	3T00B0ZZ0MKF0						12	7/8-9	17	1 1/8		15	
	18	3T00B0ZZ0MKJ0				1 1/8-7		16	1 1/8-7	22 3/4			21	
24	6	3T00B0ZZ0MM60	2 1/8	32	20	1 3/8	29 1/2	8	3/4-10	9 1/2	3/4	27 1/4	8 1/2	---
	10	3T00B0ZZ0MME0						12	7/8-9	14 1/4	1		12 3/4	
	12	3T00B0ZZ0MMF0								17			15	
30	10	3T00B0ZZ0MNE0	3 1/4	38 3/4	28	1 3/8	36	12	7/8-9	14 1/4	1 1/4	33 3/4	12 3/4	---
	12	3T00B0ZZ0MNF0	2 1/2							17	1		15	

Carbon Steel Reducing Filler Flanges
Straight-Through, Non-Taper Bore
PTFE-Lined, 150 lb. Flanged



Vacuum Rating
Although the liner cannot collapse and block flow due to vacuum, these items are technically not vacuum rated.
Repeated flexing due to vacuum cycling may reduce service life.

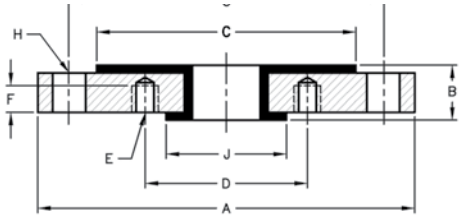
Sizes not shown may be available - contact factory.

Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	C	J	
1.5	1	3S00B0ZZ0MB10	13/16	5	4	1/2-13	3 7/8	4	1/2-13	3 1/8	7/16	2 7/8	2	45
2	1	3S00B0ZZ0M210	7/8	6	4	5/8-11	4 3/4	4	1/2-13	3 1/8	1/2	3 5/8	2	45
3	1	3S00B0ZZ0M310	1 3/16	7 1/2	4	5/8-11	6	4	1/2-13	3 1/8	5/8	5	2	---
	1.5	3S00B0ZZ0M3B0	1 5/16							3 7/8			2 7/8	
	2	3S00B0ZZ0M320							5/8-11	4 3/4			3 5/8	45
4	1	3S00B0ZZ0M410	1 5/16	9	8	3/4	7 1/2	4	1/2-13	3 1/8	11/16	6 3/16	2	---
	1.5	3S00B0ZZ0M4B0								3 7/8	5/8		2 7/8	
	2	3S00B0ZZ0M420							5/8-11	4 3/4			3 5/8	
	3	3S00B0ZZ0M430				5/8-11				6			5	
5	3	3S00B0ZZ0M530	1 5/16	10	8	3/4-10	8 1/2	4	5/8-11	6	5/8	7 5/16	5	---
6	1	3S00B0ZZ0M610	1 3/8	11	8	7/8	9 1/2	4	1/2-13	3 1/8	5/8	8 1/2	2	---
	1.5	3S00B0ZZ0M6B0								3 7/8			2 7/8	
	2	3S00B0ZZ0M620							5/8-11	4 3/4			3 5/8	
	3	3S00B0ZZ0M630								6			5	
	4	3S00B0ZZ0M640				3/4-10		8		7 1/2			6 3/16	22.5
8	2	3S00B0ZZ0M820	1 1/2	13 1/2	8	7/8	11 3/4	4	5/8-11	4 3/4	5/8	10 5/8	3 5/8	----
	3	3S00B0ZZ0M830								6			5	
	4	3S00B0ZZ0M840						8		7 1/2			6 3/16	
	6	3S00B0ZZ0M860				3/4-10			3/4-10	9 1/2	3/4		8 1/2	22.5
10	2	3S00B0ZZ0ME20	1 9/16	16	12	1	14 1/4	4	5/8-11	4 3/4	7/8	12 3/4	3 5/8	---
	3	3S00B0ZZ0ME30								6			5	
	4	3S00B0ZZ0ME40						8		7 1/2			6 3/16	
	6	3S00B0ZZ0ME60							3/4-10	9 1/2			8 1/2	
	8	3S00B0ZZ0ME80				7/8-9				11 3/4			10 5/8	
12	4	3S00B0ZZ0MF40	1 5/8	19	12	1	17	8	5/8-11	7 1/2	7/8	15	6 3/16	---
	6	3S00B0ZZ0MF60							3/4-10	9 1/2			8 1/2	
	8	3S00B0ZZ0MF80								11 3/4			10 5/8	
	10	3S00B0ZZ0MFE0				7/8-9		12	7/8-9	14 1/4			12 3/4	

Carbon Steel Reducing Filler Flanges

Straight-Through, Non-Taper Bore

PTFE-Lined, 150 lb. Flanged



Major Size (NPS)	Minor Size (NPS)	Part Numbers	Thick-ness	OD	H - Bolt Holes			E - Bolt Holes				Flare Diameters		Bolt Hole Rotation
					No.	Size	Bolt Circle Dia.	No.	Size	Bolt Circle Dia.	Depth			
			B	A			G			D	F	C	J	
14	6	3S00B0ZZ0MG60	1 3/4	21	12	1 1/8	18 3/4	8	3/4-10	9 1/2	7/8	16 1/4	8 1/2	---
	8	3S00B0ZZ0MG80								11 3/4			10 5/8	
	10	3S00B0ZZ0MGE0						12	7/8-9	14 1/4	1		12 3/4	
	12	3S00B0ZZ0MGF0				1-8				17			15	15°
16	8	3S00B0ZZ0MH80	1 13/16	23 1/2	16	1 1/8	21 1/4	8	3/4-10	11 3/4	7/8	18 1/2	10 5/8	---
	10	3S00B0ZZ0MHE0						12	7/8-9	14 1/4	1		12 3/4	
	12	3S00B0ZZ0MHF0								17			15	
18	10	3S00B0ZZ0MJE0	1 15/16	25	16	1 1/4	22 3/4	12	7/8-9	14 1/4	1	21	12 3/4	---
	12	3S00B0ZZ0MJF0								17			15	
20	12	3S00B0ZZ0MKF0	1 15/16	27 1/2	20	1 1/4	25	12	7/8-9	17	1	23	15	---
24	10	3S00B0ZZ0MME0	2 1/4	32	20	1 3/8	29 1/2	12	7/8-9	14 1/4	1 1/8	27 1/4	12 3/4	---
	12	3S00B0ZZ0MMF0								17			15	

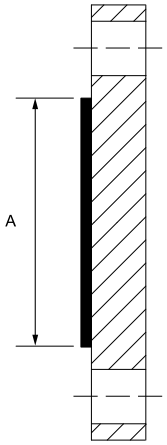
Blind Flanges
PTFE-Lined

Housing Material

FS = Forged Steel, ASTM A105

Flanges conform to ANSI B16.5.

Unlined blind flanges are intended for use with solid PTFE, PP, and PVDF blind spacers.



PTFE Liner Thickness = 1/8"

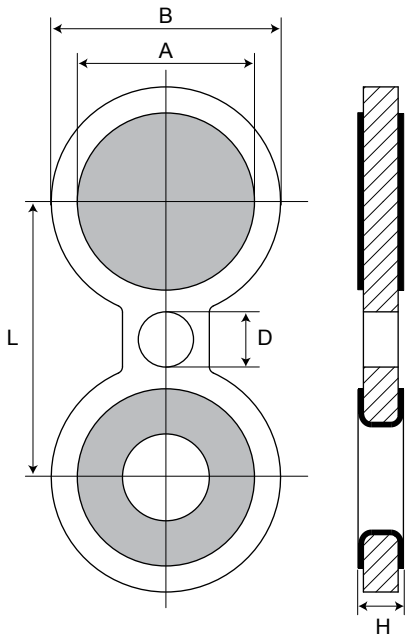
150lb. Flanged						
Size (NPS)	PTFE- Lined				Unlined	
	Part Number	A	Material		Part Number	Material
1	4000B0Z000100	2	FS		400000Z000100	FS
1.5	4000B0Z000B00	2 7/8	FS		400000Z000B00	FS
2	4000B0Z000200	3 5/8	FS		400000Z000200	FS
3	4000B0Z000300	5	FS		400000Z000300	FS
4	4000B0Z000400	6 3/16	FS		400000Z000400	FS
6	4000B0Z000600	8 1/2	FS		400000Z000600	FS
8	4000B0Z000800	10 5/8	FS		400000Z000800	FS
10	4000B0Z000E00	12 3/4	FS		400000Z000E00	FS
12	4000B0Z000F00	15	FS		400000Z000F00	FS

300lb. Flanged						
Size (NPS)	PTFE- Lined				Unlined	
	Part Number	A	Material		Part Number	Material
1	4000B0Y000100	2	FS		400000Y000100	FS
1.5	4000B0Y000B00	2 7/8	FS		400000Y000B00	FS
2	4000B0Y000200	3 5/8	FS		400000Y000200	FS
3	4000B0Y000300	5	FS		400000Y000300	FS
4	4000B0Y000400	6 3/16	FS		400000Y000400	FS
6	4000B0Y000600	8 1/2	FS		400000Y000600	FS
8	4000B0Y000800	10 5/8	FS		400000Y000800	FS

Spectacle Blind Flanges
PTFE-Lined

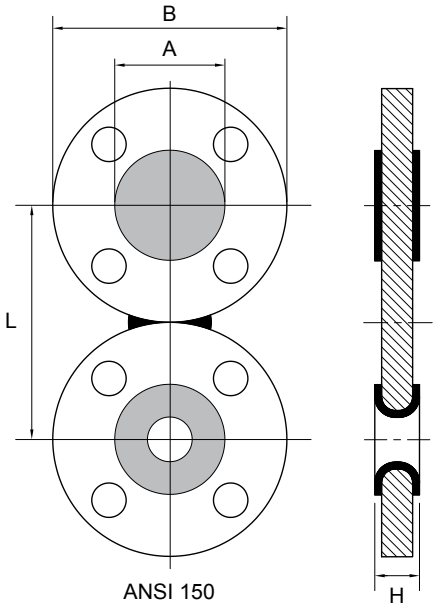
Ring Style

150 lb					
Size (NPS)	Dimensions (inches)				
	A	B	D	H	L
1	2	2 1/2	5/8	3/4	3 1/8
1.5	2 7/8	3 1/4	5/8	7/8	3 7/8
2	3 5/8	4	3/4	7/8	4 3/4
3	5	5 1/4	3/4	1 1/8	6
4	6 3/16	6 3/4	3/4	1 1/8	7 1/2
6	8 1/2	8 5/8	7/8	1 1/8	9 1/2
8	10 5/8	10 7/8	7/8	1 1/4	11 3/4
10	12 3/4	13 1/4	1	1 3/8	14 1/4
12	15	16	1	1 3/8	17



Full Face Style

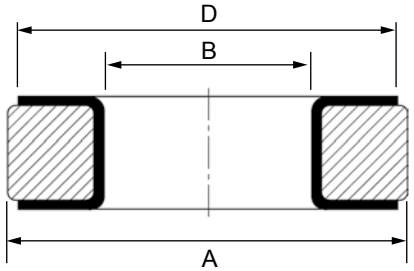
150 lb				
Size (NPS)	Dimensions (inches)			
	A	B	H	L
1	2	4 1/4	13/16	4 1/4
1.5	2 7/8	5	15/16	5
2	3 5/8	6	1	6
3	5	7 1/2	1 3/16	7 1/2
4	6 3/16	9	1 3/16	9
6	8 1/2	11	1 1/4	11
8	10 5/8	13 1/2	1 3/8	13 1/2
10	12 3/4	16	1 3/8	16
12	15	19	1 1/2	19



ANSI 150
Flange Bolt
Drilling

PTFE-Lined Ring Spacers

150 lb. Flanged				
Size (NPS)	Dimensions (in.)			
	A	B	D	Min. Length
1	2 5/8	3/4	2	1/2
1.5	3 3/8	1 3/8	2 7/8	
2	4 1/8	1 3/4	3 5/8	
3	5 3/8	2 3/4	5	
4	6 7/8	3 3/4	6 3/16	
6	8 3/4	5 23/32	8 1/2	3/4
8	11	7 11/16	10 5/8	1
10	13 3/8	9 11/16	12 3/4	
12	16 1/8	11 21/32	15	



Available in 1/16" increments between minimum length and 3.00".

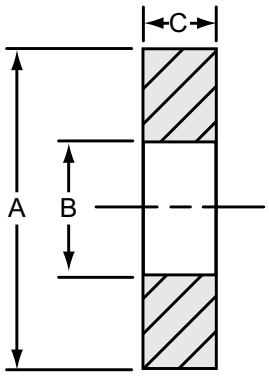
Spacers
PTFE / Polypropylene / PVDF

Class 150							
Size (NPS)	Ring	B		Full Face			
	A			D	Bolt Holes		Bolt Circle Dia.
		PP/PVDF	PTFE		No.	Size	
1	2 5/8	11/16	1	4 1/4	4	5/8	3 1/8
1.5	3 3/8	1 5/16	1.5	5			3 7/8
2	4 1/8	1 3/4	2	6		3/4	4 3/4
2.5	4 7/8	2 3/32	2.5	7			5 1/2
3	5 3/8	2 11/16	3	7 1/2			6
4	6 7/8	3 5/8	4	9	8		7 1/2
6	8 3/4	5 9/16	6	11		7/8	9 1/2
8	11	7 1/2	8	13 1/2			11 3/4
10	13 3/8	9 11/16	10	16	12	1	14 1/4
12	16 1/8	12	12	19			17

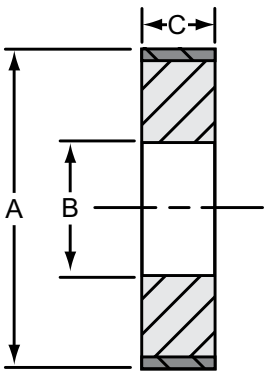
Class 300							
Size (NPS)	Ring	B		Full Face			
	A			D	Bolt Holes		Bolt Circle Dia.
		PP/PVDF	PTFE		No.	Size	
1	2 7/8	11/16	1	4 7/8	4	3/4	3 1/2
1.5	3 3/4	1 5/16	1.5	6 1/8		7/8	4 1/2
2	4 3/8	1 3/4	2	6 1/2	8	3/4	5
2.5	5 1/8	2 3/32	2.5	7 1/2		7/8	5 7/8
3	5 7/8	2 11/16	3	8 1/4			6 5/8
4	7 1/8	3 5/8	4	10			7 7/8
6	9 7/8	5 9/16	6	12 1/2	12		10 5/8
8	12 1/8	7 1/2	8	15		1	13

Standard thickness “C” is 1/2”. Custom thickness can be made upon request. Maximum thickness = 3”.

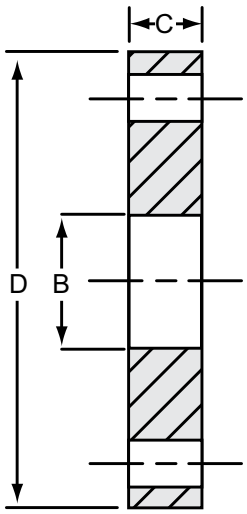
All spacers are available with many different possible modifications. Spacers may be supplied as tapered, special bored, orifice tapped, taper bored for butterfly valves, reducing, blind, etc. If such custom-machined spacers are required, consult the factory.



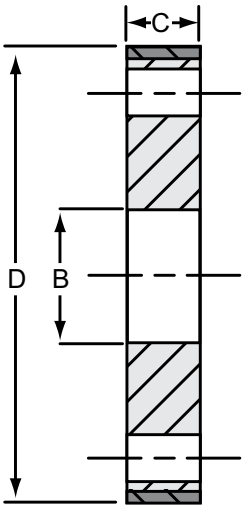
Ring Spacer



Armored Ring Spacer



Full Face Spacer



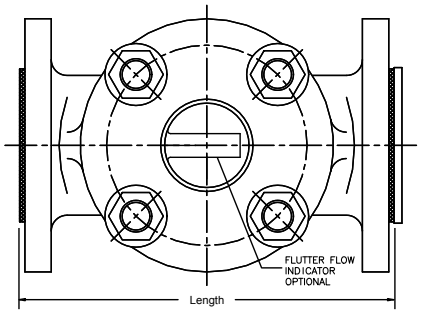
Armored Full Face Spacer

Bull's Eye Sight Flow Indicators
PTFE-Lined, 150 lb. Flanged

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 ANSI 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.



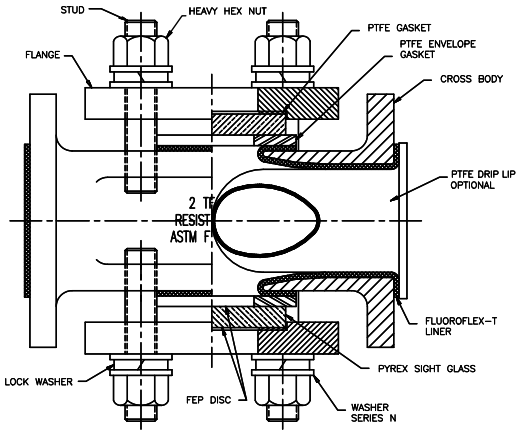
Notes: Ductile Iron (A395) Bull's Eye Sight Indicators have vacuum ratings as shown in the table and their maximum temperature rating is 400°F.
100% of Bull's Eye Sight Indicators are hydrostatically tested at 425 psig prior to shipment.

*Pyrex is a Corning Glassworks trademark.

Ductile Iron Bull's Eye Sight Indicator

Size (NPS)	Part #	Length	Vacuum Rating (in. Hg/ F)
1	5000B1VV0N100	7	FV/300
1 1/2	5000B1VV0NB00	8	FV/250
2	5000B1VV0N200	9	FV/250
3	5000B1VV0N300	11	FV/200
4	5000B1VV0N400	13	25/200
6	5000B1VV0N600	16	No Vacuum

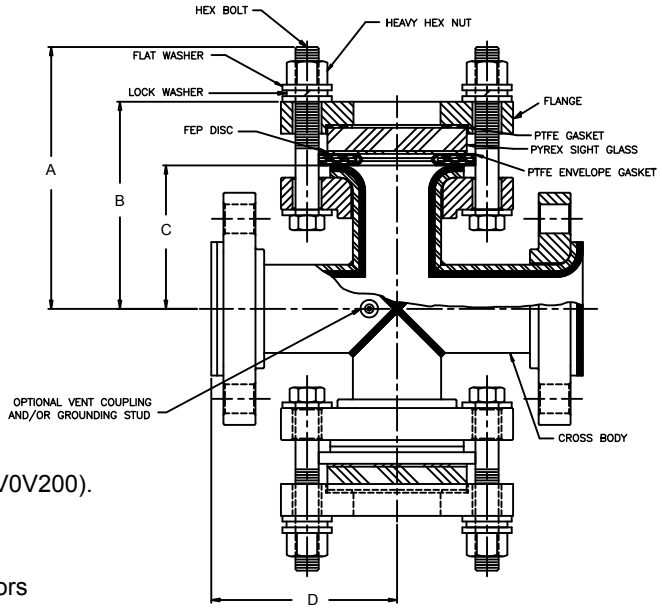
Vacuum ratings for this product are for steady-state vacuum, only. Frequent vacuum cycling may reduce service life.



If the Sight Indicator is to include a Flutter Flow Indicator, the second character in the part number should be "F" (5F00B1VV0N200). If it is to include a Drip Lip, the third character of the part number should be "D" (50D0B1VV0N200). If both a drip lip and a flutter flow are required, use both characters (5DF0B1VV0N200).

Fabricated Bull's Eye Sight Indicator in CS or SS

Size (NPS)	Part Number	A	B	C	D
1	5000M3VV0V100	4.806	3.914	2.605	3.500
1.5	5000M3VV0VB00	5.575	4.475	3.103	4.000
2	5000M3VV0V200	5.857	4.924	3.490	4.500
3	5000M3VV0V300	7.035	6.102	4.299	5.500
4	5000M3VV0V400	7.572	6.764	4.954	6.500
6	5000M3VV0V600	9.354	8.425	6.330	8.000



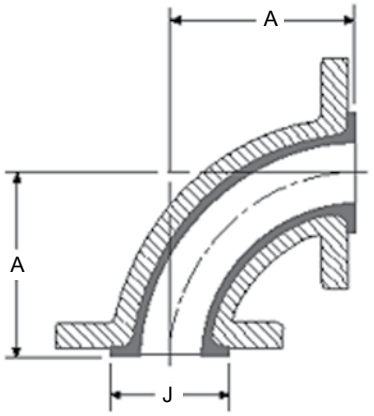
- Fabricated sight indicators are rated for full vacuum to 400°F.
- If the Sight Indicator is to include a Flutter Flow Indicator, the second character in the part number should be "F" (5F000M3VV0V200).
- 100% of Fabricated Bull's Eye Sight Indicators are hydrostatically tested at 425 psig prior to shipment.
- Drip Lip Option Not Available on Fabricated Bull's Eye Sight Indicators

90° Elbows
Polypropylene / PVDF / PFA-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.



150 lb. Flanged						
Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)	
		Polypropylene	PVDF	PFA	A	J
1	DI	E900P1VV0N100	E900K1VV0N100	N/A	3 1/2	1 7/8
	CAST STEEL	E900P2ZZ0N100	E900K2ZZ0N100	E900Q2ZZ0N100		
1.5	DI	E900P1VV0NB00	E900K1VV0NB00	N/A	4	2 11/16
	CAST STEEL	E900P2ZZ0NB00	E900K2ZZ0NB00	E900Q2ZZ0NB00		
2	DI	E900P1VV0N200	E900K1VV0N200	N/A	4 1/2	3 7/16
	CAST STEEL	E900P2ZZ0N200	E900K2ZZ0N200	E900Q2ZZ0N200		
3	DI	E900P1VV0N300	E900K1VV0N300	N/A	5 1/2	4 5/8
	CAST STEEL	E900P2ZZ0N300	E900K2ZZ0N300	E900Q2ZZ0N300		
4	DI	E900P1VV0N400	E900K1VV0N400	N/A	6 1/2	5 15/16
	CAST STEEL	E900P2ZZ0N400	E900K2ZZ0N400	E900Q2ZZ0N400		
6	DI	E900P1VV0N600	E900K1VV0N600	N/A	8	8
	CAST STEEL	E900P2ZZ0N600	E900K2ZZ0N600	N/A		
8	DI	E900P1VV0N800	E900K1VV0N800	N/A	9	10 1/16
	CAST STEEL	E900P2ZZ0N800	E900K2ZZ0N800	N/A		
10	CAST STEEL	E900P2ZZ0NE00	N/A	N/A	11	12 3/4
12	CAST STEEL	E900P2ZZ0NF00			12	15

300 lb. Flanged					
Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)	
		Polypropylene	PVDF	A	J
1"	CAST STEEL	E900P9YY0N100	E900K9YY0N100	4	1 7/8
1.5"		E900P9YY0NB00	E900K9YY0NB00	4 1/2	2 11/16
2"		E900P9YY0N200	E900K9YY0N200	5	3 7/16
3"		E900P9YY0N300	E900K9YY0N300	6	4 5/8
4"		E900P9YY0N400	E900K9YY0N400	7	5 15/16
6"		E900P9YY0N600	E900K9YY0N600	8 1/2	8

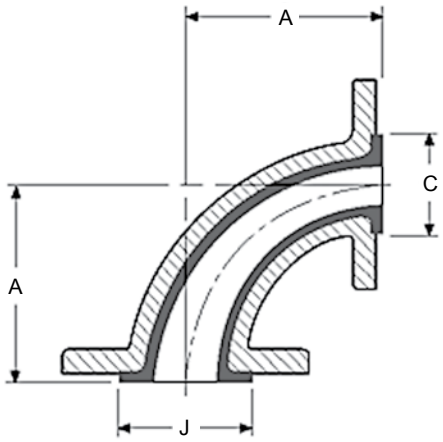
NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Reducing 90° Elbows
Polypropylene / PVDF / PFA-Lined, 150 lb. Flanged

Housing Materials
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-Lined fitting housings are castings.
Flanges are fixed.



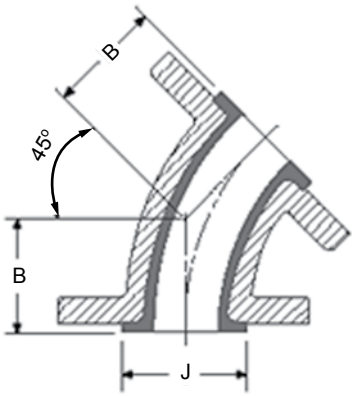
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)		
			Polypropylene	PVDF	PFA	A	J	C
1.5	1	CAST STEEL	E9R0P2ZZ0NB10	E9R0K2ZZ0NB10	E9R0Q2ZZ0NB10	4	2 11/16	1 7/8
2	1		E9R0P2ZZ0N210	E9R0K2ZZ0N210	E9R0Q2ZZ0N210	4 1/2	3 7/16	1 7/8
	1.5		E9R0P2ZZ0N2B0	E9R0K2ZZ0N2B0	E9R0Q2ZZ0N2B0			2 11/16
3	1		E9R0P2ZZ0N310	E9R0K2ZZ0N310	E9R0Q2ZZ0N310	5 1/2	4 5/8	1 7/8
	1.5		E9R0P2ZZ0N3B0	E9R0K2ZZ0N3B0	E9R0Q2ZZ0N3B0			2 11/16
	2		E9R0P2ZZ0N320	E9R0K2ZZ0N320	E9R0Q2ZZ0N320			3 7/16
4	1		E9R0P2ZZ0N410	E9R0K2ZZ0N410	E9R0Q2ZZ0N410	6 1/2	5 15/16	1 7/8
	1.5		E9R0P2ZZ0N4B0	E9R0K2ZZ0N4B0	E9R0Q2ZZ0N4B0			2 11/16
	2		E9R0P2ZZ0N420	E9R0K2ZZ0N420	E9R0Q2ZZ0N420			3 7/16
	3		E9R0P2ZZ0N430	E9R0K2ZZ0N430	E9R0Q2ZZ0N430			4 5/8
6	2		E9R0P2ZZ0N620	E9R0K2ZZ0N620	N/A	8	8	3 7/16
	3		E9R0P2ZZ0N630	E9R0K2ZZ0N630				4 5/8
	4		E9R0P2ZZ0N640	E9R0K2ZZ0N640				5 15/16
8	4		E9R0P2ZZ0N840	E9R0K2ZZ0N840		9	10 1/16	5 15/16
	6		E9R0P2ZZ0N860	E9R0K2ZZ0N860				8

45° Elbows
Polypropylene / PVDF / PFA-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are castings.
Flanged are fixed.

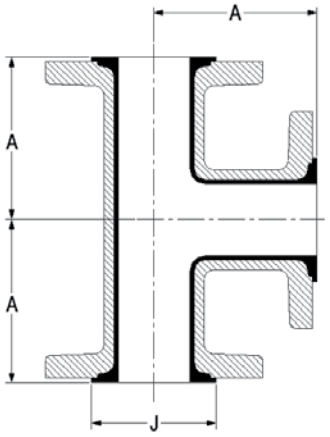


150 lb. Flanged						
Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)	
		Polypropylene	PVDF	PFA	B	J
1	DI	E500P1VV0N100	E500K1VV0N100	N/A	1 3/4	1 7/8
	CAST STEEL	E500P2ZZ0N100	E500K2ZZ0N100	E500Q2ZZ0N100		
1.5	DI	E500P1VV0NB00	E500K1VV0NB00	N/A	2 1/4	2 11/16
	CAST STEEL	E500P2ZZ0NB00	E500K2ZZ0NB00	E500Q2ZZ0NB00		
2	DI	E500P1VV0N200	E500K1VV0N200	N/A	2 1/2	3 7/16
	CAST STEEL	E500P2ZZ0N200	E500K2ZZ0N200	E500Q2ZZ0N200		
3	DI	E500P1VV0N300	E500K1VV0N300	N/A	3	4 5/8
	CAST STEEL	E500P2ZZ0N300	E500K2ZZ0N300	E500Q2ZZ0N300		
4	DI	E500P1VV0N400	E500K1VV0N400	N/A	4	5 15/16
	CAST STEEL	E500P2ZZ0N400	E500K2ZZ0N400	E500Q2ZZ0N400		
6	DI	E500P1VV0N600	E500K1VV0N600	N/A	5	8
	CAST STEEL	E500P2ZZ0N600	E500K2ZZ0N600	N/A		
8	DI	E500P1VV0N800	E500K1VV0N800	N/A	5 1/2	10 1/16
	CAST STEEL	E500P2ZZ0N800	E500K2ZZ0N800	N/A		
10	CAST STEEL	E500P2ZZ0NE00	N/A	N/A	6 1/2	12 3/4
12	CAST STEEL	E500P2ZZ0NF00			7 1/2	15

300 lb. Flanged					
Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)	
		Polypropylene	PVDF	B	J
1	CAST STEEL	E500P9YY0N100	E500K9YY0N100	2 1/4	1 7/8
1.5		E500P9YY0NB00	E500K9YY0NB00	2 3/4	2 11/16
2		E500P9YY0N200	E500K9YY0N200	3	3 7/16
3		E500P9YY0N300	E500K9YY0N300	3 1/2	4 5/8
4		E500P9YY0N400	E500K9YY0N400	4 1/2	5 15/16
6		E500P9YY0N600	E500K9YY0N600	5 1/2	8

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Equal Tees
Polypropylene / PVDF / PFA-Lined



Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.

150 lb. Flanged						
Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)	
		Polypropylene	PVDF	PFA	A	J
1	DI	TN00P1VVVN100	TN00K1VVVN100	N/A	3 1/2	1 7/8
	CAST STEEL	TN00P2ZZZN100	TN00K2ZZZN100	TN00Q2ZZZN100		
1.5	DI	TN00P1VVVNB00	TN00K1VVVNB00	N/A	4	2 11/16
	CAST STEEL	TN00P2ZZZNB00	TN00K2ZZZNB00	TN00Q2ZZZNB00		
2	DI	TN00P1VVVN200	TN00K1VVVN200	N/A	4 1/2	3 7/16
	CAST STEEL	TN00P2ZZZN200	TN00K2ZZZN200	TN00Q2ZZZN200		
3	DI	TN00P1VVVN300	TN00K1VVVN300	N/A	5 1/2	4 5/8
	CAST STEEL	TN00P2ZZZN300	TN00K2ZZZN300	TN00Q2ZZZN300		
4	DI	TN00P1VVVN400	TN00K1VVVN400	N/A	6 1/2	5 15/16
	CAST STEEL	TN00P2ZZZN400	TN00K2ZZZN400	TN00Q2ZZZN400		
6	DI	TN00P1VVVN600	TN00K1VVVN600	N/A	8	8
	CAST STEEL	TN00P2ZZZN600	TN00K2ZZZN600	N/A		
8	DI	TN00P1VVVN800	TN00K1VVVN800	N/A	9	10 1/16
	CAST STEEL	TN00P2ZZZN800	TN00K2ZZZN800	N/A		
10	CAST STEEL	TN00P2ZZZNE00	N/A	N/A	11	12 3/4
12	CAST STEEL	TN00P2ZZZNF00	N/A	N/A	12	15

300lb. Flanged - Cast Steel Body Only					
Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)	
		Polypropylene	PVDF	A	J
1	CAST STEEL	TN00P9YYYN100	TN00K9YYYN100	4	1 7/8
1.5		TN00P9YYYNB00	TN00K9YYYNB00	4 1/2	2 11/16
2		TN00P9YYYN200	TN00K9YYYN200	5	3 7/16
3		TN00P9YYYN300	TN00K9YYYN300	6	4 5/8
4		TN00P9YYYN400	TN00K9YYYN400	7	5 15/16
6		TN00P9YYYN600	TN00K9YYYN600	8 1/2	8

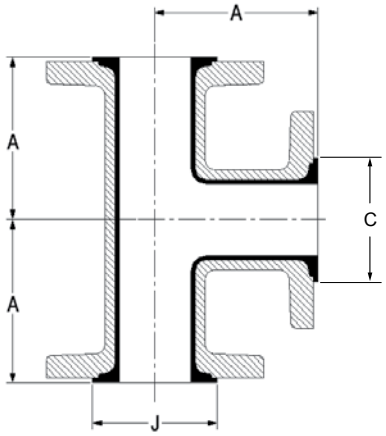
NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Reducing Tees
Polypropylene / PVDF / PFA-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.



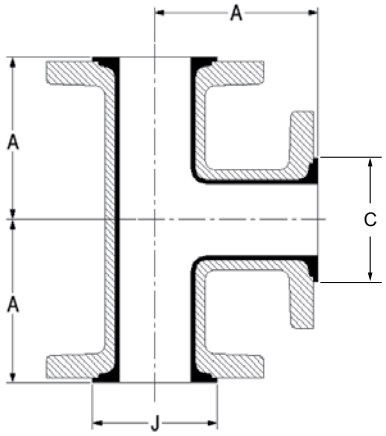
150 lb. Flanged								
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)		
			Polypropylene	PVDF	PFA	A	J	C
1.5	1	DI	TR00P1VVVNB10	TR00K1VVVNB10	N/A	4	2 11/16	1 7/8
		CAST STEEL	TR00P2ZZZNB10	TR00K2ZZZNB10	TR00Q2ZZZNB10			
2	1	DI	TR00P1VVVN210	TR00K1VVVN210	N/A	4 1/2	3 7/16	1 7/8
		CAST STEEL	TR00P2ZZZN210	TR00K2ZZZN210	TR00Q2ZZZN210			
	1.5	DI	TR00P1VVVN2B0	TR00K1VVVN2B0	N/A			2 11/16
		CAST STEEL	TR00P2ZZZN2B0	TR00K2ZZZN2B0	TR00Q2ZZZN2B0			
3	1	DI	TR00P1VVVN310	TR00K1VVVN310	N/A	5 1/2	4 5/8	1 7/8
		CAST STEEL	TR00P2ZZZN310	TR00K2ZZZN310	TR00Q2ZZZN310			
	1.5	DI	TR00P1VVVN3B0	TR00K1VVVN3B0	N/A			2 11/16
		CAST STEEL	TR00P2ZZZN3B0	TR00K2ZZZN3B0	TR00Q2ZZZN3B0			
	2	DI	TR00P1VVVN320	TR00K1VVVN320	N/A			3 7/16
		CAST STEEL	TR00P2ZZZN320	TR00K2ZZZN320	TR00Q2ZZZN320			
	2.5	DI	TR00P1VVVN3C0	TR00K1VVVN3C0	N/A			3 15/16
4	1	DI	TR00P1VVVN410	TR00K1VVVN410	N/A	6 1/2	5 15/16	1 7/8
		CAST STEEL	TR00P2ZZZN410	TR00K2ZZZN410	TR00Q2ZZZN410			
	1.5	DI	TR00P1VVVN4B0	TR00K1VVVN4B0	N/A			2 11/16
		CAST STEEL	TR00P2ZZZN4B0	TR00K2ZZZN4B0	TR00Q2ZZZN4B0			
	2	DI	TR00P1VVVN420	TR00K1VVVN420	N/A			3 7/16
		CAST STEEL	TR00P2ZZZN420	TR00K2ZZZN420	TR00Q2ZZZN420			
	3	DI	TR00P1VVVN430	TR00K1VVVN430	N/A			4 5/8
		CAST STEEL	TR00P2ZZZN430	TR00K2ZZZN430	TR00Q2ZZZN430			

Reducing Tees
Polypropylene / PVDF / PFA-Lined

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.



150lb. Flanged, cont'd.								
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)		
			Polypropylene	PVDF	PFA	A	J	C
6	1	DI	TR00P1VVVN610	N/A	N/A	8	9	1 7/8
		CAST STEEL	TR00P2ZZZN610	TR00K2ZZZN610				
	1.5	DI	TR00P1VVVN6B0	N/A	N/A	8	9	2 11/16
		CAST STEEL	TR00P2ZZZN6B0	TR00K2ZZZN6B0	N/A			
	2	DI	TR00P1VVVN620	N/A	N/A	8	9	3 7/16
		CAST STEEL	TR00P2ZZZN620	TR00K2ZZZN620	N/A			
	3	DI	TR00P1VVVN630	N/A	N/A	8	9	4 5/8
		CAST STEEL	TR00P2ZZZN630	TR00K2ZZZN630	N/A			
	4	DI	TR00P1VVVN640	N/A	N/A	8	9	5 15/16
		CAST STEEL	TR00P2ZZZN640	TR00K2ZZZN640	N/A			
8	1	CAST STEEL	TR00P2ZZZN810	TR00K2ZZZN810	N/A	9	10 1/16	1 7/8
	1.5		TR00P2ZZZN8B0	TR00K2ZZZN8B0	N/A	9	10 1/16	2 11/16
	2	DI	TR00P1VVVN820	N/A	N/A	9	10 1/16	3 7/16
		CAST STEEL	TR00P2ZZZN820	TR00K2ZZZN820				
	3	DI	TR00P1VVVN830	N/A	N/A	9	10 1/16	4 5/8
		CAST STEEL	TR00P2ZZZN830	TR00K2ZZZN830				
	4	DI	TR00P1VVVN840	N/A	N/A	9	10 1/16	5 15/16
		CAST STEEL	TR00P2ZZZN840	TR00K2ZZZN840				
	6	DI	TR00P1VVVN860	N/A	N/A	9	10 1/16	8
		CAST STEEL	TR00P2ZZZN860	TR00K2ZZZN860				

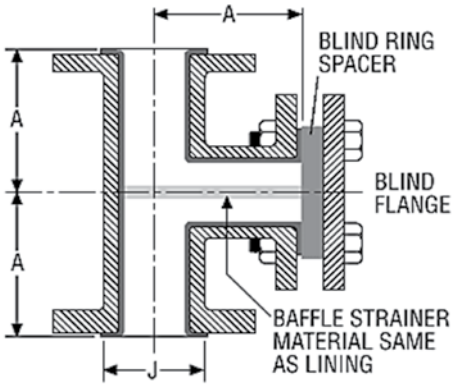
300lb. Flanged							
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)		
			Polypropylene	PVDF	A	J	C
1.5	1	CAST STEEL	TR00P9YYYNB10	N/A	4 1/2	2 11/16	1 7/8
2			TR00P9YYYN210	TR00K9YYYN210	5	3 7/16	1 7/8
3	2		TR00P9YYYN320	TR00K9YYYN320	6	4 5/8	3 7/16
4			TR00P9YYYN420	TR00K9YYYN420	7	5 15/16	3 7/16

Strainer Tee Assembly
PP / PVDF-Lined, 150 lb. Flanged

Housing Material
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.

Note: 12th character in the part number indicates the size of the holes in the strainer. All part numbers in the table are shown with an “R”, which indicates 1/8” holes. The following are the available hole sizes and their corresponding character:
Q = 1/16”; R = 1/8”; S = 3/16”; T = 1/4”; U = 5/16”; V = 3/8”



If other hole sizes are required, please contact the factory.

Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material		Dimensions (in.)	
		Polypropylene	PVDF	A	J
1	DI	T807P1VVVN1R0	T807K1VVVN1R0	3 1/2	1 7/8
	CAST STEEL	T807P2ZZZN1R0	T807K2ZZZN1R0		
1 1/2	DI	T807P1VVVNBR0	T807K1VVVNBR0	4	2 11/16
	CAST STEEL	T807P2ZZZNBR0	T807K2ZZZNBR0		
2	DI	T807P1VVVN2R0	T807K1VVVN2R0	4 1/2	3 7/16
	CAST STEEL	T807P2ZZZN2R0	T807K2ZZZN2R0		
3	DI	T807P1VVVN3R0	T807K1VVVN3R0	5 1/2	4 5/8
	CAST STEEL	T807P2ZZZN3R0	T807K2ZZZN3R0		
4	DI	T807P1VVVN4R0	T807K1VVVN4R0	6 1/2	5 15/16
	CAST STEEL	T807P2ZZZN4R0	T807K2ZZZN4R0		
6	DI	T807P1VVVN6R0	T807K1VVVN6R0	8	8
	CAST STEEL	T807P2ZZZN6R0	T807K2ZZZN6R0		
8	DI	T807P1VVVN8R0	T807K1VVVN8R0	9	10 1/16
	CAST STEEL	T807P2ZZZN8R0	T807K2ZZZN8R0		

Note: Plastic-lined baffle tee strainers are designed to prevent relatively large particles from passing. These are not designed to be fine particulate screens or filters.

Instrument Tees with 1" Branch

Polypropylene / PVDF / PFA-Lined

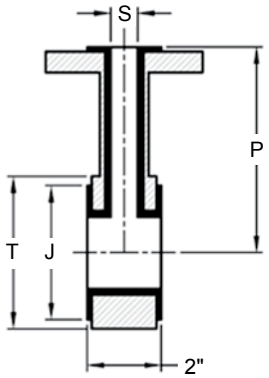
Housing Materials

CAST STEEL = ASTM A216

Vacuum Ratings

Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum-ratings of PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are castings, except for 6" and 8" size PFA. Flanged are fixed.



150 lb. Flanged								
Size (NPS)	Housing Material	Part Numbers by Liner Material			Dimensions (in.)			
		Polypropylene	PVDF	PFA	P	T	J	S
1	CAST STEEL	T400P200ZN110	T400K200ZN110	T400Q200ZN110	3 1/2	2 5/8	1 7/8	5/8
1.5		T400P200ZNB10	T400K200ZNB10	T400Q200ZNB10	4	3 3/8	2 11/16	
2		T400P200ZN210	T400K200ZN210	T400Q200ZN210	4 1/2	4 1/8	3 7/16	
3		T400P200ZN310	T400K200ZN310	T400Q200ZN310	5 1/2	5 3/8	4 5/8	
4		T400P200ZN410	T400K200ZN410	T400Q200ZN410	6 1/2	6 3/4	5 15/16	
6		T400P200ZN610	T400K200ZN610	N/A	8	8 3/4	8	
8		T400P200ZN810	T400K200ZN810	N/A	9	11	10 1/16	
10		T400P200ZNE10	N/A		11	13 3/8	12	
12		T400P200ZNF10			12	16 1/8	14 1/2	

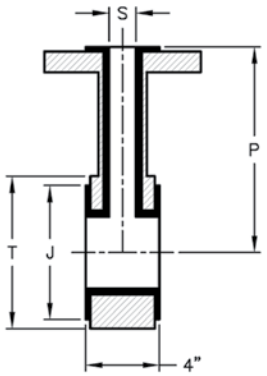
NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

300 lb. Flanged							
Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)			
		Polypropylene	PVDF	P	T	J	S
1	CAST STEEL	T400P200YN110	T400K200YN110	4	2 7/8	1 7/8	5/8
1.5		T400P200YNB10	T400K200YNB10	4 1/2	3 3/4	2 11/16	
2		T400P200YN210	T400K200YN210	5	4 3/8	3 7/16	
3		T400P200YN310	T400K200YN310	6	5 7/8	4 5/8	
4		T400P200YN410	T400K200YN410	7	7 1/8	5 15/16	
6		T400P200YN610	T400K200YN610	8 1/2	9 7/8	8	

Instrument Tees with 1.5" Branch
Polypropylene / PVDF / PFA-Lined

Housing Materials
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum-ratings of PFA-lined fittings.
Note: All PP / PVDF / PFA-lined fitting housings are castings, except for 6" and 8" size PFA. Flanged are fixed.



150 lb. Flanged								
Size (NPS)	Housing Material	Part Numbers by Liner Material			Dimensions (in.)			
		Polypropylene	PVDF	PFA	P	T	J	S
1.5	CAST STEEL	T400P200ZNBB0	T400K200ZNBB0	T400Q200ZNBB0	4	3 3/8	2 11/16	1 1/8
2		T400P200ZN2B0	T400K200ZN2B0	T400Q200ZN2B0	4 1/2	4 1/8	3 7/16	
3		T400P200ZN3B0	T400K200ZN3B0	T400Q200ZN3B0	5 1/2	5 3/8	4 5/8	
4		T400P200ZN4B0	T400K200ZN4B0	T400Q200ZN4B0	6 1/2	6 3/4	5 15/16	
6		T400P200ZN6B0	T400K200ZN6B0	N/A	8	8 3/4	8	
8		T400P200ZN8B0	T400K200ZN8B0	N/A	9	11	10 1/16	
10		T400P200ZNEB0	N/A		11	13 3/8	12	
12		T400P200ZNFB0			12	16 1/8	14 1/2	

NOTE: 6" and 8" PFA-lined instrument tees with 1.5" branch are fabricated steel with a fixed branch flange.

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Instrument Tees with 2" Branch

Polypropylene / PVDF / PFA-Lined

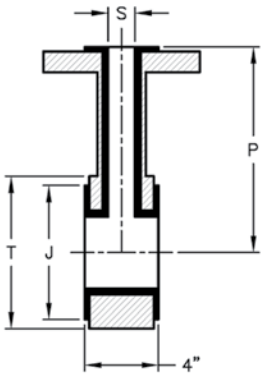
Housing Materials

CAST STEEL = ASTM A216

Vacuum Ratings

Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum-ratings of PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are castings, except for 6" and 8" size PFA. Flanged are fixed.



150 lb. Flanged								
Size (NPS)	Housing Material	Part Numbers by Liner Material			Dimensions (in.)			
		Polypropylene	PVDF	PFA	P	T	J	S
2	CAST STEEL*	T400P200ZN220	T400K200ZN220	T400Q200ZN220	4 1/2	4 1/8	3 7/16	1 5/8
3		T400P200ZN320	T400K200ZN320	T400Q200ZN320	5 1/2	5 3/8	4 5/8	
4[1]		T400P200ZN420	T400K200ZN420	T400Q200ZN420	6 1/2	6 3/4	5 15/16	
6		T400P200ZN620	T400K200ZN620	N/A	8	8 3/4	8	
8		T400P200ZN820	T400K200ZN820	N/A	9	11	10 1/16	
10		T400P200ZNE20	N/A		11	13 3/8	12	
12		T400P200ZNF20			12	16 1/8	14 1/2	

Note 1: 4" x 2" requires two 1/2" bolts to straddle the branch OD.

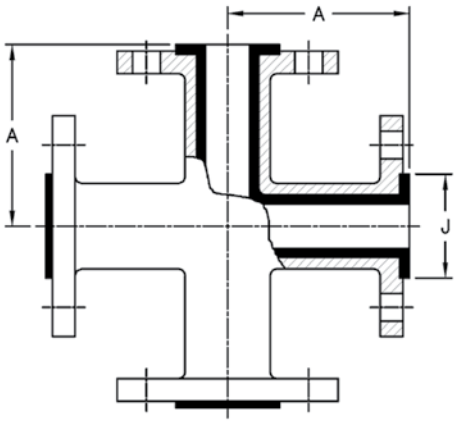
NOTE: 6" and 8" PFA-lined instrument tees with 2" branch are fabricated steel with a fixed branch flange.

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Crosses
Polypropylene / PVDF / PFA-Lined, 150 lb. Flanged

Housing Materials
CAST STEEL = ASTM A216
Crosses are not available with DI housings.

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings of PFA-lined fittings.
Note: All PP / PVDF-lined fitting housings are Castings.
Flanged are fixed.



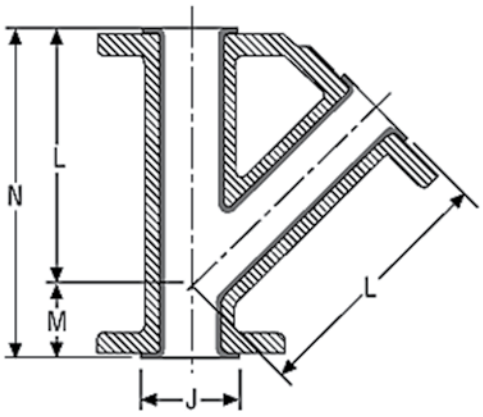
Size (NPS)	Housing Material	Part Numbers by Liner Material			Dimensions (in.)	
		Polypropylene	PVDF	PFA	A	J
1"	CAST STEEL	CN00P2ZZZN100	CN00K2ZZZN100	CN00Q2ZZZN100	3 1/2	1 7/8
1.5"		CN00P2ZZZNB00	CN00K2ZZZNB00	CN00Q2ZZZNB00	4	2 11/16
2"		CN00P2ZZZN200	CN00K2ZZZN200	CN00Q2ZZZN200	4 1/2	3 7/16
3"		CN00P2ZZZN300	CN00K2ZZZN300	CN00Q2ZZZN300	5 1/2	4 5/8
4"		CN00P2ZZZN400	CN00K2ZZZN400	CN00Q2ZZZN400	6 1/2	5 15/16
6"		CN00P2ZZZN600	CN00K2ZZZN600	N/A	8	8
8"		CN00P2ZZZN800	CN00K2ZZZN800		9	10 1/16

45° Laterals
Polypropylene / PVDF-Lined, 150 lb. Flanged

Housing Materials
CAST STEEL = ASTM A216
Laterals are not available with DI housings.

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.

Note: All PP / PVDF-lined fitting housings are Castings.
Flanged are fixed.



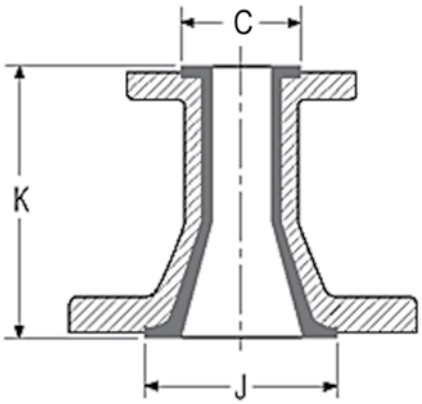
150 lb. Flanged							
Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)			
		Polypropylene	PVDF	L	M	N	J
1	CAST STEEL	LN00P2ZZZN100	LN00K2ZZZN100	5 3/4	1 3/4	7 1/2	1 7/8
1.5		LN00P2ZZZNB00	LN00K2ZZZNB00	7	2	9	2 11/16
2		LN00P2ZZZN200	LN00K2ZZZN200	8	2 1/2	10 1/2	3 7/16
3		LN00P2ZZZN300	LN00K2ZZZN300	10	3	13	4 5/8
4		LN00P2ZZZN400	LN00K2ZZZN400	12	3	15	5 15/16
6		LN00P2ZZZN600	LN00K2ZZZN600	14 1/2	3 1/2	18	8
8		LN00P2ZZZN800	LN00K2ZZZN800	17 1/2	4 1/2	22	10 1/16

Concentric Reducers
Polypropylene / PVDF / PFA-Lined, 150 lb. Flanged

Housing Materials
DI = ASTM A395 Cast Ductile Iron
CAST STEEL = ASTM A216

Vacuum Ratings
Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.



150lb. Flanged								
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)		
			Polypropylene	PVDF	PFA	K	J	C
1.5	1	DI	6000P1VV0NB10	6000K1VV0NB10	N/A	4 1/2	2 11/16	1 7/8
		CAST STEEL	6000P2ZZ0NB10	6000K2ZZ0NB10	6000Q2ZZ0NB10			
2	1	DI	6000P1VV0N210	6000K1VV0N210	N/A	5	3 7/16	1 7/8
		CAST STEEL	6000P2ZZ0N210	6000K2ZZ0N210	6000Q2ZZ0N210			
	1.5	DI	6000P1VV0N2B0	6000K1VV0N2B0	N/A			2 11/16
		CAST STEEL	6000P2ZZ0N2B0	6000K2ZZ0N2B0	6000Q2ZZ0N2B0			
3	1.5	DI	6000P1VV0N3B0	6000K1VV0N3B0	N/A	6	4 5/8	2 11/16
		CAST STEEL	6000P2ZZ0N3B0	6000K2ZZ0N3B0	6000Q2ZZ0N3B0			
	2	DI	6000P1VV0N320	6000K1VV0N320	N/A			3 7/16
		CAST STEEL	6000P2ZZ0N320	6000K2ZZ0N320	6000Q2ZZ0N320			
	2.5	DI	6000P1VV0N3C0	6000K1VV0N3C0	N/A			3 15/16
		CAST STEEL	N/A	N/A				
4	1	DI	6000P1VV0N410	6000K1VV0N410	N/A	7	5 15/16	1 7/8
		CAST STEEL	6000P2ZZ0N410	6000K2ZZ0N410	6000Q2ZZ0N410			
	1.5	DI	6000P1VV0N4B0	6000K1VV0N4B0	N/A			2 11/16
		CAST STEEL	6000P2ZZ0N4B0	6000K2ZZ0N4B0	6000Q2ZZ0N4B0			
	2	DI	6000P1VV0N420	6000K1VV0N420	N/A			3 7/16
		CAST STEEL	6000P2ZZ0N420	6000K2ZZ0N420	6000Q2ZZ0N420			
	2 1/2	DI	6000P1VV0N4C0	N/A	N/A			3 15/16
	3	DI	6000P1VV0N430	6000K1VV0N430	N/A			4 5/8
		CAST STEEL	6000P2ZZ0N430	6000K2ZZ0N430	6000Q2ZZ0N430			

Concentric Reducers
Polypropylene / PVDF / PFA-Lined, 150 lb. Flanged

150 lb. Flanged								
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material and Housing Material			Dimensions (in.)		
			Polypropylene	PVDF	PFA	K	J	C
6	1	DI	6000P1VV0N610	6000K1VV0N610	N/A	9	8	1 7/8
		CAST STEEL	6000P2ZZ0N610	6000K2ZZ0N610				
	1.5	DI	6000P1VV0N6B0	6000K1VV0N6B0				2 11/16
		CAST STEEL	6000P2ZZ0N6B0	6000K2ZZ0N6B0	N/A			
	2	DI	6000P1VV0N620	6000K1VV0N620	N/A			3 7/16
		CAST STEEL	6000P2ZZ0N620	6000K2ZZ0N620	N/A			
	3	DI	6000P1VV0N630	6000K1VV0N630	N/A			4 5/8
		CAST STEEL	6000P2ZZ0N630	6000K2ZZ0N630	N/A			
	4	DI	6000P1VV0N640	6000K1VV0N640	N/A			5 15/16
		CAST STEEL	6000P2ZZ0N640	6000K2ZZ0N640	N/A			
8	1	DI	6000P1VV0N810	6000K1VV0N810	N/A	11	10 1/16	1 7/8
		CAST STEEL	6000P2ZZ0N810	6000K2ZZ0N810				
	1.5	DI	6000P1VV0N8B0	6000K1VV0N8B0				2 11/16
		CAST STEEL	6000P2ZZ0N8B0	6000K2ZZ0N8B0				
	2	DI	6000P1VV0N820	6000K1VV0N820				3 7/16
		CAST STEEL	6000P2ZZ0N820	6000K2ZZ0N820				
	3	DI	6000P1VV0N830	6000K1VV0N830				4 5/8
		CAST STEEL	6000P2ZZ0N830	6000K2ZZ0N830				
	4	DI	6000P1VV0N840	6000K1VV0N840	N/A			5 15/16
		CAST STEEL	6000P2ZZ0N840	6000K2ZZ0N840	N/A			
	6	DI	6000P1VV0N860	6000K1VV0N860	N/A			8
		CAST STEEL	6000P2ZZ0N860	6000K2ZZ0N860	N/A			
10	4	CAST STEEL	6000P2ZZ0NE40	N/A	N/A	12	12 3/4	5 15/16

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

300 lb. Flanged							
Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Numbers by Liner Material		Dimensions (in.)		
			Polypropylene	PVDF	K	J	C
1.5	1	CAST STEEL	6000PAYY0NB10	6000KAYY0NB10	4 1/2	2 11/16	1 7/8
2	1		6000PAYY0N210	6000KAYY0N210	5	3 7/16	1 7/8
	1.5		6000PAYY0N2B0	6000KAYY0N2B0			2 11/16
3	1		6000PAYY0N310	6000KAYY0N310	6	4 5/8	1 7/8
	1.5		6000PAYY0N3B0	6000KAYY0N3B0			2 11/16
	2		6000PAYY0N320	6000KAYY0N320			3 7/16
4	2		6000PAYY0N420	6000KAYY0N420	7	5 15/16	3 7/16
	3		6000PAYY0N430	6000KAYY0N430			4 5/8
6	2		6000PAYY0N620	6000KAYY0N620	9	8	3 7/16
	3		6000PAYY0N630	6000KAYY0N630			4 5/8
	4		6000PAYY0N640	6000KAYY0N640			5 15/16

Eccentric Reducers

Polypropylene / PVDF / PFA-Lined, 150lb. Flanged

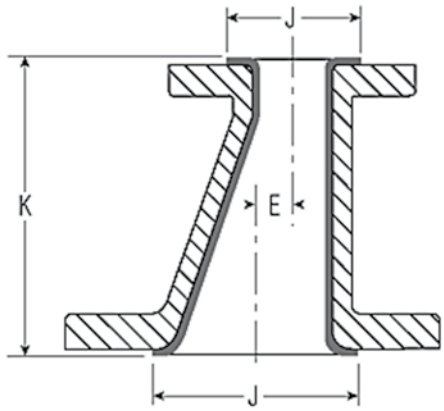
Housing Materials

Eccentric Reducers lined with PP/PVDF/PFA are only available in CAST STEEL = ASTM A216

Vacuum Ratings

Polypropylene-lined fittings are rated for full vacuum at 225°F.
PVDF-lined fittings are rated for full vacuum at 275°F.
Consult factory for vacuum ratings on PFA-lined fittings.

Note: All PP / PVDF / PFA-lined fitting housings are Castings.
Flanged are fixed.



Major Size (NPS)	Minor Size (NPS)	Housing Material	Part Number by Liner Material			Dimensions (in.)			
			Polypropylene	PVDF	PFA	K	J	C	E
1.5	1	CAST STEEL	8000P2ZZ0NB10	8000K2ZZ0NB10	N/A	4 1/2	2 11/16	1 7/8	3/8
2	1		8000P2ZZ0N210	8000K2ZZ0N210	8000Q2ZZ0N210	5	3 7/16	1 7/8	1/2
	1.5		8000P2ZZ0N2B0	8000K2ZZ0N2B0	8000Q2ZZ0N2B0			2 11/16	3/16
3	1		8000P2ZZ0N310	8000K2ZZ0N310	8000Q2ZZ0N310	6	4 5/8	1 7/8	1 1/16
	1.5		8000P2ZZ0N3B0	8000K2ZZ0N3B0	8000Q2ZZ0N3B0			2 11/16	1 1/16
	2		8000P2ZZ0N320	8000K2ZZ0N320	8000Q2ZZ0N320			3 7/16	1/2
4	1		8000P2ZZ0N410	8000K2ZZ0N410	8000Q2ZZ0N410	7	5 15/16	1 7/8	1 9/16
	1.5		8000P2ZZ0N4B0	8000K2ZZ0N4B0	8000Q2ZZ0N4B0			2 11/16	1 3/16
	2		8000P2ZZ0N420	8000K2ZZ0N420	8000Q2ZZ0N420			3 7/16	1
	3		8000P2ZZ0N430	8000K2ZZ0N430	8000Q2ZZ0N430			4 5/8	1/2
6	1		8000P2ZZ0N610	8000K2ZZ0N610	N/A	9	8	1 7/8	2 9/16
	1.5		8000P2ZZ0N6B0	8000K2ZZ0N6B0	N/A			2 11/16	2 1/4
	2		8000P2ZZ0N620	8000K2ZZ0N620	N/A			3 7/16	2 1/16
	3		8000P2ZZ0N630	8000K2ZZ0N630	N/A			4 5/8	1 1/2
	4		8000P2ZZ0N640	8000K2ZZ0N640	N/A			5 15/16	1 1/16
8	1		8000P2ZZ0N810	N/A	N/A	11	10 1/16	1 7/8	3 1/2
	2		8000P2ZZ0N820					3 7/16	3
	3		8000P2ZZ0N830					4 5/8	2 1/2
	4		8000P2ZZ0N840	8000K2ZZ0N840	N/A			5 15/16	2
	6		8000P2ZZ0N860	8000K2ZZ0N860	N/A			8	15/16
10	8		8000P2ZZ0NE80	N/A	N/A	12	12 3/4	5 15/16	1 1/16
12	10		8000P2ZZ0NFE0			14	15	12 3/4	1

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

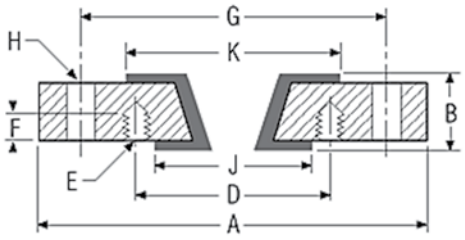
Carbon Steel Reducing Filler Flanges
Polypropylene / PVDF-Lined

Carbon Steel conforms to ASTM A516 GR 70 or SAE 1010-1030.

All of the PP/PVDF lined reducing flanges are rated full vacuum (FV).

PP is FV to 225°F; PVDF is FV to 275°F.

For sizes not available or not shown, Resistoflex makes special PTFE-lined steel reducing filler flanges from 1" to 36" nominal size.



150 lb. Flanged													
Major Size (NPS)	Minor Size (NPS)	Part Number by Liner Material		Thick-ness	OD	Bolt Holes					Flare Diameters		Bolt Hole Rotate
		Polypropylene	PVDF			No.	Size	Bolt Circle Dia.		Depth			
				B	A			G	D	F	K	J	
1	.5	3T00P0ZZ00170	3T00K0ZZ00170	1 1/2	4 1/4	H=4 E=4	H=1/2-13 E=1/2-13	3 1/8	2 3/8	11/16	2	1 7/8	45
	.75*	3T00P0ZZ00190	3T00K0ZZ00190						2 3/4				
1.5	.5	3T00P0ZZ00B70	3T00K0ZZ00B70	1 1/2	5	H=4 E=4	H=1/2-13 E=1/2-13	3 7/8	2 3/8	11/16	2 11/16	1 7/8	None
	1*	3T00P0ZZ00B10	3T00K0ZZ00B10						3 1/8	9/16			45
2	1*	3T00P0ZZ00210	3T00K0ZZ00210	1 1/2	6	H=4 E=4	H=5/8-11 E=1/2-13	4 3/4	3 1/8	9/16	3 7/16	1 7/8	None
	1.5*	3T00P0ZZ002B0	3T00K0ZZ002B0						3 7/8	5/8		2 11/16	45
3	1*	3T00P0ZZ00310	3T00K0ZZ00310	1 1/2	7 1/2	H=4 E=4	H=5/8-11 E=1/2-13	6	3 1/8	9/16	4 5/8	1 7/8	None
	1.5*	3T00P0ZZ003B0	3T00K0ZZ003B0						3 7/8	5/8		2 11/16	
	2*	3T00P0ZZ00320	3T00K0ZZ00320				H=5/8-11 E=5/8-11		4 3/4	3/4		3 7/16	45
4	1*	3T00P0ZZ00410	3T00K0ZZ00410	2	9	H=8 E=4	H=3/4 E=1/2-13	7 1/2	3 1/8	9/16	5 15/16	1 7/8	None
	1.5*	3T00P0ZZ004B0	3T00K0ZZ004B0						3 7/8	5/8		2 11/16	
	2*	3T00P0ZZ00420	3T00K0ZZ00420	1 1/2			H=5/8-11 E=5/8-11		4 3/4	3/4		3 7/16	
	3*	3T00P0ZZ00430	3T00K0ZZ00430						6			4 5/8	
6	1	3T00P0ZZ00610	3T00K0ZZ00610	2	11	H=8 E=4	H=7/8 E=1/2-13	9 1/2	3 1/8	9/16	8	1 7/8	None
	1.5	3T00P0ZZ006B0	3T00K0ZZ006B0						3 7/8	5/8		2 11/16	
	2	3T00P0ZZ00620	3T00K0ZZ00620				H=7/8 E=5/8-11		4 3/4	3/4		3 7/16	
	3	3T00P0ZZ00630	3T00K0ZZ00630						6			4 5/8	
	4	3T00P0ZZ00640	3T00K0ZZ00640	1 1/2		H=8 E=8	H=3/4-10 E=5/8-11		7 1/2			5 15/16	
8	2	3T00P0ZZ00820	3T00K0ZZ00820	2	13 1/2	H=8 E=4	H=7/8 E=5/8-11	11 3/4	4 3/4	3/4	10 1/16	3 7/16	None
	3	3T00P0ZZ00830	3T00K0ZZ00830						6			4 5/8	
	4	3T00P0ZZ00840	3T00K0ZZ00840			H=8 E=8			7 1/2			5 15/16	
	6	3T00P0ZZ00860	3T00K0ZZ00860	1 1/2			H=3/4-10 E=3/4-10		9 1/2	13/16		8	
10	4	3T00P0ZZ00E40	N/A	2 1/4	16	H=12 E=8	H=1 E=5/8-11	14 1/4	7 1/2	11/16	12 3/4	5 15/16	None
	6	3T00P0ZZ00E60					H=1 E=3/4-10		9 1/2	13/16		8	
	8	3T00P0ZZ00E80	3T00K0ZZ00E80				H=7/8-9 E=3/4-10		11 3/4			10 1/16	
12	6	3T00P0ZZ00F60	N/A	2 1/4	19	H=12 E=8	H=1 E=3/4-10	17	9 1/2	13/16	15	8	None
	8	3T00P0ZZ00F80	3T00K0ZZ00F80						11 3/4			10 1/16	
	10	3T00P0ZZ00FE0	N/A			H=12 E=12	H=7/8-9 E=7/8-9		14 1/4	1 1/4		12 3/4	

* These sizes, only, are available with PFA liner.

NOTE: 10" and 12" Polypropylene-lined fittings are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

Carbon Steel Reducing Filler Flanges

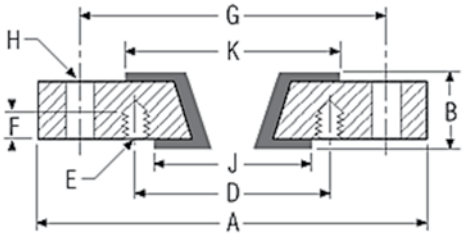
Polypropylene / PVDF-Lined, 300 lb. Flanged

Carbon Steel conforms to ASTM A516 GR 70 or SAE 1010-1030.

All of the PP/PVDF lined reducing flanges are rated full vacuum (FV).

PP is FV to 225°F; PVDF is FV to 275°F.

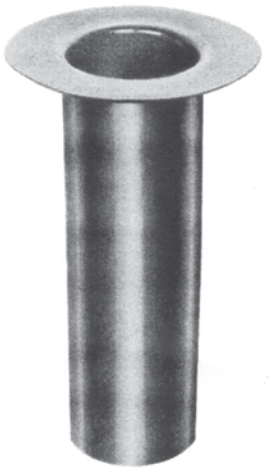
For sizes not available or not shown, Resistoflex makes special PTFE-lined steel reducing filler flanges from 1" to 36" nominal size.

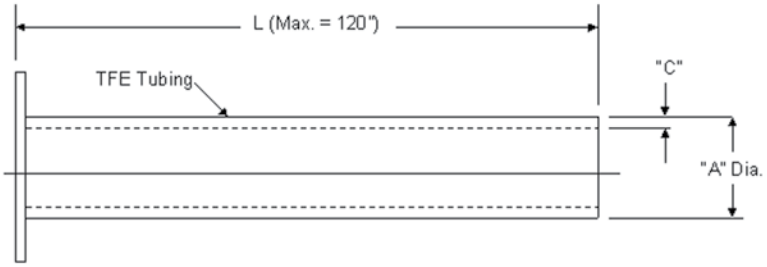


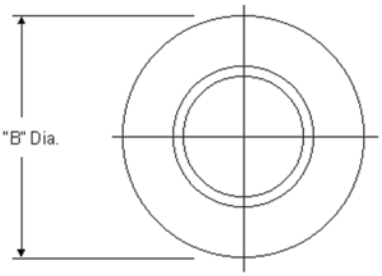
300 lb. Flanged													
Major Size (NPS)	Minor Size (NPS)	Part Number by Liner Material		Thick-ness	OD	Bolt Holes					Flare Diameters		Bolt Hole Rotate
		Polypropylene	PVDF			No.	Size	Bolt Circle Dia.		Depth			
				B	A			G	D	F	K	J	
1.5	1	3T00P0YY00B10	3T00K0YY00B10	1 1/2	6 1/8	H=4 E=4	H=3/4-10 E=5/8-11	4 1/2	3 1/2	5/8	2 7/8	2	45
	1	3T00P0YY00210	3T00K0YY00210	1 1/2	6 1/2	H=8 E=4	H=5/8-11 E=5/8-11	5	3 1/2	5/8	3 5/8	2	---
	1.5	3T00P0YY002B0	3T00K0YY002B0				H=5/8-11 E=3/4-10		4 1/2			2 7/8	
3	1	3T00P0YY00310	3T00K0YY00310	1 1/2	8 1/4	H=8 E=4	H=3/4-10 E=5/8-11	6 5/8	3 1/2	5/8	5	2	
	1.5	3T00P0YY003B0	3T00K0YY003B0				H=3/4-10 E=3/4-10		4 1/2			2 7/8	
	2	3T00P0YY00320	3T00K0YY00320			H=8 E=8	H=3/4-10 E=5/8-11		5	3/4		3 5/8	22.5
4	1	3T00P0YY00410	3T00K0YY00410	2	10	H=8 E=4	H=7/8 E=5/8-11	7 7/8	3 1/2	5/8	6 3/16	2	---
	1.5	3T00P0YY004B0	3T00K0YY004B0				H=7/8 E=3/4-10		4 1/2			2 7/8	
	2	3T00P0YY00420	3T00K0YY00420	1 1/2		H=8 E=8	H=3/4-10 E=5/8-11		5	3/4		3 5/8	22.5
	3	3T00P0YY00430	3T00K0YY00430				H=3/4-10 E=3/4-10		6 5/8			5	
6	1	3T00P0YY00610	3T00K0YY00610	2	12 1/2	H=12 E=4	H=7/8 E=5/8-11	10 5/8	3 1/2	5/8	8 1/2	2	---
	1.5	3T00P0YY006B0	3T00K0YY006B0				H=7/8 E= 3/4-10		4 1/2			2 7/8	
	2	3T00P0YY00620	3T00K0YY00620			H=12 E=8	H=7/8 E=5/8-11		5	3/4		3 5/8	
	3	3T00P0YY00630	3T00K0YY00630				H=7/8 E=3/4-10		6 5/8			5	
	4	3T00P0YY00640	3T00K0YY00640	1 1/2			H=3/4-10 E=3/4-10		7 7/8			6 3/16	7.5
8	3	3T00P0YY00830	3T00K0YY00830	2	15	H=12 E=8	H=1 E=3/4-10	13	6 5/8	3/4	10 5/8	5	---
	4	3T00P0YY00840	3T00K0YY00840						7 7/8			6 3/16	
	6	3T00P0YY00860	3T00K0YY00860	1 1/2		H=12 E=12	H=7/8-9 E=3/4-10		10 5/8	13/16		8 1/2	15

Fluoroflex-T (PTFE) Nozzle Liner

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.







All dimensions in inches unless otherwise noted

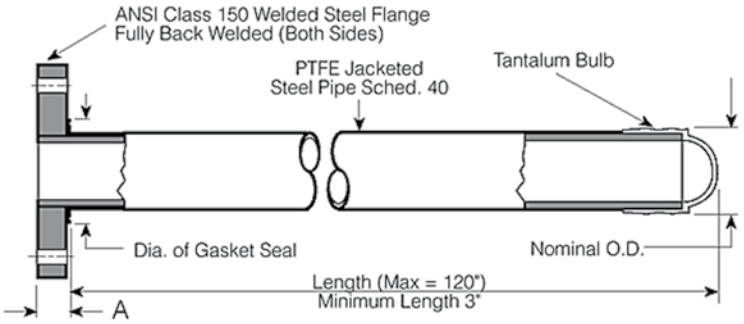
Part No.	Nominal Pipe Size	Tube Extension O.D. "A"	Flare Dia. "B"	Wall Thickness "C"
R19360-008L	1/2	17/32	1 3/8	1/16
R19360-012L	3/4	45/64	1 11/16	
R19360-016L	1	29/32	2	
R19360-024L	1 1/2	1 15/32	2 7/8	
R19360-032L	2	1 29/32	3 5/8	
R19360-048L	3	2 27/32	5	5/64
R19360-064L	4	3 25/32	6 3/16	3/32
R19360-096L	6	5 45/64	8 1/2	7/64
R19360-128L	8	7 1/2	10 5/8	5/32
R19360-160L	10	10 1/16	12 3/4	3/16

" L" is expressed in inches with fractions of an inch in eighths, e.g., 36", 47 1/2", 62 5/8", etc.
Length tolerance: To 36" ± 1/4", over 36" ± 1/2".

Thermowell Baffles

Jacketed with PTFE

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 also 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./cm2/°C/sec. is provided through the tantalum bulb, which combines good chemical resistance with high thermal conductivity.



Dimensional Data						
Part #	NPS	Flange Size	Gasket Seal Dia.	A	Nominal O.D.*	Max. Recommended Unsupported Length** Ft.
R19282A-08-L	1/2	1	1 7/8	11/16	1	3
R19282A-16-L	1	1 1/2	2 3/4	13/16	1 15/32	4
R19282A-24-L	1 1/2	2	3 1/2	7/8	2 1/16	5
R19282A-32-L	2	3	4 3/8	1 1/16	2 9/16	6

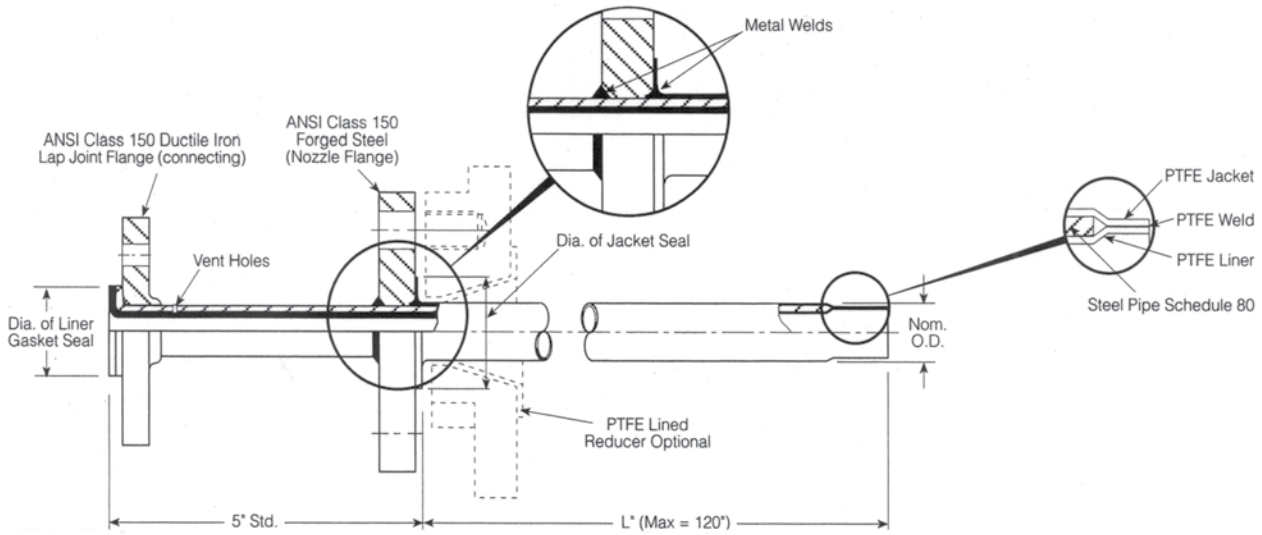
*Thermowells have oversize O.D., which will not fit directly into standard size vessel nozzles. By selecting a smaller size pipe and a R60692 Special Reducing Flange, the correct fit can be achieved.
**Recommended maximum length for mild agitation is shown as a general guide for liquids having about 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.

Reinforced Dip Pipes

Lined and Jacketed with PTFE for Loading, Unloading & 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 #	Pipe & Connecting Flange Size	Nozzle Flange Size	Min. Diameter of Jacket Gasket Seal	Diameter of Liner Gasket Seal	Nominal O.D.	Max. Recommended Length** Ft.
R6808-16-L	1/2	1	1 7/8	1 3/8	1	3
R6816-24-L	1	1 1/2	2 3/4	2	1 7/16	4
R6824-32-L	1 1/2	2	3 1/2	2 7/8	2 1/64	5
R6832-48-L	2	3	4 3/8	3 5/8	2 1/2	6
R6848-64-L	3	4	5 7/16	5	3 5/8	8

" L" = 120" max.

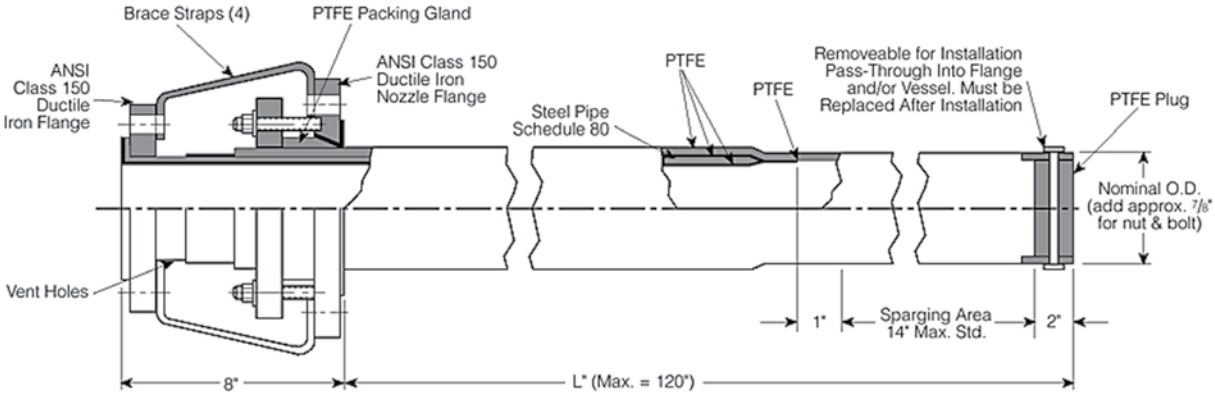
**Recommended maximum length for mild agitation is shown as a general guide for liquids having about the same density and viscosity as water. For longer lengths, or more severe operating loads (density, viscosity and velocity of fluid at the pipe), a larger size of internal bracing should be employed.

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.

Reinforced 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.

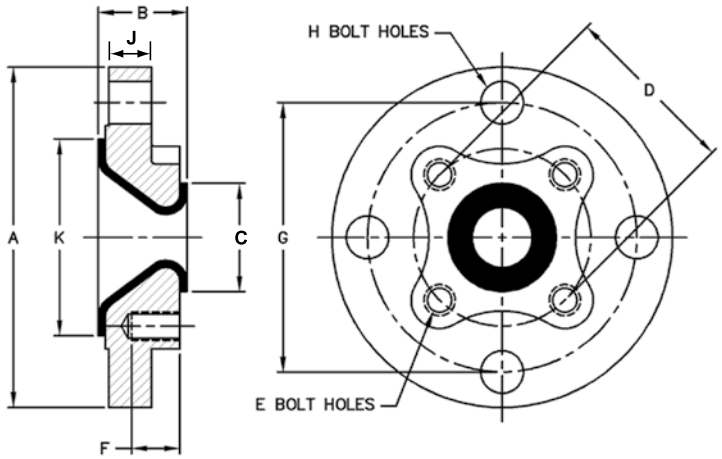
Warning: Exceeding the maximum recommended service temperature and/or pressure, or recommended unsupported length can result in premature failure and personnel and/or equipment hazard.

Dimensional Data				
Part #	Pipe & Connecting Flange Size	Nozzle Flange Size	Nominal O.D.*	Max. Recommended Unsupported Length** Ft.
R671632-L-XX	1	2	1 15/16	4
R672448-L-XX	1 1/2	3	2 9/16	5
R672464-L-XX	1 1/2	4	2 33/64	5
R673264-L-XX	2	4	3	6
R674896-L-XX	3	6	4 1/8	8

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 use w/Dip Pipes

Ductile Iron conforms to ASTM A395



Part Number	Nominal Size (NPS)		Actual Smallest I.D.	Dimensions					H Holes			E Holes				Bolt Hole Rotation **	Weight (lbs.)
	Major	Minor		B	J	A	K	C	No. Holes	Dia.	D (B.C.)	No. Holes	Thread	G (B.C.)	F Depth		
3T00M0VV0C170	1	1/2	13/32	1 5/8	9/16	4 1/4	2	1 3/8	4	5/8	3 1/8	4	1/2-13	2 3/8	7/8	45°	2.8
3T00M0VV0C190	1	3/4	5/8	1 5/8	9/16	4 1/4	2	1 11/16	4	5/8	3 1/8	4	1/2-13	2 3/4	7/8	45°	3.0
3T60B0VV0CB10	1 1/2	1	1 1/8	1 9/16	11/16	5	2 7/8	2	4	5/8	3 7/8	4	1/2-13	3 1/8	7/8	45°	4.3
3T60B0VV0C210	2	1	1 1/8	1 9/16	3/4	6	3 5/8	2	4	3/4	4 3/4	4	1/2-13	3 1/8	7/8	45°	6.0
3T60B0VV0C2B0	2	1 1/2	1 5/8	1 9/16	3/4	6	3 5/8	2 7/8	4	3/4	4 3/4	4	1/2-13	3 7/8	7/8	45°	6.3
3T60B0VV0CC20	2 1/2	2	2 1/8	1 9/16	7/8	7	4 1/8	3 5/8	4	3/4	5 1/2	4	5/8-11	4 3/4	7/8	45°	9.0
3T60B0VV0C310	3	1	1 1/8	1 5/8	15/16	7 1/2	5	2	4	3/4	6	4	1/2-13	3 1/8	3/4	45°	11.5
3T60B0VV0C3B0	3	1 1/2	1 5/8	1 5/8	15/16	7 1/2	5	2 7/8	4	3/4	6	4	1/2-13	3 7/8	7/8	45°	12.8
3T60B0VV0C320	3	2	2 1/8	1 3/4	15/16	7 1/2	5	3 5/8	4	3/4	6	4	5/8-11	4 3/4	7/8	45°	10.5
3T00M0VV0C3C0	3	2 1/2	2 3/16	1 5/8	13/16	7 1/2	5	4 1/5	4	3/4	6	4	5/8-11	5 1/2	7/8	45°	11.0
3T60B0VV0C410	4	1	1 1/8	1 7/8	15/16	9	6 3/16	2	8	3/4	7 1/2	4	1/2-13	3 1/8	11/16	--	15.8
3T60B0VV0C4B0	4	1 1/2	1 5/8	1 5/8	15/16	9	6 3/16	2 7/8	8	3/4	7 1/2	4	1/2-13	3 7/8	7/8	--	15.5
3T60B0VV0C420	4	2	2 1/8	2	15/16	9	6 3/16	3 5/8	8	3/4	7 1/2	4	5/8-11	4 3/4	7/8	--	14.5
3T00M0VV0C430	4	3	2 25/32	1 3/4	15/16	9	6 3/16	5	8	3/4	7 1/2	4	5/8-11	6	7/8	--	14.58
3T00M0VV0C540	5	4	3 3/4	1 5/8	15/16	10	7 5/16	6 3/16	8	7/8	8 1/2	8	5/8-11	7 1/2	1	22.5°	16.8
3T60B0VV0C6B0	6	1 1/2	1 5/8	1 7/8	1	11	8 1/2	2 7/8	8	7/8	9 1/2	4	1/2-13	3 7/8	11/16	--	24.5
3T60B0VV0C620	6	2	2 1/8	1 7/8	1	11	8 1/2	3 5/8	8	7/8	9 1/2	4	5/8-11	4 3/4	3/4	--	24.3
3T00M0VV0C630	6	3	2 31/32	1 3/4	1	11	8 1/2	5	8	7/8	9 1/2	4	5/8-11	6	1	--	22.3
3T00M0VV0C640	6	4	3 3/4	2 1/8	1	11	8 1/2	6 3/16	8	7/8	9 1/2	8	5/8-11	7 1/2	7/8	22.5°	22.0
3T00M0VV0C650	6	5	4 25/32	1 3/4	7/8	11	8 1/2	7 5/16	8	7/8	9 1/2	8	3/4-10	8 1/2	1	22.5°	22.0
3T00M0VV0C840	8	4	3 29/32	2	1 1/8	13 1/2	10 5/8	6 3/16	8	7/8	11 3/4	8	5/8-11	7 1/2	7/8	22.5°	39.5
3T00M0VV0C860	8	6	5 25/32	2	1 1/8	13 1/2	10 5/8	8 1/2	8	7/8	11 3/4	8	3/4-10	9 1/2	1 1/8	22.5°	36.3
3T00M0VV0CE40	10	4	4 1/16	2 7/16	1 3/16	16	12 3/4	6 3/16	12	1	14 1/4	8	5/8-11	7 1/2	7/8	--	62.0
3T00M0VV0CE60	10	6	5 29/32	2 7/16	1 3/16	16	12 3/4	8 1/2	12	1	14 1/4	8	3/4-10	9 1/2	1	--	58.5
3T00M0VV0CE80	10	8	7 11/16	2 7/16	1 3/16	16	12 3/4	10 5/8	12	1	14 1/4	8	3/4-10	11 3/4	1	--	50.0

For larger sizes or special size combinations - consult factory.
All fittings have Safety Vent Holes.

**Amount of bolt hole rotation required in mating flange to have adjacent piping components straddle center line.

"3T6" Series reducing flanges have extra large bores to accommodate the oversized O.D. of reinforced dip pipes, spargers and thermowells through 2" nominal pipe size.

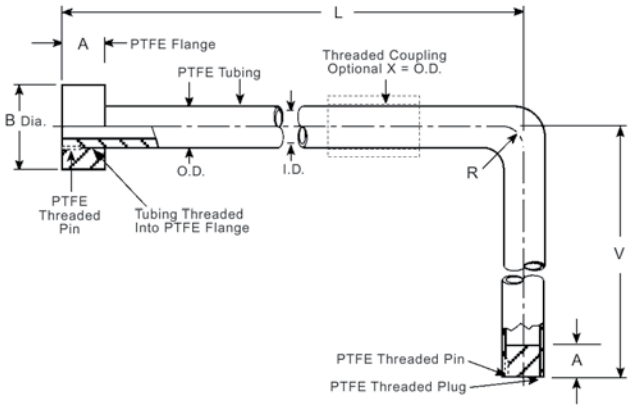
Solid PTFE Dip Pipes and Spargers

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, or recommended unsupported length can result in premature failure and personnel and/or equipment hazard.

Dimensional Data (inches)				
Tubing Size		Flange and Plug Thickness A	Bend Radius R	Coupling O.D. X
O.D.	I.D.			
1 1/4	1/2	1	2	2 1/8
1 3/8	3/4	1	2	2 1/4
1 3/4	1	1 1/2	3	2 5/8
2 1/4	1 1/2	2	4	3 3/8
3	2	2 1/2	8	4 3/8



R671XXX-L-V

Part Number Code:

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

Length Callout

PTFE

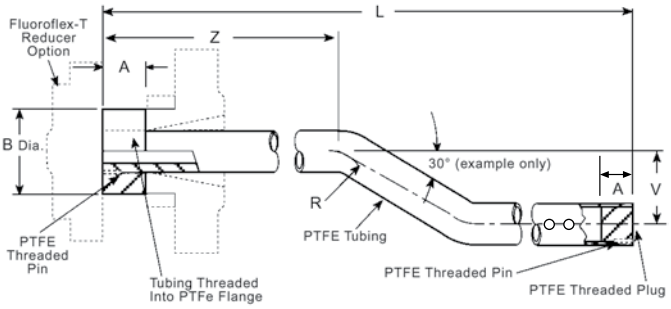
Style
5 = Dip Pipe
7 = Sparger

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

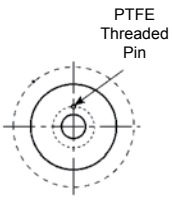
Tubing Size
1 = 1 1/4" OD x 1/2" ID
2 = 1 3/8" OD x 3/4" ID
3 = 1 3/4" OD x 1" ID
4 = 2 1/4" OD x 1 1/2" ID
5 = 3" OD x 2" ID

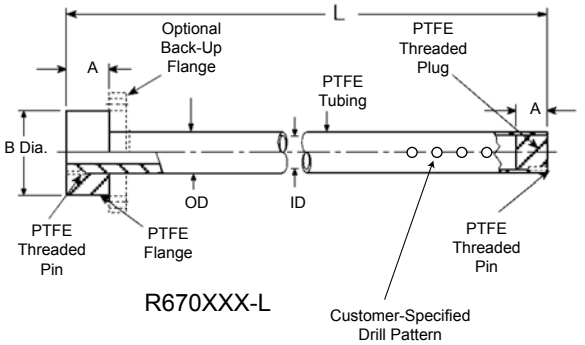
PTFE Flange Dia. "B"
1 = (2" OD for 1" Flange)
2 = (2 7/8" OD for 1.5" Flange)
3 = (3 5/8" OD for 2" Flange)
4 = (5" OD for 3" Flange)
5 = (6 3/16" OD for 4" Flange)

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



R676XXX-L-V-X



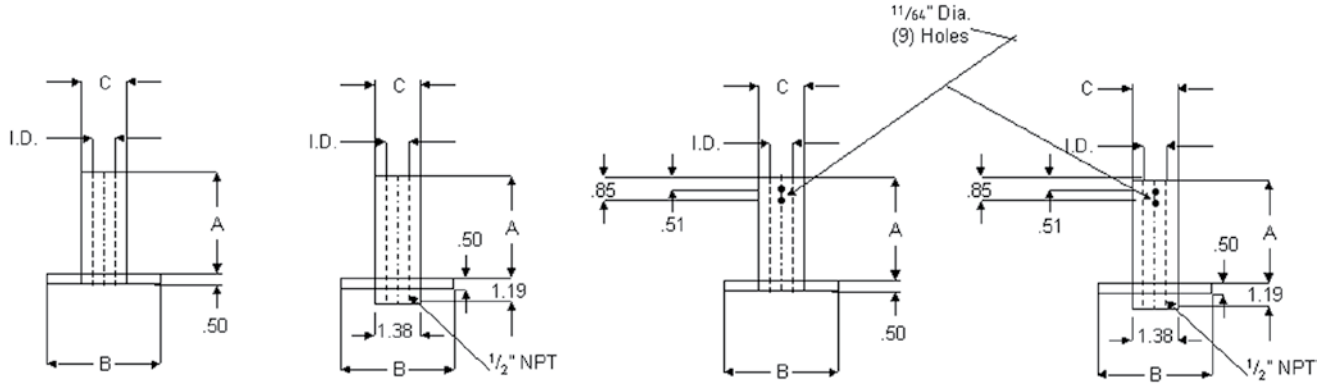


R670XXX-L

Solid PTFE Mixing Tee Nozzles

Acid mixing tees are used to introduce acid to the system. The solid PTFE nozzle is specially designed to disperse the acid uniformly into the process. Various nozzle sizes are available for different outlet diameters. Optional open-ended constructions are also available. The tees are made in 1" through 8" sizes for standard and reducing tees, and are available on special request. The PTFE mixing nozzle is also used with plastic lined tees. 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, depending on size and construction. Mixing tees and nozzles should be purchased together to enable a factory fit.



Detail 1
(open end, no thread)

Detail 2
(open end, threaded connection)

Detail 3
(radial holes, no thread)

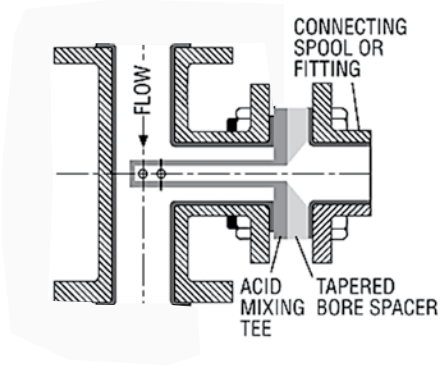
Detail 4
(radial holes, threaded connection)

Part No.: WM0WM00000_ _0 — Size Code

WM0XM00000_ _0

WM0YM00000_ _0

WM0ZM00000_ _0



For Standard Tees					
Size Code	Size	A	B	C	I.D.
10	1	3 1/2	2 5/8	9/16	1/4
B0	1 1/2	4	3 3/8	1 1/5	1/2
20	2	4 1/2	4 1/8	1 3/8	7/8
30	3	5 1/2	5 3/8	2 1/2	1 1/2
40	4	7 3/8	6 7/8	2 1/2	1 1/2
60	6	9 3/8	8 3/4	2 1/2	1 1/2
80	8	11	11	2 1/2	1 1/2
C0	2 1/2	5	4 7/8	1 3/4	1

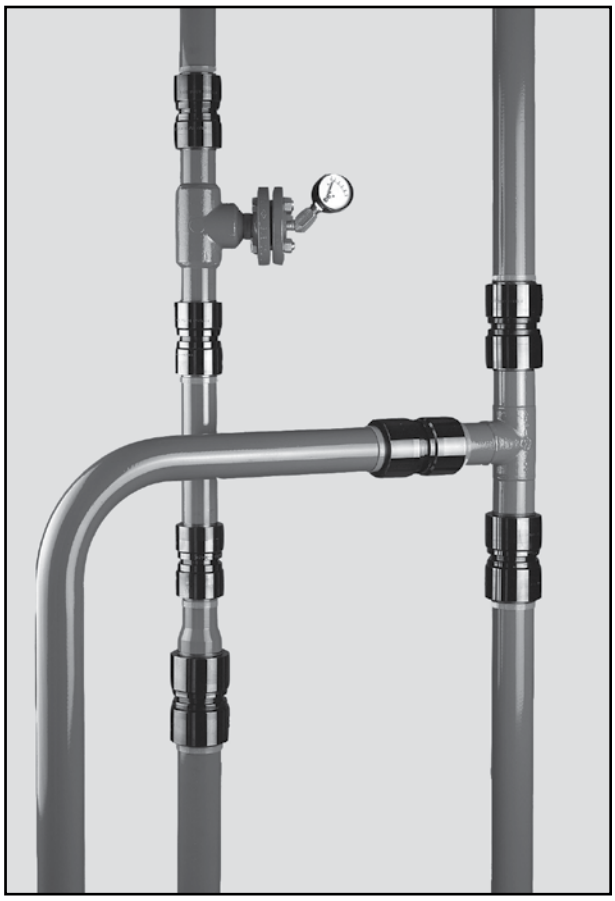
For Reducing Tees					
Size Code	Size	A	B	C	I.D.
B1	1 1/2 x 1	4	2 5/8	9/16	1/4
21	2 x 1	4 1/2	2 5/8	9/16	1/4
2B	2 x 1 1/2	4 1/2	3 3/8	1 1/8	1/2
31	3 x 1	5 1/2	2 5/8	9/16	1/4
3B	3 x 1 1/2	5 1/2	3 3/8	1 1/8	1/2
32	3 x 2	5 1/2	4 1/8	1 3/8	7/8
4B	4 x 1 1/2	7 3/8	3 3/8	1 1/8	1/2
42	4 x 2	7 3/8	4 1/8	1 3/8	7/8
43	4 x 3	7 3/8	5 3/8	2 1/2	1 1/2
62	6 x 2	9 3/8	4 1/8	1 3/8	7/8
63	6 x 3	9 3/8	5 3/8	2 1/2	1 1/2
64	6 x 4	9 3/8	6 7/8	2 1/2	1 1/2
81	8 x 1	11	2 5/8	9/16	1/4
8B	8 x 1 1/2	11	2 3/8	1 1/8	1/2
82	8 x 2	11	4 1/8	1 3/8	7/8
84	8 x 4	11	6 7/8	2 1/2	1 1/2
86	8 x 6	11	8 3/4	2 1/2	1 1/2
41	4 x 1	7 3/8	2 5/8	9/16	1/4
6B	6 x 1 1/2	9 3/8	3 3/8	1 1/8	1/2
C1	2 1/2 x 1	5	2 5/8	9/16	1/4
CB	2 1/2 x 1 1/2	5	3 3/8	1 1/8	1/2
C2	2 1/2 x 2	5	4 1/8	1 3/8	7/8
61	6 x 1	9 3/8	2 5/8	9/16	1/4

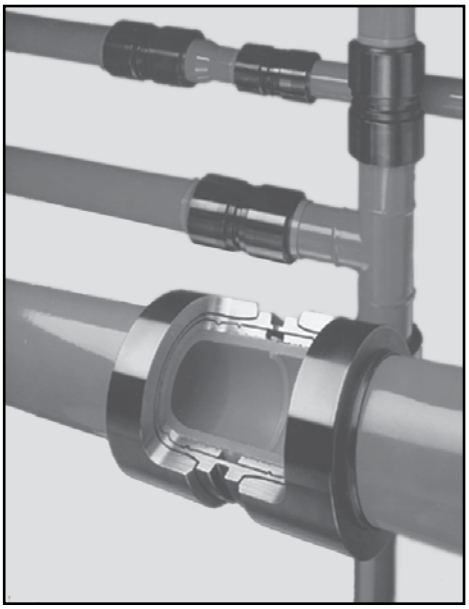
Note: PTFE Mixing Tee Nozzles are made with glass-filled resin and are not recommended for hydrofluoric acid or sodium hydroxide service

CONQUEST® Flangeless Lined Piping System

Available in 1" - 4" PTFE, PP and PVDF (1"-2" PFA)

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%.





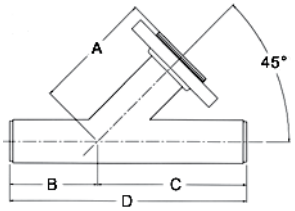
Final on-site assembly is done using Resistoflex butt-fusion weld tooling that can be rented or purchased.

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

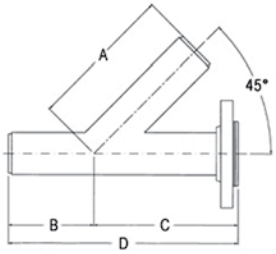
CONQUEST® Dimensional Data and Weights

Laterals - PTFE Only

Fitting Dia.	Option	Part Number	A	B	C	D
2"	Flange on Outlet	LN00M3WWZR200	6 5/8	4 13/16	8 3/16	1'-1"
2"	Flange on Run	LN00M3WZWR200	8 3/16	4 13/16	8 1/8	1'-015/16
3"	Flange on Run	LN00M3WZWR300	11 3/8	6 13/16	1'-1 9/16	1'-8 3/8



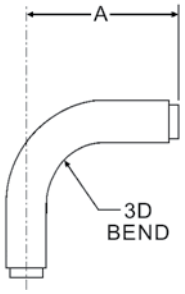
Flange on outlet



Flange on run

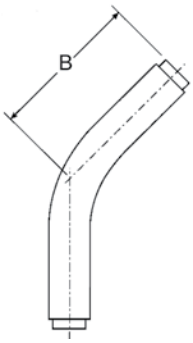
90° Elbows

Fitting Dia. in. (mm)	A in. (mm)	PTFE	PVDF	PP	Weight lbs. (kg)
1 (25)	11 (279)	E900M3WW00100	E900K3WW00100	E900P3WW00100	4 (1.8)
1.5 (40)	13 (330)	E900M3WW00B00	E900K3WW00B00	E900P3WW00B00	7 (3.2)
2 (50)	15 (381)	E900M3WW00200	E900K3WW00200	E900P3WW00200	10.4 (4.7)
3 (80)	21 (533)	E900M3WW00300	E900K3WW00300	E900P3WW00300	28.5 (13.2)
4 (100)	26 (660)	E900M3WW00400	E900K3WW00400	E900P3WW00400	50.1 (22.7)



45° Elbows

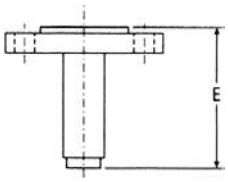
Fitting Dia. in. (mm)	B in. (mm)	PTFE	PVDF	PP	Weight lbs. (kg)
1 (25)	8 (203)	E500M3WW00100	E500K3WW00100	E500P3WW00100	3 (1.4)
1.5 (40)	9 (229)	E500M3WW00B00	E500K3WW00B00	E500P3WW00B00	5 (2.3)
2 (50)	10 (254)	E500M3WW00200	E500K3WW00200	E500P3WW00200	7.5 (3.4)
3 (80)	13 (330)	E500M3WW00300	E500K3WW00300	E500P3WW00300	19.1 (8.7)
4 (100)	17 (432)	E500M3WW00400	E500K3WW00400	E500P3WW00400	36 (16.3)



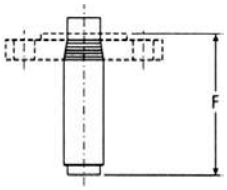
Adapters

Dia. in. (mm)	E in. (mm)	F in. (mm)
1 (25)	10 (254)	4 (102)
1.5 (40)	11 (279)	5 (127)
2 (50)	12 (305)	6 (152)
3 (80)	15 1/2 (394)	8 (203)
4 (100)	18 (457)	8 (203)

Adapter With Flange

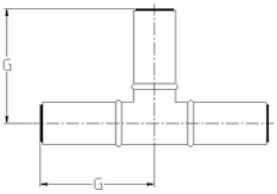


Adapter Without Flange

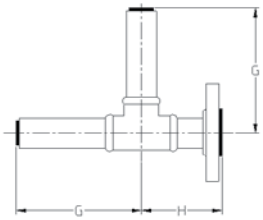


CONQUEST® Dimensional Data and Weights

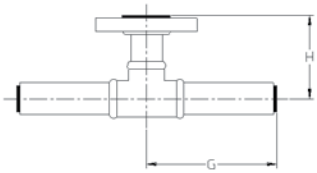
Standard Tees and Instrument Tees



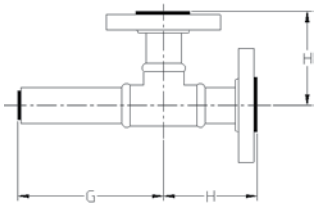
All Conquest



Flange on Run



Flange on Outlet or Instrument Tee



Flanged on Both Ends

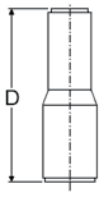
Size (NPS)	Dimensions (in.)		Option	PTFE	PVDF	PP
	G	H				
1	5 1/2	3 1/2	All CONQUEST®	TN00M3WWW0100	TN00K3WWW0100	TN00P3WWW0100
			Flange on Run	N/A	TN00K3WZWS100	TN00P3WZWS100
			Flange on Outlet	N/A	TN00K3WWZS100	TN00P3WWZS100
			Flange on Both	N/A	TN00K3WZZS100	TN00P3WZZS100
			Instrument	T400M3WWZS110	T400K3WWZS110	T400P3WWZS110
1.5	6	4	All CONQUEST®	TN00M3WWW0B00	TN00K3WWW0B00	TN00P3WWW0B00
			Flange on Run	N/A	TN00K3WZWSB00	TN00P3WZWSB00
			Flange on Outlet	TN00M3WWZNB00	TN00K3WWZSB00	TN00P3WWZSB00
			Flange on Both	N/A	TN00K3WZZSB00	TN00P3WZZSB00
			Instrument	T400M3WWZSB10	T400K3WWZSB10	T400P3WWZSB10
2	6 1/2	4 1/2	All CONQUEST®	TN00M3WWW0200	TN00K3WWW0200	TN00P3WWW0200
			Flange on Run	N/A	TN00K3WZWS200	TN00P3WZWS200
			Flange on Outlet	TN00M3WWZN200	TN00K3WWZS200	TN00P3WWZS200
			Flange on Both	N/A	TN00K3WZZS200	TN00P3WZZS200
			Instrument	T400M3WWZS210	T400K3WWZS210	T400P3WWZS210
3	7 1/2	5 1/2	All CONQUEST®	TN00M3WWW0300	TN00K3WWW0300	TN00P3WWW0300
			Flange on Run	N/A	TN00K3WZWS300	TN00P3WZWS300
			Flange on Outlet	N/A	TN00K3WWZS300	TN00P3WWZS300
			Flange on Both	N/A	TN00K3WZZS300	TN00P3WZZS300
			Instrument	T400M3WWZS310	T400K3WWZS310	T400P3WWZS310
4	9 1/2	6 1/2	All CONQUEST®	TN00M3WWW0400	TN00K3WWW0400	TN00P3WWW0400
			Flange on Run	N/A	TN00K3WZWS400	TN00P3WZWS400
			Flange on Outlet	N/A	TN00K3WWZS400	TN00P3WWZS400
			Flange on Both	N/A	TN00K3WZZS400	TN00P3WZZS400
				T400M3WWZS410	T400K3WWZS410	T400P3WWZS410

Instrument port outlet is 1" pipe size

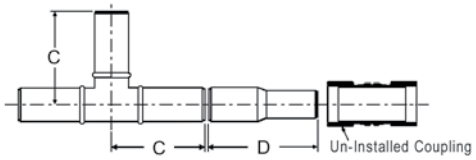
CONQUEST® Dimensional Data and Weights

Concentric Reducers

Fitting Dia. in. (mm)	D in. (mm)	PTFE	PVDF	PP	Weight lbs. (kg)
1.5 x 1 (40 x 25)	6.5 (165)	6000M3WW00B10	6000K3WW00B10	6000P3WW00B10	7 (3.2)
2 x 1 (50 x 25)	7.5 (191)	6000M3WW00210	6000K3WW00210	6000P3WW00210	7 (3.2)
2 x 1 1/2 (50 x 40)	7.5 (191)	6000M3WW002B0	6000K3WW002B0	6000P3WW002B0	7 (3.2)
3 x 2 (80 x 50)	10.5 (267)	6000M3WW00320	6000K3WW00320	6000P3WW00320	14 (6.4)
4 x 3 (100 x 80)	13 (330)	6000M3WW00430	6000K3WW00430	6000P3WW00430	30 (13.6)

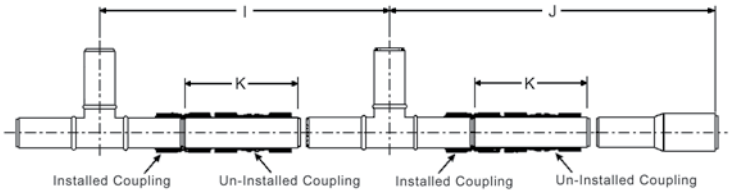


Standard Tee-to-Concentric Reducer



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

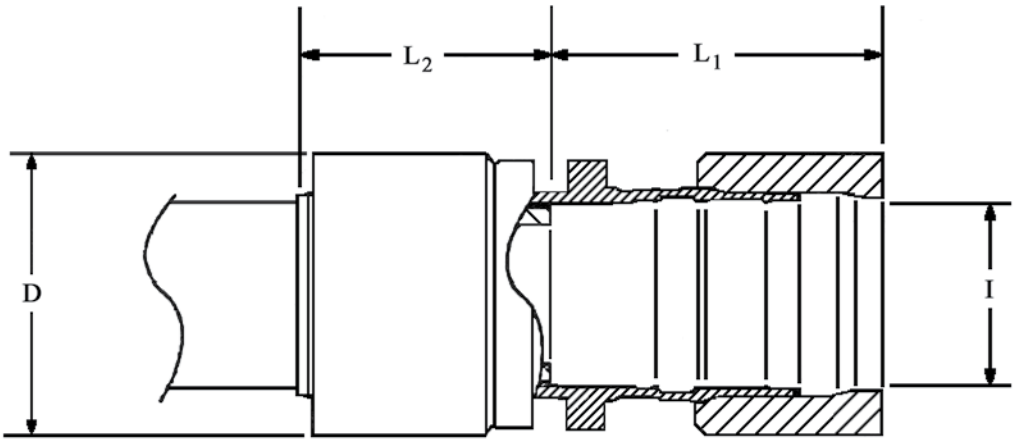
Standard Tee-to-Tee, or Tee-to-Concentric Reducer



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

Fitting Dia. in. (mm)	I in. (mm)	J in. (mm)	K in. (mm)
1 (25)	20 (508)	21 (533)	9 3/8 (238)
1.5 (40)	23 3/4 (603)	23 3/4 (603)	10 5/8 (270)
2 (50)	24 5/8 (625)	28 5/8 (727)	12 (305)
3 (80)	30 1/2 (775)	31 1/2 (800)	15 7/8 (403)
4 (100)	37 1/4 (946)	40 3/4 (1035)	18 1/4 (464)

CONQUEST® Coupler Dimensions



Fitting Size in. (mm)	($2xL_1$) Overall Length Max. Prior to Installation	($2xL_2$) Overall Length, Max. After Installation	D Outside Diameter, Max.	I Inside Diameter, Max.
1 (25)	4.55	3.42	1.97	1.338
1 1/2 (40)	5.44	4.10	2.64	1.923
2 (50)	6.54	5.03	3.28	2.415
3 (80)	9.55	6.80	4.45	3.536
4 (100)	11.03	7.77	5.60	4.551

1. Fittings are designed for use on Resistoflex plastic-lined steel pipe, schedule 40.
2. Standard coating for Swage Rings is black oxide per LMS-93-12. Contact factory for other platings.
3. Fittings available with and without 1/8” vent hole between tool flange.

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. (Learn more about Venting and 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 breech 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

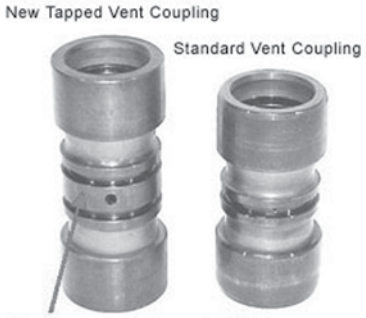
  In some cases, venting of even minute quantities of permeants to the atmosphere is undesirable. This may be true with extremely hazardous or toxic chemicals, or in environmentally sensitive areas. The tapped vent allows attachment of collection systems to prevent permeant release to atmosphere.

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 breech. 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:



To accommodate the extra thickness, a center rib has been added to the coupling body.

Size	Part Number		Standard Couplings - w/ or w/o Vent		Part Number	Tapped Vent Couplings	
	Standard w/o Vent	Standard w/ Vent	As Shipped Length	Installed Length	Tapped Vent	As Shipped Length	Installed Length
1"	K00003W000100	KV0003W000100	4.50"	3.37"	KV0003W000101	5.64"	4.51"
1.5"	K00003W000B00	KV0003W000B00	5.44"	4.06"	KV0003W000B01	6.55"	5.21"
2"	K00003W000200	KV0003W000200	6.50"	5.00"	KV0003W000201	7.68"	6.15"
3"	K00003W000300	KV0003W000300	9.50"	6.81"	KV0003W000301	10.76"	8.16"
4"	K00003W000400	KV0003W000400	11.25"	7.75"	KV0003W000401	12.02"	9.00"

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 i 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. Tl locking process distributes the liner's thermal expansion an contraction stress evenly throughout the entire steel pipe.

Table 1: Coefficients of Thermal Expansion for Plastic Liners and Steel

Material	α (in/in/°F)	α (mm/mm/°C)
Polypropylene (PP)	4.8×10^{-5}	8.64×10^{-5}
Polyvinylidene Fluoride (PVDF Homopolymer)	$6.6\text{-}8.0 \times 10^{-5}$	$11.9\text{-}14.4 \times 10^{-5}$
PVDF/Hexafluoropropylene (PVDF/HFP Copolymer)	7.8×10^{-5}	14×10^{-5}
Polytetrafluoroethylene (PTFE)	5.5×10^{-5}	9.9×10^{-5}
Perfluoroalkoxy (PFA)	7.8×10^{-5}	14×10^{-5}
Steel	5.9×10^{-6}	10.6×10^{-6}

How to Calculate Expansion Loop

Size and Dimensional Change - The expansion and contraction (ΔL) of a piping system is a function of the coefficient of therm expansion for the piping material (α), 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:

ΔL = Dimensional change due to thermal expansion or contraction (inches).

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

$(T_1\text{-}T_2)$ = 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 fabri-cated by using a combination of straight pipe, elbows, and/ or MULTI-AXIS® precision-bent pipe.

To calculate loop size, use Equation 2 where:

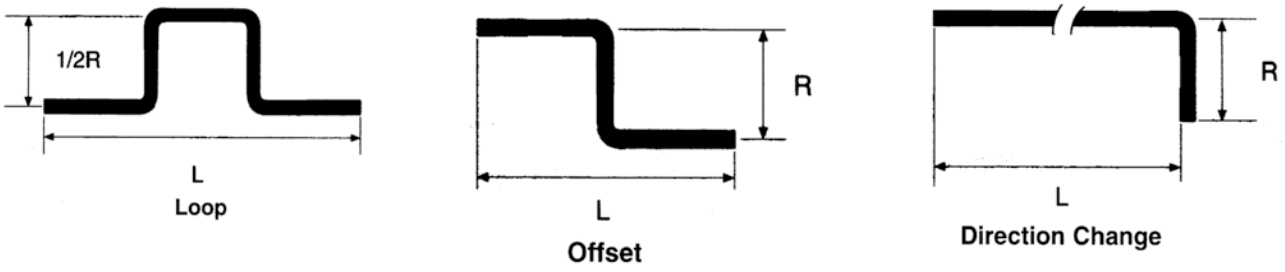
R = Minimum expansion loop length (in feet or mm)

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

ΔL = 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.

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

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

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

Table 2: Maximum Allowable Torque Values

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)

MULTI-AXIS® Bent Piping

- Available in 1" - 4" CS lined with PTFE, PP, PVDF (1" - 2", only, in PFA)*.
- Eliminates flange connections at elbows.
- Up to 4 compound bends (3D) in a single piece of pipe
- Sections are bent at any angle up to 90° with a tolerance of ±1°.
- Reduces pressure drop across the bend and reduces energy costs.
- Longer bend radius (3 diameters vs. 1.5 diameters).

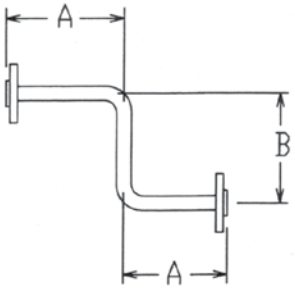
The Bending Process

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.

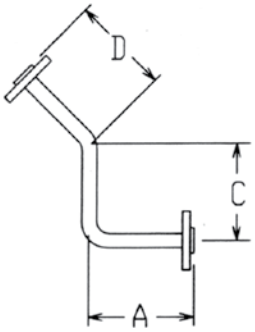
Resistoflex uses special bending equipment and proprietary manufacturing techniques to provide bends in any angle up to 90° and compound bends on a single section of pipe. MULTI-AXIS pipe is a high-quality product with dimensional tolerances of ± 0.125" (3.2mm), even on pieces with multiple bends. Due 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.

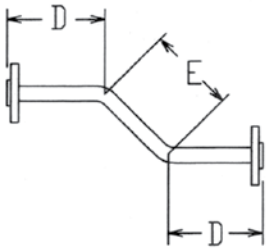
Minimum Lengths Required for MULTI-AXIS Plastic Lined Pipe



90˚ Bends



90° & 45° Bends



45˚ Bends

Pipe Size in. (mm)	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"
Bend angle = +/- 1°

1.5" and larger available as rotationally lined with Tefzel® ETFE. Consult factory for dimensional requirements.

Note: Angle can be within 1 degree of specified angle. 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 Piping for PTFE

Testing and Verification Data for CONQUEST Flangeless Piping Systems 1" to 4" Polytetrafluoroethylene (PTFE) Lined Systems

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

A summary of these tests and results are contained in this technical data sheet.

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.

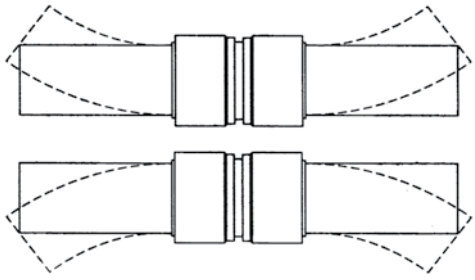


Table 1 - Bend Test Results

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 connectir two sections of plastic-lined pipe from RESISTOFLEX Plas Lined Piping Products with a mechanical coupling. Each e 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 the applied and steadily increased. These tests were performe 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 fo three different sizes of plastic-lined pipe and is summarize Table 2. Note that in each case the pipe burst, which demo strates that the coupling is actually stronger than the steel pipe.

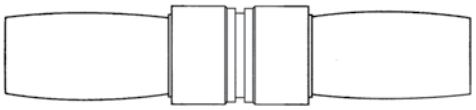


Table 2 - Coupling Burst Test Results

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

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.

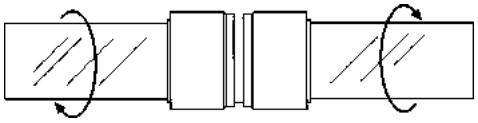


Table 3 - Torsion Test Results

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

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 4500 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.

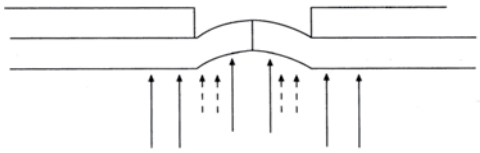


Table 4 - Burst Test Results			
Pipe Size in. (mm)	Liner Type	Minimum Burst Pressure Requirement psi (Bar)	Max. Burst Test Pressure psi (Bar)
1 (25)	PTFE	1,100 (76)	4,500 (310)†
2 (50)	PTFE	1,100 (76)	4,500 (310)†
4 (100)	PTFE	1,100 (76)	4,500 (310)†

†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.

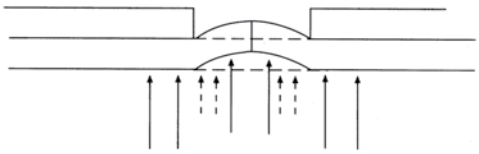


Table 5 - Pressure Fatigue Test Results			
Pipe Size in. (mm)	Liner Type	Minimum Number of Cycles Required	Actual Number of Cycles Achieved
1 (25)	PTFE	7,000	100,000
2 (50)	PTFE	7,000	100,000
4 (100)	PTFE	7,000	100,000

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 / PVDF / PFA

Testing and Verification Data for CONQUEST Flangeless Piping Systems with 1" to 4" PP, 1" to 4" PVDF/HFP, and 1" & 2" PFA Liners

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.

A summary of these tests and results are contained in this technical data sheet.

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.

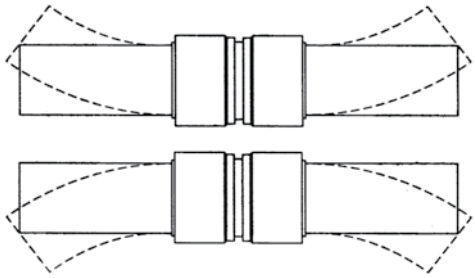


Table 1 - Bend Test Results		
Pipe Size in. (mm)	Number of Cycles	Result
1 (25)	71,089	Pass
1 1/2 (40)	7,399	Pass
2 (50)	7,251	Pass
3 (80)	7,500	Pass

B. Coupling Burst Test

Test Procedure - Test samples were produced by connectin two sections of plastic-lined pipe from RESISTOFLEX Plast Lined Piping Products with a mechanical coupling. Each en 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 performe 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 Table 2. Note that in each case the pipe burst, which demor strates that the coupling is actually stronger than the steel pipe.

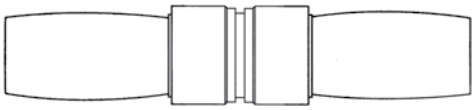


Table 2 - Coupling Burst Test Results		
Pipe Size in. (mm)	Burst Pressure psi (Bar)	Result
2 (50)	7,500 (517)	Pipe Rupture
3 (80)	10,000 (690)	Pipe Rupture
4 (100)	5,200 (359)	Pipe Rupture

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.

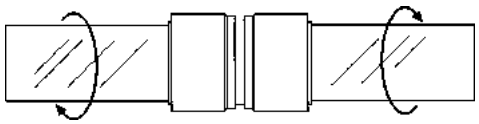


Table 3 - Torsion Test Results

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 witha 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.

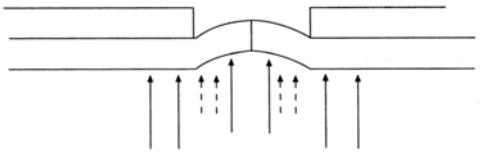


Table 4 - Burst Test Results			
Pipe Size in. (mm)	Liner Type	Minimum Burst Pressure Requirement psi (Bar)	Burst Pressure Range psi (Bar)
1 (25), 1 1/2 (40), 2 (50), 3 (80), 4 (100)	PP	1,100 (76)	3,500 - 4,400 (241-303)
1 (25), 1 1/2 (40), 2 (50), 3 (80), 4 (100)	PVDF	1,100 (76)	4,500 - 5,000 (311-345)†
1 (25), 1 1/2 (40), 2 (50)	PFA	1,100 (76)	2,000 - 3,000 (139-208)

†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.

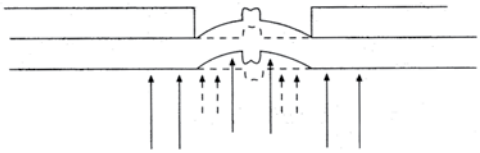


Table 5 - Pressure Fatigue Test Results			
Pipe Size in. (mm)	Liner Type	Minimum Number of Cycles Required	Actual Number of Cycles Achieved
2 (50)	PP	7,000	50,115
2 (50)	PVDF	7,000	50,115

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 RESISTOFLE 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 wit 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 flangeles connection at the mid-point. The test spools contained th standard flanged connection at each end. The test involve 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 RESISTOFLE 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 connec tion 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 minimu 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 hours. Visually inspect each sample after each 8-hour interval.

Results - All spools withstood a low freezer temperature c -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 and maintenance costs
- Costs associated with flange leaks

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 additional 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 includes:

- 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.

- 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 weigth, 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 retorqing 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 is U.S. dollars.

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 retorqing 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.

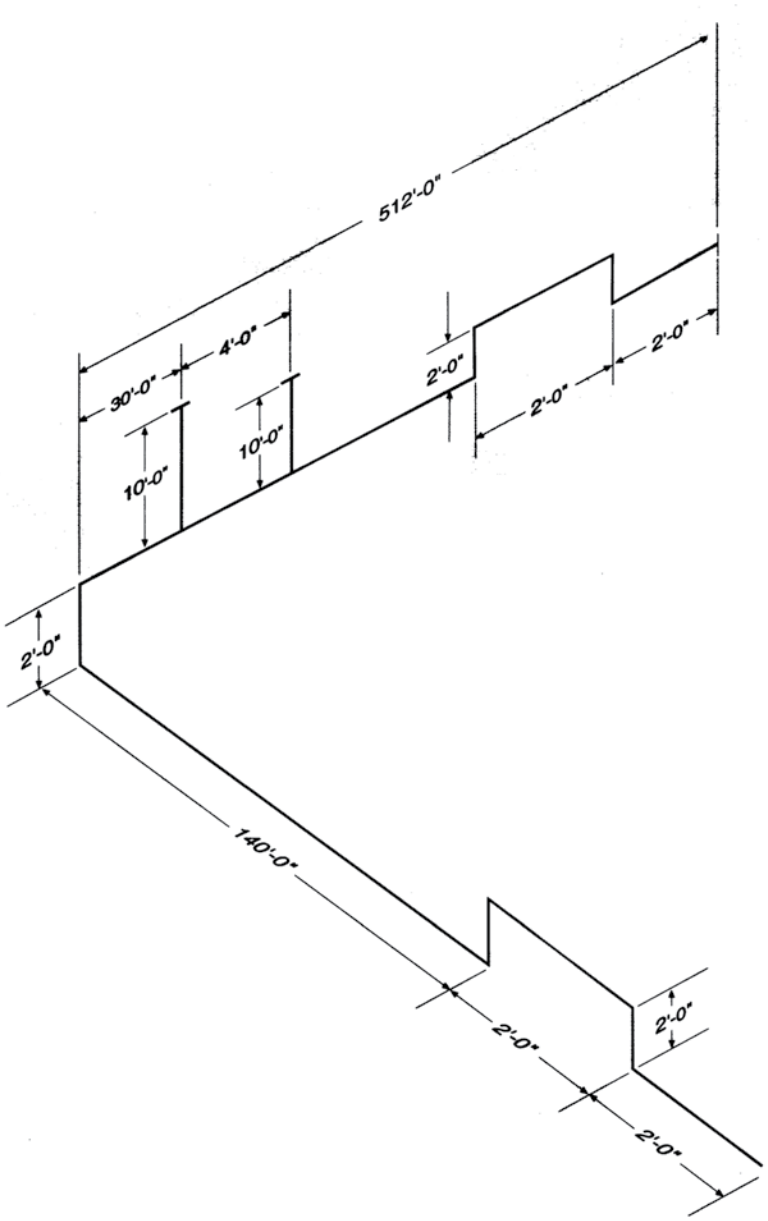
So, if both the initial acquisition costs and the initial acquisition labor is considered, the total installed cost of the system that incorporates CONQUEST® flangeless joints and MULTI-AXIS® precision-bent piping is $3,800 less than the same system installed with conventional flanged plastic-lined piping.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



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.

	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

A simplistic comparison of the cost of an un-installed CONQUEST® connector with the cost of two threaded flanges would have clearly supported the continued use a flanged plastic-lined pipe. That approach would have shown it "cost" about $60 per connection to have a flangeless joint. This approach ignores the total elimination of any type of connection due to the use of MULTI-AXIS® piping and the total cost of the hardware and labor needed to install a piping system. It obviously doesn't consider the long-term maintenance cost of the connections, either.

A slightly more sophisticated approach would have been to consider the total cost of the pipe, fittings, flanges, collars and connectors for each system. But, this evaluation would also have resulted in an incorrect specification. This is because the piping materials for a conventional system are about $3,040 less expensive than for a JRT system with the same configuration.

It isn't until the installation hardware (nuts, bolts, spray shields) and labor is considered that the truly "less expensive" alternative is revealed. A JRT system costs about $3,800 less to purchase, install and commission than does the same system in conventional flanged PLP.

The recurring annual cost savings realized by elimination of 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.

We've based our study on costs in the upper mid-west and are interested in the experience in your facility. Please contact us to share your comments and insight.

Fight Lined Pipe Flange Leaks With The Resistoflex HIF Adapter!!

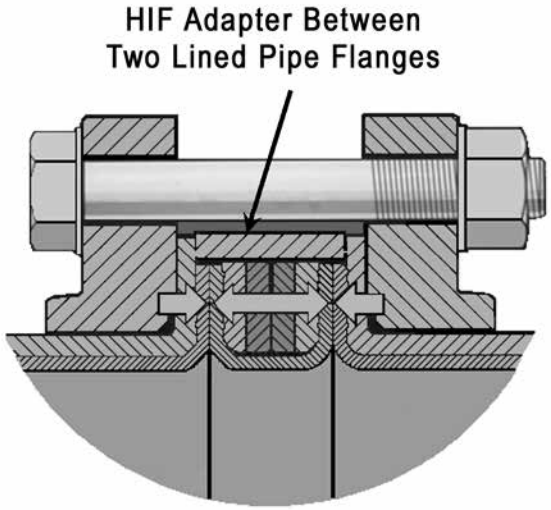
One of the leading causes of lined pipe flange leaks is loss of bolt torque due to the effects of temperature cycling and pipe ending loads. Specified bolt torque values for standard lined pipe connections are purposely low in order to prevent damage to the plastic sealing faces. The combination of low bolt torques and the natural tendency for plastics to “creep” under load can result in lined pipe leaks. In many applications, frequent re-torquing is necessary, which can actually make the problem worse. The Resistoflex High Integrity Flange (HIF) Adapter is a “drop-in” flange adapter that through the use of engineered belleville washers and a metal-to-metal load path, allows the use of very high torque values for plastic-lined pipe flange connections. The HIF Adapter delivers the same virtually maintenance-free benefits of the full HIF piping system lined with Teflon®, without the design and installation issues.

The HIF Adapter

The Resistoflex HIF Adapter allows you to convert a standard plastic-lined ANSI flanged connection into a high strength dual-load path design. The HIF adapter design allows for proper bolt stress (up to 50% of yield strength) without over-stressing the plastic-to-plastic seal beyond its yield point. Flange bolts that are properly stressed in this manner are far less likely to lose torque due to system temperature fluctuations. This is achieved using three (3) simple components:

1.) Belleville Washer (Coned Disc Spring)
2.) Thick Washer (Force Distribution Ring)
3.) Load Bearing Ring

The HIF Adapter is a proven problem-solver in After-Market Installtions in Resistoflex PTFE, PP and PVDF Lined Systems[1].



Belleville Washers Provide Optimum Sealing Force on Plastic Faces while Load Bearing Ring Creates Metal-to-Metal Positive Stop

Benefits:

- High Bolt Torques Practically Eliminate Maintenance
- HIF Adapter Can be Used in Resistoflex PTFE, PP and PVDF Systems[1]
- “Wafer”-Type Fitting is Easy to Install
- HIF Adapter is Part of a Patented, Proven System
- Available in 1” - 8” Sizes (consult Factory for Larger Sizes)
- HIF-Ready PFA-Lined Ball and Plug Valves Available (as manufactured by XOMOX)

[1]After-market conversion limited to Resistoflex Swaged pipe and fixed flanged fittings and may require minor modification of the lined pipe flare for a proper fit.
*Teflon® is a trademark of DuPont.

HIF Adapter - Inner Core
and Load Bearing Ring

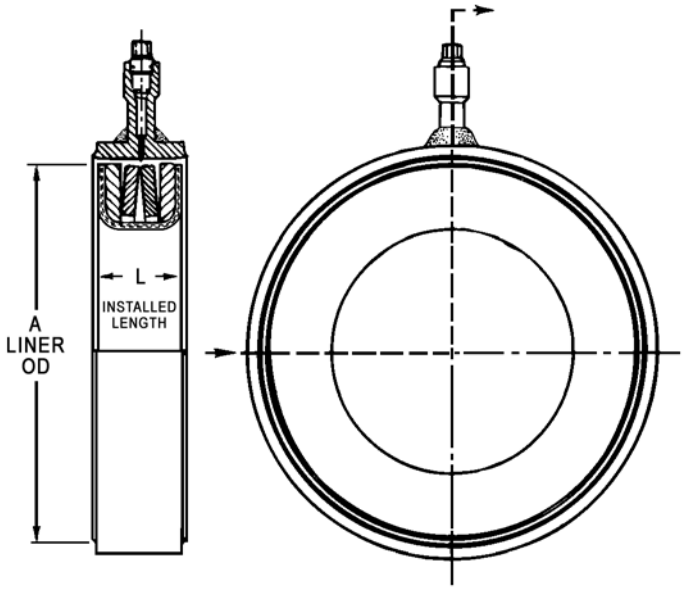
HIF Trim Tool Sizes Existing Flares For Use With the HIF Adapter

After-Market HIF Trim Head, Expander, and Wrench

HIF Adapter Dimensions

Nom. Size (in.)	A (in.)	Installed L (in.)
1	1.906	0.812
1 1/2	2.719	0.906
2	3.469	1.062
3	4.656	1.250
4	6.025	1.438
6	8.031	2.438
8	10.125	2.812

*Contact Factory for part numbers, which vary according to liner material of piping system.



HIF Adapter Installation Guidelines

Bolt and Stud Requirements

Use bolts or studs of ASTM A193 Gr. B7 (bolts) and A194 Gr. 2H (nuts).
Flat Washers are to be used under bolt heads and nuts. To achieve maximum torque loads, it is recommended that a high temperature anti-seize lubricant (Chesterton 725 Nickel Anti-Seize) be applied to the bolt/studs before torquing.
Note: When using studs rather than bolts, increase the length sufficiently to allow for the additional length of a nut.

Bolt Torquing Procedures

1) Tighten initially to approximately 2/3 of final torque using the alternate and opposite method.

2) Tighten to the final torque shown in the table, again, using the alternate and opposite method.

3) Repeat tightening to the final torque shown at least twice to ensure that flanges are permanently set.

Size	No. of Bolts	Bolt Dia. (in.)	Bolt Length, in.	Approx. Initial Torque, Ft-lbs.	Final Torque, Ft.-lbs.
1"	4	1/2	3 1/2	25	40
1.5"	4	1/2	4	35	50
2"	4	5/8	4 1/2	50	80
3"	4	5/8	4 3/4	70	110
4"	8	5/8	5 1/4	60	90
6"	8	3/4	6 1/2	85	130
8"	8	3/4	7 1/2	100	150

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"	0.6933
1.5"	0.2433
2"	0.1322
3"	0.0543
4"	0.0300
6"	0.0132
8"	0.0073
10"	0.0045
12"	0.0031

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

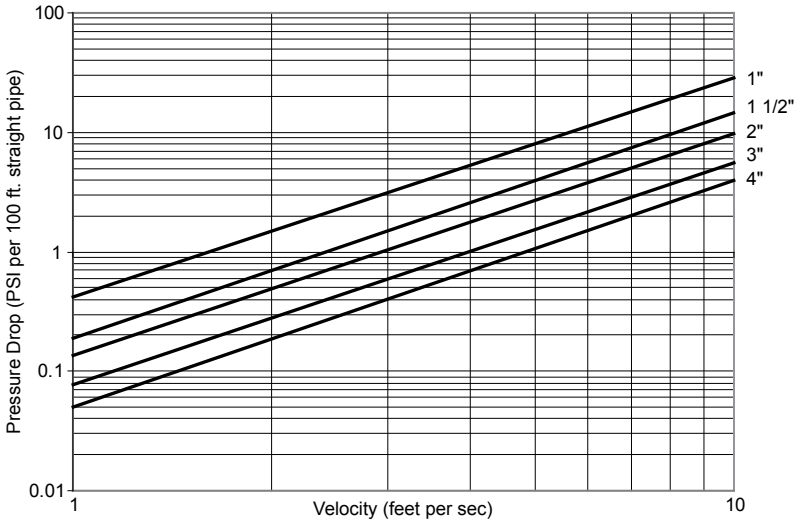
Example:

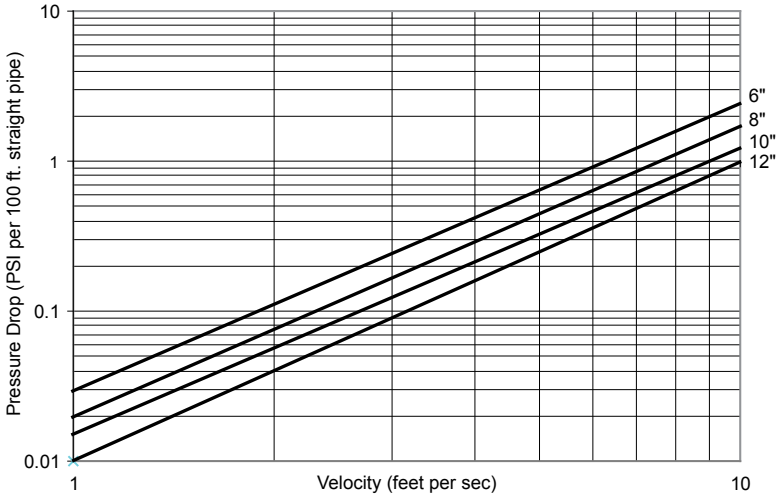
What is the pressure drop in 2" pipe at 60 gpm? First multiply 60 gpm x 0.1322 (CF factor for 2") to get a velocity of 7.93 feet per second. Look up the pressure drop for that velocity and line size in the charts. The pressure drop is approx. 4.5 psi per 100 ft. of straight pipe.

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 perfectly smooth pipes.

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.

FLOW OF FLUIDS
www.flowoffluids.com

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, which is also available as software.

Flange Bolt Torquing

for Resistoflex Plastic-Lined Piping Products

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 seq-uentially 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 are not required at lined pipe and/or fittings connections.

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 should also be used when mating plastic-lined piping to unlined pipe, fittings, valves, pumps, etc.

Belleville washers may be used if properly engineered.

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.

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:

$P_t = (1.5\ PS_t)/S$

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 in 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.

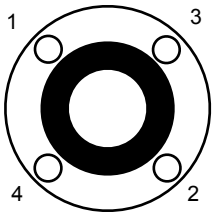
The above is a description of some pressure test methods. In general, most systems are hydrostatically tested as described in ASME B31.3. If the hydrostatic test is impractical, then the pneumatic test can be substituted, however, extreme caution must be observed during this potentially hazardous test.

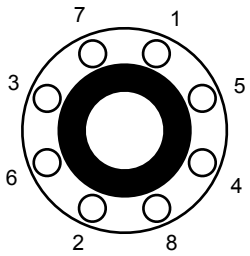
Bolt Torque Requirements

ANSI Class 150 Systems Lightly Oiled A193 Gr. B7 Bolts and A194 2H Nuts								
Pipe Size	Bolt Torque (ft-lb per Bolt)							
	PP		PVDF		PTFE		PFA	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	13	17	17	21	8	13	12	17
1.5	31	41	41	50	19	31	28	41
2	65	85	85	104	39	65	59	85
3	103	134	134	165	62	103	93	134
4	67	88	88	108	40	67	61	88
6	124	161	161	199	75	124	112	161
8	167	217	217	267	100	167	150	217
10	157	204	- -	- -	157	204	142	204
12	193	251	- -	- -	193	251	174	251

ANSI Class 300 Systems Lightly Oiled A193 Gr. B7 Bolts and A194 2H Nuts								
Pipe Size	Bolt Torque (ft-lb per Bolt)							
	PP		PVDF		PTFE		PFA	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	17	22	22	27	10	17	15	22
1.5	47	61	61	75	28	47	42	61
2	33	42	42	52	20	33	29	42
3	62	80	80	99	37	62	56	80
4	81	105	105	130	49	81	73	105
6	83	108	108	132	50	83	75	108
8	130	169	169	207	78	130	117	169
10	135	175	- -	- -	135	175	121	175
12	186	242	- -	- -	186	242	167	242

Always tighten bolts in crisscross pattern





Note: These maximum torques are only valid for LIGHTLY OILED A193 B7 bolts. Lightly oiled is considered lubrication with WD-40 or equivalent. Please contact us for guidance on torques for other bolting/lubrication systems.

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, anytime gaskets or spring type washers are used, we suggest using the minimum recommended torque value and that the torque be increased only to obtain satisfactory sealing. For systems that will require frequent disassembly, we suggest using the minimum recommended torque value initially to avoid distortion of the plastic face.

Note: For Resistoflex components rotationally-lined with Tefzel® ETFE, use the same torque values as for PVDF.

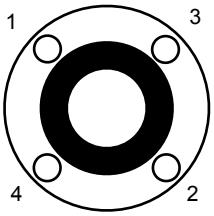
Bolt Torque Requirements

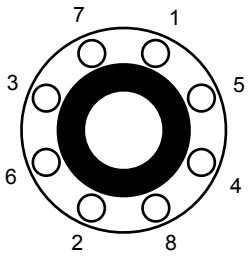
ANSI Class 150 Systems PTFE-Coated A193 Gr. B7 Bolts and A194 2H Nuts								
Pipe Size	Bolt Torque (ft-lb per Bolt)							
	PP		PVDF		PTFE		PFA	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	8	10	10	13	5	8	7	10
1.5	19	25	25	30	11	19	17	25
2	39	51	51	62	23	39	35	51
3	62	80	80	99	37	62	56	80
4	40	53	53	65	24	40	36	53
6	75	97	97	119	45	75	67	97
8	100	130	130	160	60	100	90	130
10	94	123	- -	- -	94	123	- -	- -
12	116	150	- -	- -	116	150	- -	- -

ANSI Class 300 Systems PTFE-Coated A193 Gr. B7 Bolts and A194 2H Nuts								
Pipe Size	Bolt Torque (ft-lb per Bolt)							
	PP		PVDF		PTFE		PFA	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	10	13	13	16	6	10	9	13
1.5	28	37	37	45	17	28	25	37
2	20	25	25	31	12	20	18	25
3	37	48	48	59	22	37	33	48
4	49	63	63	78	29	49	44	63
6	50	65	65	79	30	50	45	65
8	78	101	101	124	47	78	70	101
10	81	105	- -	- -	81	105	- -	- -
12	112	145	- -	- -	112	145	- -	- -

ANSI Class 150 Systems Zinc Plated A193 Gr. B7 Bolts and A194 2H Nuts								
Pipe Size	Bolt Torque (ft-lb per Bolt)							
	PP		PVDF		PTFE		PFA	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	19	25	25	31	12	19	17	25
1.5	46	59	59	73	27	46	41	59
2	94	123	123	151	57	94	85	123
3	149	194	194	239	90	149	134	194
4	98	127	127	157	59	98	88	127
6	180	234	234	288	108	180	162	234
8	242	314	314	387	145	242	217	314
10	228	296	- -	- -	228	296	- -	- -
12	280	364	- -	- -	280	364	- -	- -

Always tighten bolts in crisscross pattern





Bolt & Stud Length Requirements

for Resistoflex Plastic-Lined Pipe and Fittings

F x F = Fixed x Fixed
F x R = Fixed x Rotatable
R x R = Rotatable x Rotatable

ANSI Class 150 Bolt and Stud Length Requirements (all dimensions in inches)							
Flange Size	Bolt Size	Stud Length			Bolt Length		
		F x F	F x R	R x R	F x F	F x R	R x R
1	1/2 - 13	3	3 1/4	3 1/4	2 1/2	2 3/4	2 3/4
1.5	1/2 - 13	3 1/4	3 1/2	3 1/2	2 3/4	3	3
2	5/8 - 11	4	4	4 1/4	3 1/4	3 1/4	3 1/2
3	5/8 - 11	4 1/4	4 1/2	4 1/2	3 1/2	3 3/4	4
4	5/8 - 11	4 1/4	4 1/2	4 1/2	3 1/2	3 3/4	4
6	3/4 - 10	5	5	5 1/4	4 1/4	4 1/4	4 1/2
8	3/4 - 10	5	5 1/4	5 1/2	4 1/4	4 1/2	4 3/4
10	7/8 - 9	5 1/2	5 3/4	6	4 1/2	4 3/4	5 1/4
12	7/8 - 9	5 1/2	5 3/4	6 1/4	4 3/4	5	5 1/2

ANSI Class 300 Bolt and Stud Length Requirements (all dimensions in inches)							
Flange Size	Bolt Size	Stud Length			Bolt Length		
		F x F	F x R	R x R	F x F	F x R	R x R
1	5/8 - 11	3 1/2	3 3/4	3 3/4	3	3 1/4	3 1/4
1.5	3/4 - 10	4	4 1/4	4 1/2	3 1/2	3 3/4	3 3/4
2	5/8 - 11	4	4	4 1/4	3 1/4	3 1/2	3 3/4
3	3/4 - 10	4 3/4	5 1/4	5 1/4	4 1/4	4 3/4	4 3/4
4	3/4 - 10	5	5 1/2	5 1/2	4 1/2	5	5
6	3/4 - 10	5 1/2	5 3/4	6	4 3/4	5 1/4	5 1/4
8	7/8 - 9	6 1/4	7	7	5 1/4	5 3/4	6 1/4
10	1 - 8	7	7 1/4	7 3/4	6	6 1/4	6 3/4
12	1 1/8 - 7	7 3/4	8	8 1/4	6 1/2	6 3/4	7

Note: Bolt/Stud lengths for both Class 150 and 300 are calculated to include two threads past the nut, then rounded to the nearest 1/4", to result in a commercially available length. Lengths include flat washers on both sides.

Storage and Maintenance

Handling and Storing Plastic-Lined Pipe

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 tor 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 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-erectio 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 Plastic Lined Pipe

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 th 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
Perfluoroalkoxyflurocarbon (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

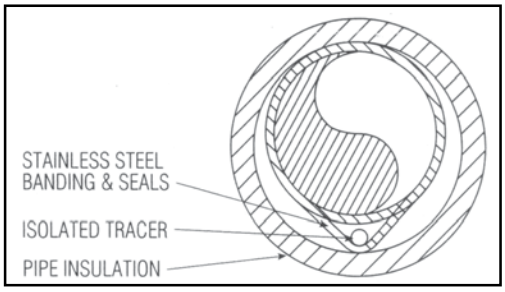
Application (per Chemical Resistance Guide)

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 designe 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. Useful temperature range: 200°F-350°F
   b. Temperature control difficult
   c. High installation and day-to-day maintenance

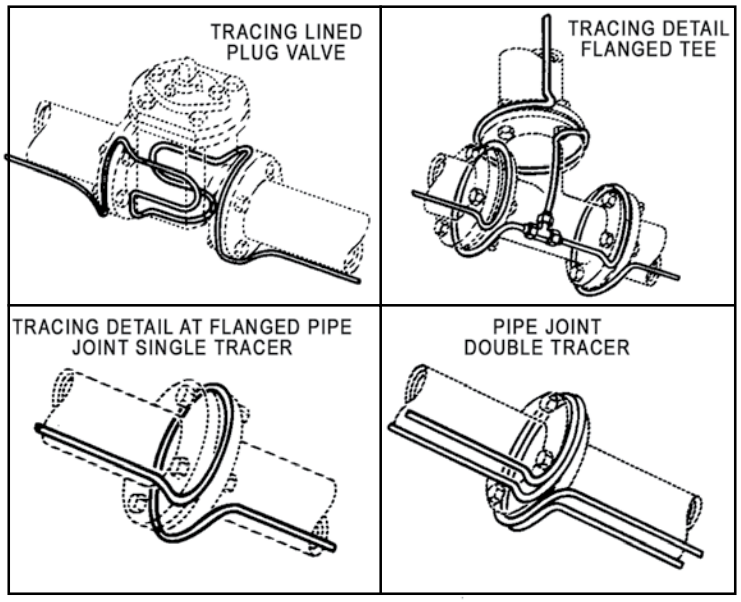
Recommended steam tracing technique



Fluid Tracing: Special Design Considerations

1. Inlet Fluid Media Temperature and Pressure
2. Fluid Media: Density, Specific Heat Viscosity
3. Maximum Allowable Fluid Pressure Drop and Outlet Temperature
4. Advantages
   a. Good for close temperature control
   b. Very good for cooling application
   c. Less susceptible to low temperature problems during system shutdown
5. Disadvantages
   a. Tracing fluids typically have a low heat capacity
   b. Environmental concerns with possible leaks
   c. Many tracing fluids are very expensive and require occasional regeneration

Recommended tracing configurations for joints, fittings and valves.



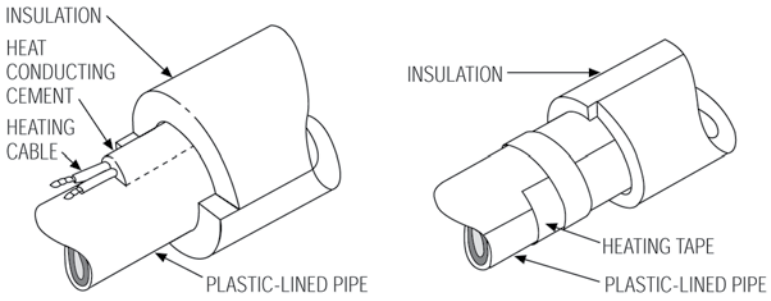
Electric Tracing: Special Design Considerations

1. Available Voltage
2. Hazardous Area Limitations
3. Do not use an electric heating cable with a T-Rating above the recommended liner temperature for the application in question.
4. Advantages
   a. Readily available in any plant facility
   b. Very low heat output capabilities
   c. Very good temperature control capabilities
5. Disadvantages
   a. Restricted in flammable/hazardous areas
   b. If sized for temperature maintenance, electric heat tracing provides slow heat up to the maintenance temperature

When heat tracing plastic line pipe, the maximum liner temperature and any decrease of this temperature due to the service application must be considered. Each heat tracing method has its own strengths and limitations and are all recommended for plastic lined pipe. However, when steam heat tracing Polypropylene (PP) a specially designed isolated tracing system must be used.

Some material extracted from “Steam vs. Fluid vs. Electric Heat Tracing,” Thermon, 1990.

Electrical tracing methods and configurations



Venting and Insulation

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.

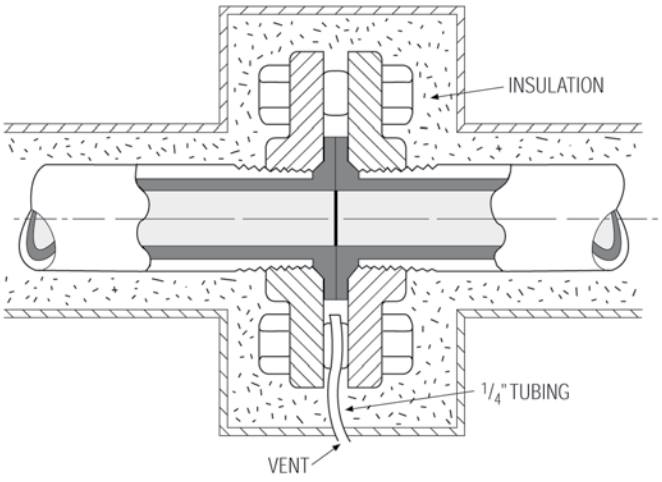
Swaged PTFE-lined pipe spools are designed to vent at the flange. Spiral grooves on the interior of the steel shell transport permeated vapors to the flange area, whereby they exit the annulus along a patented vent collar.

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.

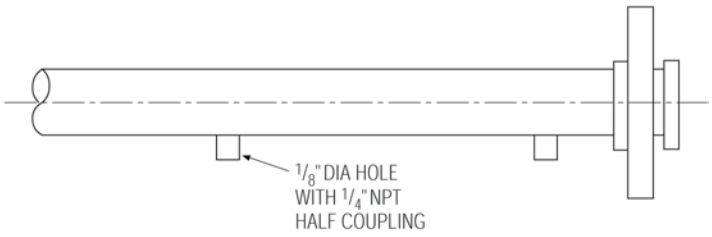
THERMALOK® PTFE-lined pipe and PTFE-lined fittings are vented via vent holes in the pipe, casting or fabricated steel shell. Welded half couplings and vent extenders can be used to extend the vent path through insulation on pipe or around fittings, as shown in Illustration B & C. Couplings are available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

Venting Resistoflex plastic-lined pipe with Swaged pipe

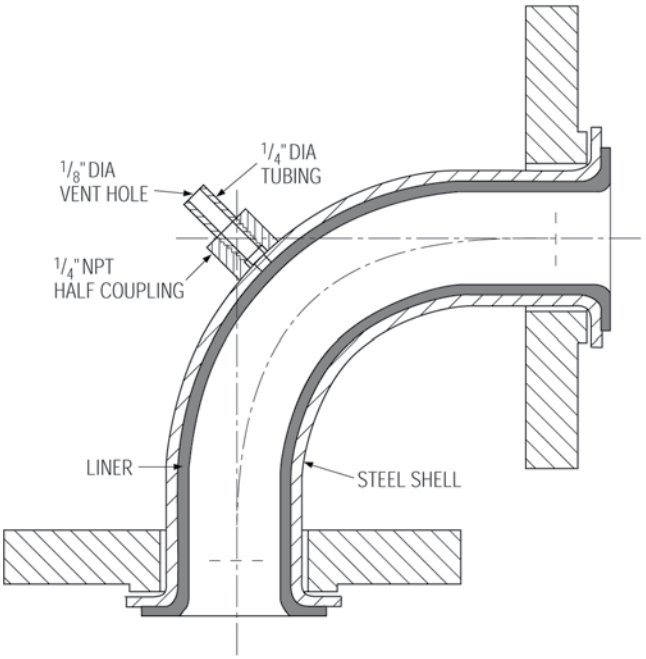
A. Vent extender at insulated pipe joint



B. Vent holes and couplings on THERMALOK® pipe



C. Vent extender for fittings



RESISTOFLEX®

CRANE ChemPharma & Energy

One Quality Way
Marion, NC 28752

Tel: (828) 724-4000
Fax: (828) 724-4783

www.cranechempharma.com
www.craneenergy.com

CRANE

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.

FLOW OF FLUIDS
www.flowoffluids.com

ALOYCO · CENTER LINE · COMPAC-NOZ · CRANE · DEPA · ELRO · DUO-CHEK · FLOWSEAL · JENKINS · KROMBACH ARMATUREN · NOZ-CHEK · PACIFIC VALVES · RESISTOFLEX · revo · Saunders the science inside · STOCKHAM · Triangle · UNI-CHEK · wta · XOMOX

CP_EG-RESISTOFLEX-DM2013-BU-EN-L15-5-2013-2