



**Digital
Catalog**

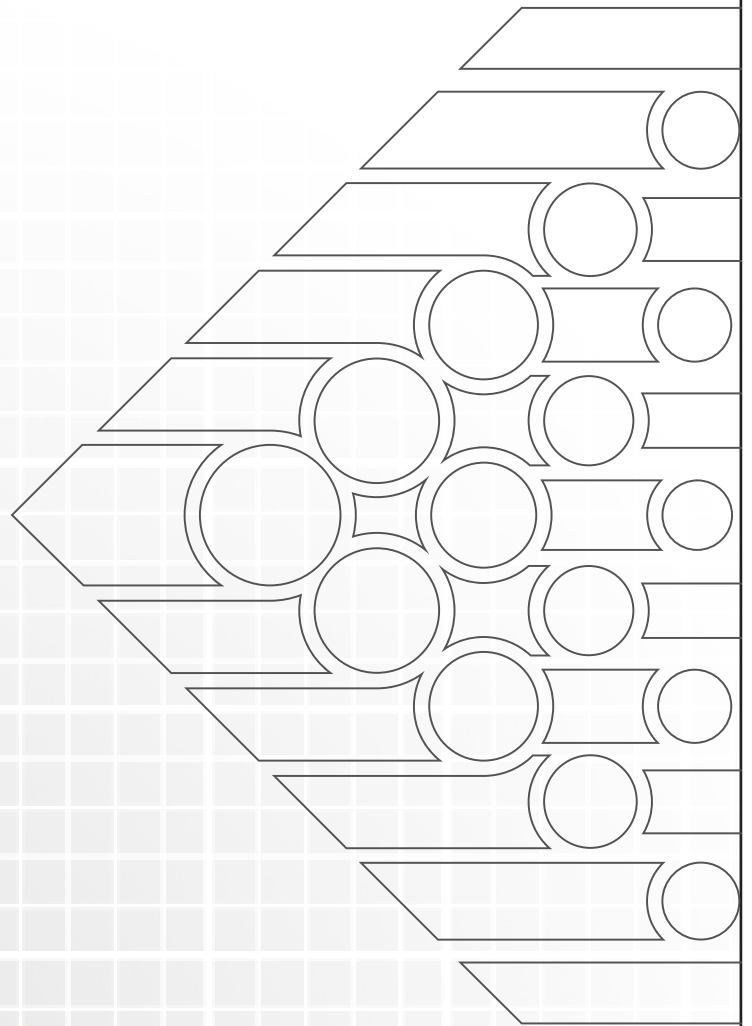


Table of Contents

In Adobe Acrobat, please use [Bookmarks](#) to navigate this document.

RPS Products Overview

- Chemical Resistance Guide
- Products and Capabilities Line Card
- Field Service and Construction Line Card
- FGD Products and Capabilities Line Card
- Pipe Selection Guide

RPS Tank and Vessel Bulletins

- Tank and Vessel Specifications
- Tank and Vessel Configurations
- De-Risking Vessel Procurement with ASME RTP-1 Certification

RPS Pipe Product Bulletins

- HPPE A-150 Pipe and Fittings Specifications
- HPPE H-150 Pipe and Fittings Specifications
- HPPE H-150-200 Pipe and Fittings Specifications
- HPPE P-150 Pipe and Fittings Specifications
- AA-Series Slurry Spray Piping Specifications
- Wet FGD Slurry Guidelines
- Large Diameter Pipe and Duct Systems
- RPS Piping Accessories
- Seamless MAXAR Blue FEP/FRP Dual Laminate Pipe and Fittings Specifications
- Seamless MAXAR Red PVDF/FRP Dual Laminate Pipe and Fittings Specifications
- Seamless MAXAR White PFA/FRP Dual Laminate Pipe and Fittings Specifications
- Seamless PP/FRP Dual Laminate Pipe and Fittings Specifications
- Seamless CPVC/FRP Dual Laminate Pipe and Fittings Specifications
- Seamless PVC/FRP Dual Laminate Pipe and Fittings Specifications
- Advantages of Dual Laminate Piping
- MAXAR*flex* Overview

Dimensions

- Pipe Fitting and Dimensions Catalog (FRP products only)

Joining Systems

- RPS Joining Systems
- Estimated Joining Times
- Benefits and Savings of Tapered Adhesive Joints

Design

- Design Manual

Installation

- Pipe and Fittings Installation Manual
- Pipe Supports Catalog



RPS Chemical Resistance Guide

HPPE Dual Laminate and FRP Piping Systems



RPS Chemical Resistance Guide



FRP and Dual Laminate piping systems are inherently resistant to chemical attack, and are often the material of choice for aggressive chemical services. RPS has developed a number of piping systems, which have been designed to provide outstanding resistance to a wide range of chemical environments. The RPS family of HPPE (High Performance Pre-Engineered) piping systems is composed of:

HPPE MAXAR™ Blue – Our standard corrosion-resistant fluoropolymer dual laminate (FEP/FRP) piping system; liner resists aggressive services up to 150°C/300°F.

HPPE MAXAR™ White – Our corrosion-resistant fluoropolymer dual laminate (PFA/FRP) piping system; liner resists aggressive services up to 230°C/450°F.

HPPE MAXAR™ Red – Our corrosion-resistant fluoropolymer dual laminate (PVDF/FRP) piping system; liner resists aggressive services up to 110°C/230°F and also provides excellent abrasion resistance.

HPPE P-150 – Our standard corrosion-resistant vinylester FRP piping system for a wide range of corrosive applications up to 82°C/180°F.

HPPE H-150 – Our high temperature corrosion-resistant vinylester FRP piping system, appropriate for corrosive applications up to 93°C/200°F.

HPPE H-150-200 – Our high temperature corrosion-resistant vinylester FRP piping system with a fortified corrosion barrier for more aggressive services with temperatures up to 104°C/220°F.

HPPE A-150 – Our corrosion and abrasion-resistant vinylester FRP piping system preferred for slurry services with > 5% solids and temperatures up to 82°C/180°F.

This Guide is intended as a reference to assist engineers in selecting and specifying FRP and Dual Laminate piping systems. The recommendations in this guide are based on corrosion testing, published information, case histories, and RPS judgement. It is RPS' belief that adherence to these recommendations, along with proper system design, installation, operation and maintenance, will result in excellent service life. However, the determination of the suitability of any piping products described in this Guide is the sole responsibility of the user. *RPS makes no warranties, expressed or implied, for the use of this information.*

How to Use this Guide:

The Guide contains hundreds of chemical environments with a rating and maximum temperature for which the rating applies. The ratings are:

- A – Long term chemical resistance can be expected up to the listed temperature. Note: For MAXAR™ piping, the temperatures represent the capability of the lining material. For services with temperatures above 82°C (180°F), RPS should be contacted for recommendations.
- B – Moderate service can be expected, but RPS should be contacted for recommendations to improve performance.
- C – Only limited service life can be expected (likely not more than 1 year). RPS should be contacted for recommendations to improve performance.
- NR – The product is not recommended for the service.

RPS HPPE FRP piping systems should be selected in preference to RPS HPPE MAXAR™ piping systems if they are suitable for the service as they will generally provide a more cost-effective solution.

Whatever your service requirements are, we encourage you to contact our technical staff to find the best solution for your chemical-resistant piping needs.

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Acetic Acid	0.5 - 10	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Acetic Acid	11-25	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Acetic Acid	26 - 50	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Acetic Acid	51 - 75	A to 150°C/300°F	A to 230°C/450°F	A to 52°C/125°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Acetic Acid	76 - 85	A to 150°C/300°F	A to 230°C/450°F	A to 40°C/100°F	A to 40°C/110°F	A to 40°C/110°F	A to 40°C/110°F	
Acetic Acid	86 - 98	A to 150°C/300°F	A to 230°C/450°F	B to 23°C/75°F	NR	NR	NR	NR
Acetic Acid	99 - 100	A to 150°C/300°F	A to 230°C/450°F	C to 23°C/75°F	NR	NR	NR	NR
Alcoholic Spirits	All	A to 150°C/300°F	A to 93°C/200°F	A to 93°C/200°F	A to 40°C/100°F	A to 60°C/140°F	A to 60°C/140°F	
Alumina Hydrate	All			A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Aluminum Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Aluminum Chlorohydrate	All			A to 77°C/170°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Aluminum Chlorohydroxide	50			A to 60°C/140°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Aluminum Hydroxide	100	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Aluminum Nitrate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Aluminum Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ammonia gas (dry)	100	A to 150°C/300°F	A to 230°C/450°F	NR	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Ammonia gas (wet)	100	A to 93°C/200°F		NR	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Ammonia, fumes, wet	40 vol %	A to 93°C/200°F		B to 40°C/100°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Ammonium Bicarbonate	All	A to 93°C/200°F		A to 100°C/212°F	A to 70°C/160°F	A to 70°C/160°F	A to 70°C/160°F	
Ammonium Bisulfite black liquor				A to 80°C/175°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Ammonium Bisulfite cooking liquor				A to 80°C/175°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Ammonium Bromide	All			A to 110°C/230°F	A to 70°C/160°F	A to 70°C/160°F	A to 70°C/160°F	
Ammonium Carbonate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Ammonium Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ammonium Fluoride	Sat'd	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	B to 65°C/150°F <5>	B to 65°C/150°F <5>	C to 65°C/150°F	NR
Ammonium Hydroxide	0.5 - 5 (as NH ₃)	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 65°C/150°F	A to 65°C/150°F	
Ammonium Hydroxide	6 - 20 (as NH ₃)	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 65°C/150°F	A to 40°C/100°F	A to 40°C/100°F	
Ammonium Nitrate	All	A to 140°C/280°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ammonium Phosphate, dibasic	All	A to 140°C/280°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ammonium Phosphate, monobasic	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ammonium Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Arsenic Acid	> 0.5	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Barium Bromide	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Barium Carbonate (slurry)	All	A to 93°C/200°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Barium Chloride	All	A to 93°C/200°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Barium Hydroxide	> 0.5	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Barium Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 80°C/176°F	
Black Liquor (pulp & kraft mill)	Thin	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/175°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	C to 82°C/180°F	NR

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Black Liquor, thick, heavy (pulp & kraft mill)	Thick	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/175°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	C to 82°C/180°F	NR
Boric Acid	> 0.5	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Brine, chlorinated, pH < 2.5	All	A to 150°C/300°F <2>	A to 230°C/450°F	A to 93°C/200°F	B to 82°C/180°F	B to 82°C/180°F	A to 95°C/200°F	NR
Brine, chlorinated, pH 2.5 - 9	All	A to 150°C/300°F <2>	A to 230°C/450°F	A to 93°C/200°F	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Brine, chlorinated, pH > 9	All	A to 150°C/300°F <2>	A to 230°C/450°F	A to 93°C/200°F	C to 82°C/180°F	C to 65°C/150°F	B to 65°C/150°F	NR
Brine, salt	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Bromine liquid	All	A to 93°C/200°F	A to 230°C/450°F	A to 52°C/125°F	NR	NR	NR	NR
Bromine water	Sat'd	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 75°C/165°F			
Brown stock				A to 80°C/175°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Butadiene	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Calcium Bisulfite	All	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Calcium Bromide	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Calcium Carbonate (slurry)	All	A to 150°C/300°F <4>	A to 230°C/450°F <4>	A to 110°C/230°F	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F
Calcium Chlorate	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Calcium Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Calcium Hydroxide	100	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F <5>	B to 65°C/150°F <5>	C to 65°C/150°F	NR
Calcium Hypochlorite	All	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	C to 82°C/180°F	C to 82°C/180°F	B to 82°C/180°F	NR
Calcium Nitrate	> 0.5	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Calcium Sulfate	All	A to 150°C/300°F <4>	A to 230°C/450°F <4>	A to 110°C/230°F	A to 82°C/180°F <4>	A to 93°C/200°F <4>	A to 100°C/212°F <4>	A to 82°C/180°F
Calcium Sulfite	All	A to 21°C/70°F		A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Carbon Dioxide	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	A to 82°C/180°F

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Chlorinated Brine; see Brine, chlorinated								
Chlorinated Pulp	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 93°C/200°F	
Chlorine Dioxide, Chlorine (bleaching solution, with or without pulp)	All			A to 65°C/150°F	A to 82°C/180°F	A to 93°C/200°F	A to 93°C/200°F	
Chlorine Dioxide, no Chlorine (bleaching solution, with or without pulp)	All			A to 65°C/150°F	A to 82°C/180°F	A to 93°C/200°F	A to 93°C/200°F	
Chlorine, dry gas, acidic pH	100	A to 150°C/300°F	A to 150°C/300°F	A to 77°C/170°F	B to 82°C/180°F	B to 93°C/200°F	A to 100°C/212°F	NR
Chlorine, wet gas, acidic pH	100	A to 150°C/300°F <2>	A to 150°C/300°F <2>	A to 77°C/170°F	B to 82°C/180°F	B to 93°C/200°F	A to 100°C/212°F	NR
Chlorine liquid	100	A to 150°C/300°F <2>	A to 150°C/300°F <2>	A to 80°C/175°F				
Chloroacetic Acid (Monochloroacetic Acid)	1	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 50°C/120°F	A to 50°C/120°F	A to 50°C/120°F	
Chloroacetic Acid	2 - 25	A to 150°C/300°F	A to 230°C/450°F	B to 40°C/100°F	A to 50°C/120°F	A to 50°C/120°F	A to 50°C/120°F	
Chloroacetic Acid	26 - 50	A to 150°C/300°F	A to 230°C/450°F	C to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Chloroacetic Acid	51 - 85	A to 150°C/300°F	A to 230°C/450°F	C to 23°C/75°F	A to 25°C/80°F	A to 25°C/80°F	A to 25°C/80°F	
Chloroacetic Acid	86 - 100	A to 150°C/300°F	A to 230°C/450°F	NR	NR	NR	NR	NR
Chromic Acid	0.5 - 10	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Chromic Acid	11-20	A to 150°C/300°F	A to 230°C/450°F	A to 82°C/180°F	A to 50°C/120°F	A to 65°C/150°F	A to 65°C/150°F	
Chromic Acid	30			A to 80°C/175°F	NR	NR	NR	NR
Chromic Acid	40	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/175°F	NR	NR	NR	NR

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Citric Acid	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Cobalt Sulfate	All	A to 150°C/300°F <4>	A to 230°C/450°F <4>	A to 100°C/212°F	A to 82°C/180°F <4>	A to 93°C/200°F <4>	A to 100°C/212°F <4>	A to 82°C/180°F
Copper Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Copper Nitrate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Copper Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Corn Syrup	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Crude Oil	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Diesel Fuel	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Ethanol	All	A to 150°C/300°F	A to 230°C/450°F		NR	NR	NR	NR
Ethyl Acetate	All	A to 150°C/300°F	A to 230°C/450°F	NR	NR	NR	NR	NR
Ethylene Dichloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	NR	NR	NR
Ferric Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ferric Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ferrous Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Ferrous Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Formaldehyde	37	A to 150°C/300°F	A to 230°C/450°F	A to 52°C/125°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Formaldehyde	50	A to 150°C/300°F	A to 230°C/450°F					
Formaldehyde	100	A to 150°C/300°F	A to 150°C/300°F					
Formic Acid	10	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Formic Acid	25	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 50°C/120°F	A to 65°C/150°F	A to 65°C/150°F	

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Formic Acid	50	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 50°C/120°F	A to 50°C/120°F	A to 50°C/120°F	
Formic Acid	85	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 25°C/80°F	A to 25°C/80°F	A to 25°C/80°F	
Formic Acid	100	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	A to 40°C/100°F	A to 40°C/100°F	NR
Fructose	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Gasoline		A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	A to 60°C/140°F	A to 60°C/140°F	NR
Glucose		A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	
Green Liquor	All	A to 93°C/200°F		A to 110°C/230°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	B to 82°C/180°F	NR
Gypsum Slurry, see also Calcium Sulfate	All	A to 150°C/300°F <4>	A to 230°C/450°F <4>	A to 110°C/230°F	A to 82°C/180°F <4>	A to 93°C/200°F <4>	A to 100°C/212°F <4>	A to 82°C/180°F
Hydrobromic Acid	1 - 25	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Hydrobromic Acid	48	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Hydrobromic Acid	62	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	A to 40°C/100°F	A to 40°C/100°F	A to 40°C/100°F	
Hydrochloric Acid	1 - 15	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F	B to 93°C/200°F	A to 100°C/212°F	NR
Hydrochloric Acid	16 - 20	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	C to 82°C/180°F	B to 93°C/200°F	A to 100°C/212°F	NR
Hydrochloric Acid	21 - 32	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	C to 82°C/180°F	A to 82°C/180°F	NR
Hydrochloric Acid	33 - 34	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	C to 82°C/180°F	A to 70°C/160°F	NR
Hydrochloric Acid	35 - 36	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	NR	A to 60°C/140°F	NR
Hydrochloric Acid	37	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	NR	NR	A to 50°C/120°F	NR
Hydrocyanic Acid	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Hydrofluoric Acid	1 - 15	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	C to 65°C/150°F	C to 40°C/100°F	NR	NR
Hydrofluoric Acid	20	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	C to 40°C/100°F	C to 40°C/100°F	NR	NR

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Hydrofluoric Acid	40	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F				
Hydrogen Gas	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F				
Hydrogen Bromide	50	A to 150°C/300°F	A to 230°C/450°F		A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Hydrogen Bromide	100	A to 150°C/300°F	A to 150°C/300°F		A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Hydrogen Peroxide	All	A to 150°C/300°F	A to 230°C/450°F		NR	NR	NR	NR
Hydrogen Sulfide, aqueous	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Hypochlorous Acid	All	A to 150°C/300°F	A to 230°C/450°F					
Isopropanol	All	A to 150°C/300°F	A to 230°C/450°F	A to 60°C/140°F	A to 50°C/120°F	A to 50°C/120°F	A to 50°C/120°F	
Jet Fuel (JP4,JP5)	All	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 60°C/140°F	A to 82°C/180°F	A to 82°C/180°F	
Kerosene	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 60°C/140°F	A to 82°C/180°F	A to 82°C/180°F	
Lime Slurry, see also Calcium Hydroxide	100	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F <5>	B to 65°C/150°F <5>	C to 65°C/150°F	NR
Limestone Slurry, see also Calcium Carbonate	All	A to 150°C/300°F <4>	A to 230°C/450°F <4>	A to 110°C/230°F	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F
Lithium Bromide	All	A to 150°C/300°F		A to 105°C/220°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Lithium Carbonate	All			B to 40°C/100°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	C to 82°C/180°F	NR
Lithium Chloride	All	A to 52°C/125°F	A to 93°C/200°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Lithium Hydroxide	All	A to 52°C/125°F	A to 93°C/200°F	A to 105°C/220°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	C to 82°C/180°F	NR
Lithium Hypochlorite	All			A to 50°C/120°F	C to 82°C/180°F	C to 82°C/180°F	B to 82°C/180°F	NR
Magnesium Carbonate	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Magnesium Chloride	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Magnesium Hydroxide	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Magnesium Nitrate	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Magnesium Phosphate	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Magnesium Sulfate	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Methanol	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	NR	NR	NR	NR
Methyl Bromide	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	NR	NR	NR	NR
Nickel Chloride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Nickel Nitrate	> 0.5	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Nitric Acid	1	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/176°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Nitric Acid	2 - 5	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/176°F	A to 65°C/150°F	A to 82°C/180°F	A to 82°C/180°F	
Nitric Acid	6 - 10	A to 150°C/300°F	A to 230°C/450°F	A to 80°C/176°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Nitric Acid	11 - 20	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	A to 50°C/120°F	A to 65°C/150°F	A to 65°C/150°F	
Nitric Acid	21 - 29	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	A to 50°C/120°F	A to 50°C/120°F	NR
Nitric Acid	30 - 35	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	A to 40°C/120°F	A to 40°C/120°F	NR
Nitric Acid	36 - 40	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	NR	A to 25°C/80°F	NR
Nitric Acid	50	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	NR	NR	NR
Nitric Acid	70	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	NR	NR	NR	NR
Perchloric Acid	5	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Perchloric Acid	10	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 65°C/150°F	A to 65°C/150°F	A to 65°C/150°F	
Perchloric Acid	30	A to 150°C/300°F	A to 230°C/450°F	A to 65°C/150°F	A to 40°C/120°F	A to 40°C/120°F	A to 40°C/120°F	
Phosphoric Acid	0.5 - 100	A to 150°C/300°F	A to 150°C/300°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	

A = Long term chemical resistance can be expected (See Note 1).
 B = Moderate service can be expected. Contact RPS for recommendations to improve performance.
 C = Only limited service can be expected. Contact RPS for recommendations to improve performance.
 NR = Not recommended
 Blank = Data not available

Notes:
 1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
 2. Service may cause blisters to form in corrosion barrier.
 3. Service may discolor corrosion barrier.
 4. A-150 is preferred for slurry services.
 5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Phosphorous Acid	70	A to 150°C/300°F	A to 230°C/450°F	A to 23°C/75°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Potassium Bicarbonate	All	A to 150°C/300°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Potassium Bromide	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Potassium Carbonate	0 - 50	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F <5>	B to 40°C/120°F <5>	B to 40°C/120°F	NR
Potassium Chloride	All	A to 150°C/300°F	A to 205°C/400°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Potassium Fluoride	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	B to 82°C/180°F	NR
Potassium Hydroxide	0 - 50	A to 150°C/300°F	A to 230°C/450°F	C to 40°C/100°F	B to 65°C/150°F <5>	NR	NR	NR
Potassium Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Salt Brine	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sea Water		A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Silicon Tetrachloride	All	A to 38°C/100°F		A to 52°C/125°F				
Silver Nitrate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Bicarbonate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Sodium Bichromate	All	A to 150°C/300°F	A to 230°C/450°F					
Sodium Bromate	All	A to 93°C/200°F	A to 93°C/200°F	A to 93°C/200°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Bromide	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Carbonate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	B to 82°C/180°F <5>	B to 65°C/150°F <5>	C to 65°C/150°F	NR
Sodium Chlorate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Chloride (Brine, salt)	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Cyanide	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Hydroxide	0.5	A to 150°C/300°F	A to 93°C/200°F	A to 23°C/75°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	NR	NR

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Sodium Hydroxide	1	A to 150°C/300°F	A to 93°C/200°F	A to 52°C/125°F	B to 82°C/180°F <5>	B to 82°C/180°F <5>	NR	NR
Sodium Hydroxide	5	A to 150°C/300°F	A to 93°C/200°F	A to 23°C/75°F	B to 82°C/180°F <5>	B to 40°C/100°F <5>	NR	NR
Sodium Hydroxide	10	A to 150°C/300°F	A to 93°C/200°F	A to 23°C/75°F	B to 65°C/150°F <5>	NR	NR	NR
Sodium Hydroxide	25	A to 150°C/300°F	A to 93°C/200°F	B to 40°C/100°F	B to 65°C/150°F <5>	NR	NR	NR
Sodium Hydroxide	50	A to 150°C/300°F	A to 93°C/200°F	B to 23°C/75°F	B to 82°C/180°F <5>	NR	NR	NR
Sodium Hypochlorite (stable, alkaline pH > 11)	2 - 5	A to 150°C/300°F	A to 93°C/200°F	A to 110°C/230°F	B to 65°C/180°F	C to 40°C/100°F	B to 40°C/100°F	NR
Sodium Hypochlorite (stable, alkaline pH > 11)	6 - 15	A to 150°C/300°F	A to 93°C/200°F	A to 93°C/200°F	B to 50°C/120°F <5>	NR	NR	NR
Sodium Nitrate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Sulfate	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Sulfide	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sodium Sulfite	All			A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Solvent Extraction Solutions (3% Isodecanol, 6% Amines tri-C8-C10-alkyl, 91% Kerosene)					A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Solvent Extraction Solutions (4% Triethylphosphine Oxide (TOPO), 4% Di 2-Ethylhexyl Phosphoric Acid (DEHPA), 92% Kerosene)					A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	

A = Long term chemical resistance can be expected (See Note 1).

B = Moderate service can be expected. Contact RPS for recommendations to improve performance.

C = Only limited service can be expected. Contact RPS for recommendations to improve performance.

NR = Not recommended

Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

Continued...

RPS Chemical Resistance Guide

Chemical Environment	Concentration (wt % UNO)	HPPE Product						
		MAXAR™ Piping <1>			FRP Piping			
		Blue (FEP)	White (PFA)	Red (PVDF)	P-150	H-150	H-150-200	A-150
Steam, dry (no condensation)		A to 230°C/450°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Steam, wet (condensation)		A to 230°C/450°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 82°C/180°F	A to 82°C/180°F	
Sulfuric Acid	0.5 - 25	A to 205°C/400°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sulfuric Acid	26 - 50	A to 205°C/400°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Sulfuric Acid	51 - 70	A to 205°C/400°F	A to 230°C/450°F	A to 93°C/200°F	A to 82°C/180°F <3>	A to 82°C/180°F <3>	A to 82°C/180°F <3>	
Sulfuric Acid	71 - 75	A to 205°C/400°F	A to 230°C/450°F	A to 93°C/200°F	A to 40°C/100°F <3>	A to 50°C/120°F <3>	A to 50°C/120°F <3>	
Sulfuric Acid	76 - 80	A to 205°C/400°F	A to 230°C/450°F	A to 93°C/200°F	A to 40°C/100°F <3>	A to 40°C/100°F <3>	A to 40°C/100°F <3>	
Sulfuric Acid	81 - 92	A to 205°C/400°F	A to 230°C/450°F	A to 93°C/200°F	NR	NR	NR	NR
Sulfuric Acid	93 - 98	A to 205°C/400°F	A to 230°C/450°F	A to 65°C/150°F	NR	NR	NR	NR
Sulfuric Acid	> 98	A to 205°C/400°F	A to 230°C/450°F		NR	NR	NR	NR
Tall Oil	All	A to 150°C/300°F	A to 230°C/450°F	A to 110°C/230°F	A to 82°C/180°F	A to 93°C/200°F	A to 100°C/212°F	
Titanium Dioxide	All			A to 93°C/200°F	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F <4>	A to 82°C/180°F
Water, Deionized	100	A to 150°C/300°F	A to 100°C/212°F	A to 110°C/230°F	A to 82°C/180°F <2>	A to 82°C/180°F <2>	A to 82°C/180°F <2>	
Water, Demineralized	100	A to 150°C/300°F	A to 100°C/212°F	A to 110°C/230°F	A to 82°C/180°F <2>	A to 82°C/180°F <2>	A to 82°C/180°F <2>	
Water, Distilled	100	A to 150°C/300°F	A to 100°C/212°F	A to 110°C/230°F	A to 82°C/180°F <2>	A to 82°C/180°F <2>	A to 82°C/180°F <2>	
White Liquor	All	A to 150°C/300°F	A to 93°C/200°F		B to 82°C/180°F	B to 82°C/180°F	B to 82°C/180°F	
Xylene	All	A to 150°C/300°F	A to 230°C/450°F	A to 95°C/200°F	A to 25°C/80°F	A to 25°C/80°F	A to 25°C/80°F	
Zinc Bromide	All	A to 21°C/70°F		A to 110°C/230°F	A to 82°C/180°F	A to 100°C/212°F	A to 100°C/212°F	

For more information: RPSComposites.com
Advisor@RPSComposites.com
 1-800-343-9355

A = Long term chemical resistance can be expected (See Note 1).
 B = Moderate service can be expected. Contact RPS for recommendations to improve performance.
 C = Only limited service can be expected. Contact RPS for recommendations to improve performance.
 NR = Not recommended
 Blank = Data not available

Notes:

1. Temperatures listed for MAXAR™ represent capability of lining material. For service temperatures above 82°C/180°F, contact RPS for recommendations.
2. Service may cause blisters to form in corrosion barrier.
3. Service may discolor corrosion barrier.
4. A-150 is preferred for slurry services.
5. Customized P-150 or H-150 available with A rating at listed temperature. Contact RPS for more information.

RPS CRG 09/22

FRP and Dual Laminate Equipment Manufacturing



Corrosion and Abrasion Resistant Tanks and Vessels

RPS is certified by ASME to fabricate FRP (fiberglass reinforced plastic) and dual laminate tanks and vessels to ASME RTP-1. Dual laminate liners include PVC, CPVC, PP, PVDF, ECTFE, FEP, PTFE, PE, and PFA. Custom built to your specifications.



Dual Laminate Pipe Systems 1" through 24"

A dual laminate pipe system incorporates a thermoplastic liner in an FRP structure, combining the enhanced corrosion resistance of thermoplastics with the higher strength and load carrying capabilities of FRP.

- MAXAR Blue FEP/FRP
- MAXAR Red PVDF/FRP
- MAXAR White PFA/FRP
- ECTFE/FRP
- CPVC/FRP
- PP/FRP
- PVC/FRP



FRP Pipe Systems 1" through 120"

RPS corrosion and abrasion resistant FRP pipe systems offer significant performance and cost advantages over steel, alloy, and rubber lined steel materials.

- Corrosion Resistant HPPE P-150 – Vinyl Ester (VE) Resin
 - Corrosion/Abrasion Resistant HPPE A-150 – Abrasion Resistant VE Resin
 - AA Series FGD Slurry Spray Piping – Abrasion Resistant VE Resin
 - High Temperature Corrosion Resistant HPPE H-Series – Novalac VE Resin
 - Pipe Supports
- Note: HPPE P-150, HPPE A-150, and H-Series are ASME NM.2 compliant



Custom Composite Equipment

- Containment Liners
- Acid Cells
- Covers
- Platforms
- Manifolds
- Decks
- Beams
- Strippers
- Strainers
- Baffles
- Pipe supports
- Headers
- Stacks
- Deflectors
- Linings
- Duct
- Roofs
- Lamella
- Alignment grids
- Conical Outlets
- Panels



Construction/Field Services

RPS field service crews are available 24 hours a day seven days a week, for installation, inspection, and maintenance of composite equipment.

- Inspection
- Installation
- Training
- Maintenance
- Panel Linings
- Laminating
- Field Joints
- Emergency Repair
- Relining
- Non-Destructive Testing and Inspection
- Thermoplastic Welding
- Long Term Service Agreements

Engineering Services

When you work with RPS Composites you have full support from our in-house team of professional engineers.

- Material Selection
- Finite Element Analysis (FEA)
- Tank and Vessel Design
- Specification
- Component and Equipment Design
- Pipe Stress Analysis (PSA)
- Inspection

Facilities

RPS operates multiple FRP and dual laminate manufacturing, inspection, distribution, and service centers near dense industrial corridors and transportation hubs, enabling us to fulfil large capex projects, and to provide timely local service.

United States — Alabama (Mobile) • Louisiana (Baton Rouge) • Ohio (Cincinnati) • Texas (Houston) • Utah (Salt Lake City)
 Virginia (Front Royal) • Pennsylvania (Pittsburgh) • Washington (Vancouver)
 Canada — Nova Scotia (Mahone Bay) • Ontario (Toronto)

Field Service and Construction



- Inspection
- Installation
- Bonder and welder training
- Spray-on linings
- Thermoplastic welding
- Non-destructive testing
- Overwrapping
- Shutdown work
- Maintenance
- Panel linings
- Rubber lining repairs
- Fiberglass lamination
- Emergency repairs
- Piping modifications
- Field joints
- Long Term Service Agreements

RPS Field Service crews are available 24 hours a day seven days a week to support your composite equipment.



Why Choose our Team?

Focused on safety - RPS invests in safety protocols at all levels of the Company. From continuous safety training, and individual job safety planning, to safety-specific leadership positions, the health and safety of our workers and your site is our first priority.

Quality Results - Driven by customer satisfaction, RPS ensures high performance, quality, and reliability are evident in every part of our operation. It starts with Recruitment, and carries on through Manufacturing, and Field Service.

Responsive - RPS teams are available on demand, and scalable, as the work dictates; deployable from service centers around the US, we aim to be on site within 24hrs of any emergency call.

Experience and training - Many of our team members have been with us for 10+ years, developing their craft, year over year. We also have rigorous training, qualification, and re-certification programs and have recently created a Training division.

Efficient - Backed by modern technology, tools, and proprietary applications, our Project Managers ensure your job flows as effectively as possible. Our field service teams are equipped with an inventory of standard pipe and fittings, supported by 3 flagship manufacturing plants, and a team of Engineers.

Sole sourced - From initial planning, design, and testing, through manufacturing, installation, inspection, maintenance, and retirement, RPS can provide support from cradle to grave, streamlining your procurement, accounting, and communication efforts.

Risk mitigation - Every project comes with a degree of risk. Working with RPS helps reduce your exposure to liabilities involving safety, scheduling, delivery, quality, compliance, pricing, and more.



Chemical Processing

Supply and install dual laminate and FRP piping systems; field joints; overwrap vent lines; repair cracked fittings; wet ESP repair; interior scrubber repair; tank recoating; bonder training; in-service NDT inspection; outage repairs; ECTFE tank liner repair; vessel inspection; rubber lining repairs and testing

Chlor-Alkali

Supply, install, modify chlorine dioxide piping; bleach tank inspection, repair, and reline; ECTFE tank liner repair; cell inspection and repair; start up support; PFA liner repair; field welds; dual laminate installation; spark test PVDF tank; shut down repairs; manufacture, demo, and install brine piping

Mineral Processing

Reline leach tank; vent line installation; duct repair; damaged tank liner repair; scrubber piping inspection, repair and replacement; in-service HCl tank inspection; outage repairs on cooling tower; outage work at acid plant; reline lithium chloride tank; emergency repairs to hydromet effluent line

Sub-Contracting

Repair CPVC/FRP piping; supply on site QA/QC, Supervisor, Project Management support; perform FRP field joints; UPVC/FRP field welds; supply and install FRP and dual laminate pipe and fittings; piping modifications; emergency FRP repair; training and certification

Pulp and Paper

Demo and replace chlorine dioxide line; outage work; FRP piping inspection and repair; rubber lined cation tank inspection; chlorine dioxide tank modifications; fan blade repair and balance; magnesium sulfate tank repair; tank relining; emergency demo and repair

Metal Finishing

Repair and rebuild of anode boxes; pickling line equipment supply and repair; tank relining; fabricate and install catchment trays; tank insulation jacket repair; roaster roof repair; waste acid storage tank repair; fume duct modification; repair vapor scrubber; reline conical tank bottom; exhaust stack repair

Power/FGD

Manufacture and install spray headers; repair slurry recycle lines; CCR piping supply and install; stack liner inspection; field butt and wrap joints; inspect discharge piping; repair spray header piping; outage work; tank repair; duct supply and install; repair gypsum transfer line; repair rubber on agitator shaft

Semiconductor

Supply and install PFA/FRP piping; repair leaks on PVC/FRP piping; reline hydrochloric acid tank; demo, manufacture, install FEP/FRP piping; reline DI water tank; inspect FEP/FRP vessel

Wastewater Treatment

FRP tank inspection, supply, install; reline sodium hypochlorite tank; repair underground FRP piping; perform field joints; repair fluorosilicic acid tank; training and certification

Pharmaceutical

Shutdown inspections and repair; repair tank accessories; install FRP wastewater piping; repair tank knuckle cracks; repair scrubber column; overwrap FRP lines

Facilities

RPS operates multiple FRP and dual laminate manufacturing, inspection, distribution, and service centers near dense industrial corridors and transportation hubs, enabling us to fulfil large capex projects, and to provide timely local service.

United States — Alabama (Mobile) • Louisiana (Baton Rouge) • Ohio (Cincinnati) • Texas (Houston) • Utah (Salt Lake City)
Virginia (Front Royal) • Pennsylvania (Pittsburgh) • Washington (Vancouver)
Canada — Nova Scotia (Mahone Bay) • Ontario (Toronto)



Products & Capabilities: FGD / Utility Systems

Since 1970 RPS has supplied composite materials to more than 200 FGD plants worldwide. From internal absorber spray pipes and recycle piping, to complete internals for jet bubbling reactors, our customers have come to rely on us for our high performance products and expertise in the industry.

RPS corrosion and abrasion resistant composites have a proven track record and offer the best value when compared to other composites, rubber lined carbon steel, or high nickel alloy materials.



As power generation has evolved our focus has shifted from working with EPCs on large capital projects to maintenance contracts, replacement parts, and providing solutions for CCR/ELG compliance.



- 1970s
 - Absorber internal spray piping manufacturing and installation
 - External slurry recycle piping
 - Fly-ash slurry recycle piping from precipitator to ponds
 - Pond return water piping
 - Internal slurry nozzles
 - Wastewater treatment piping
 - Replace rubber-lined steel slurry process piping
- 1980s
 - Slurry process piping
 - Demister wash piping
 - Replace carbon steel slurry process piping
 - Internal oxidation air piping
- 1990s
 - Jet bubbling reactor piping
 - Overflow piping seal boxes
 - Water process piping
 - Deck wash piping
- 2000s
 - Dewatering and reagent piping
 - Pipe supports
 - Quench recycle pipe
 - Process vent stacks
- 2010s
 - JBR scrubber internals
 - Replacement piping
 - Outage repairs & maintenance
 - CCR/ELG wastewater piping
 - JBR alignment grids (VI)
 - JBR alignment grid beams (VI)
- 2020s
 - Carbon capture

Available 24 hours a day,
7 days a week.

Inspection, Distribution, and Service Centers

RPS has *Inspection, Distribution, and Service Centers* in each of our facilities, putting us within driving distance of many of the coal-fired power plants in the US.

- Alabama (Mobile) •
- Louisiana (Baton Rouge) •
- Ohio (Cincinnati) •
- Pennsylvania (Pittsburgh) •
- Texas (Houston) •
- Utah (Salt Lake City) •
- Virginia (Front Royal) •
- Washington (Vancouver) •
- Nova Scotia (Mahone Bay) •
- Ontario (Toronto) •

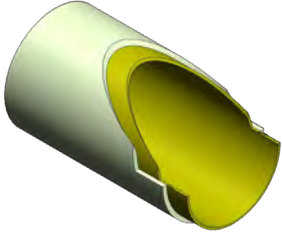
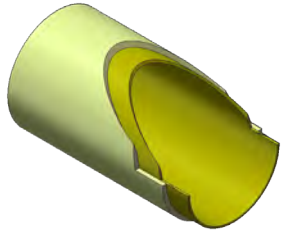
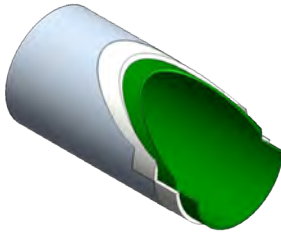
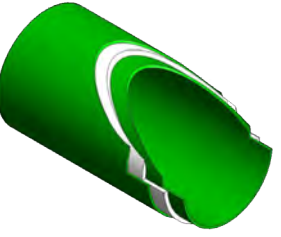
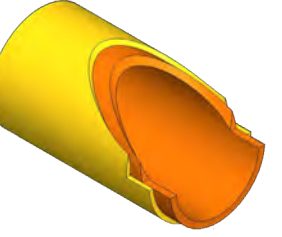


- Long-term Maintenance Contracts • FRP Panel Linings • Training • Rubber Lining Repairs •
- Spray-on Linings • Fiberglass Lamination • Thermoplastic Welding • Emergency Repairs •



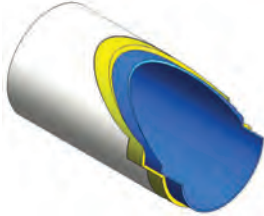

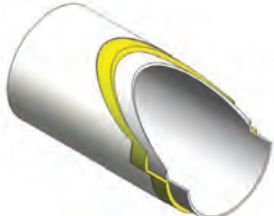
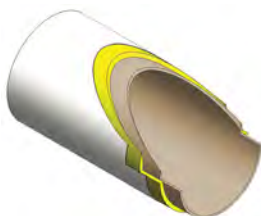
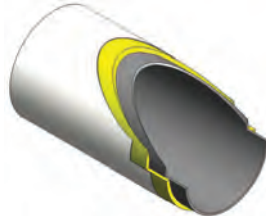
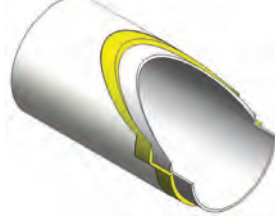
- Pipe and Tank Inspections, Fit for Use (FFU) Investigations, UltraAnalytix® NDT •



TYPE	HPPE P-150	HPPE H-150 HPPE H-150-200	HPPE A-150	AA-series (Internally and Externally Abrasion Resistant)	Custom
	<p>Highly corrosion resistant pipe system. Reinforced chemical resistant barrier in pipe and fittings. Available with RPS Tapered Adhesive joint (sizes 1" – 12") for maximum chemical resistance at lowest installed cost. ASME NM.2 compliant.</p> 	<p>Improved resistance to strong acids, solvents, and oxidizing agents. Higher temperature capability, to 220°F. H-series offers maximum chemical resistance. ASME NM.2 compliant.</p> 	<p>Corrosion resistant pipe system with the proprietary RPS A-series, abrasion/corrosion resistant liner in pipe and fittings. A-series outperforms standard FRP and rubber lined carbon steel in fine particle slurries (eg. limestone, gypsum, lime). ASME NM.2 compliant.</p> 	<p>Custom designed spray piping system incorporating an internal and external RPS A-series, abrasion/corrosion resistant liner. The preferred material for Flue Gas Desulphurization (FGD) spray pipe.</p> 	<p>Piping system designed and built to specific customer or service condition. Custom designed pipe systems can optimize the cost:performance relationship.</p> 
Size (Diameter)	1" – 120"	1" – 120"	1" – 120"	1" – 60"	1" – 120"
Corrosion Barrier	0.100"	0.100" or 0.200"	0.100"	0.050" TO 0.500" (inside & outside)	0.050" to 0.500"
Pipe Structure	Filament Wound	Filament Wound	Filament Wound	Filament Wound or Contact Molded	Filament Wound or Contact Molded
Flange	Laminated	Laminated	Laminated	Laminated	Laminated
Resin System	Bisphenol A epoxy vinyl ester	Brominated epoxy novolac vinyl ester	Vinyl ester	Vinyl ester	Vinyl ester Brominated epoxy novolac vinyl ester Bisphenol A Isophthalic
Fire Retardance	Optional	Standard	Optional	Optional	Optional
Joint Types	Tapered Adhesive Butt & Wrap O-Ring	Tapered Adhesive Butt & Wrap	Tapered Adhesive Butt & Wrap	Tapered Adhesive Butt & Wrap	Butt & Wrap
Pressure Ratings	50 – 150 psi	50 – 150 psi	50 – 150 psi	50 – 150 psi (full vacuum rating available)	25 – 150 psi (full vacuum rating available)
Temp. Range	-40°F (-40°C) to 180°F (82°C)	-40°F (-40°C) to 220°F (104°C) *	-40°F (-40°C) to 180°F (82°C)	-40°F (-40°C) to 180°F (82°C)	
Typical Applications**	Caustics, acids, brine solutions, industrial chemicals, sewer and effluent lines, chlorine dioxide, pickling lines, and other services demanding highly corrosion resistant resins.	Higher Temperature Capabilities As P-series, H-series is capable of handling a wide range of acids and oxidizing agents. H-series has improved performance with solvents, and at elevated temperatures.	Enhanced Erosion Resistance Excellent performance in handling lime, limestone, and gypsum slurries; as found in wet limestone scrubber systems. Suitable for other fine particle slurries (eg. TiO ₂).	Internal & External Erosion Resistance Wet limestone FGD Spray Piping, and other applications where both internal and external erosion are a concern.	Chlorine and custom applications.

* H series piping systems with a continuous operating temperature above 210°F (99°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

** Please consult our Chemical Resistance Guide for specific recommendations, available at RPSComposites.com/Company-Literature.

	Fluoropolymers			Polyolefin	Vinyls	
TYPE	FEP/FRP (MAXAR Blue)	PVDF/FRP (MAXAR Red)	PFA/FRP (MAXAR White)	PP/FRP	CPVC/FRP	PVC/FRP
	<p>MAXAR Blue (fluorinated ethylene propylene) piping products exhibit excellent chemical resistance at elevated temperatures. A fully bonded liner reinforced with a premium vinyl ester resin offering seamless flanged spools up to 20 ft. The improved impact and elongation properties have proven beneficial for many applications. Field spooling can be done by maintenance crews with MAXARFlex.</p> 	<p>MAXAR Red (polyvinylidene fluoride) is valued for its toughness, high abrasion resistance and low permeability to most gases and liquids. These qualities offer additional chemical benefits in high pH solutions, increased impact strength at ambient and colder temperatures. Field spooling can be done by maintenance crews with MAXARFlex.</p> 	<p>MAXAR White (perfluoroalkoxy) provides excellent chemical / solvent resistance and is the most temperature resistant of all our dual laminate piping systems. Field spooling can be done by maintenance crews with MAXARFlex.</p> 	<p>Polypropylene has many advantageous in process piping. Strength, low weight, abrasion resistance, and broad temperature range provides numerous chemical applications.</p> 	<p>CPVC has physical properties at 73°F similar to PVC and chemical resistance generally better than that of PVC. CPVC has proven to be an excellent piping material for hot corrosive liquids, hot and cold water distribution and similar applications above the temperature range of PVC.</p> 	<p>Known as the most frequently specified of all thermoplastics materials, PVC is characterized by distinctive physical properties, and is resistant to corrosion and chemical attack by acids, alkalis, salt solutions etc.</p> 
Size (Diameter)	1" – 24" (Seamless thru 20")	1" – 24" (Seamless thru 12")	1" – 24" (Seamless thru 10")	1" – 24" (Seamless thru 20")	1" – 24"	1" – 24"
Pipe Structure	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded
Flange	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded	Filament Wound or Contact Molded
Resin System	Vinyl Ester	Vinyl Ester	Vinyl Ester	Vinyl Ester	Vinyl Ester	Vinyl Ester
Fire Retardance	Optional	Optional	Optional	Optional	Optional	Optional
Joint Types	Flow fusion or hot air/gas FRP Overwrap	Hot plate butt weld, flow fusion or hot air/gas FRP Overwrap	Flow fusion or hot air/gas FRP Overwrap	Hot plate butt weld or hot air/gas FRP Overwrap	Solvent/Socket, hot plate butt weld or hot air/gas; FRP Overwrap	Solvent/Socket, hot plate butt weld or hot air/gas; FRP Overwrap
Pressure Ratings	100 psi - 150 psi (full vacuum rated)	100 psi - 150 psi (full vacuum rated)	100 psi - 150 psi (full vacuum rated)	100 psi - 150 psi (full vacuum rated)	100 psi - 150 psi (full vacuum rated)	100 psi - 150 psi (full vacuum rated)
Temp. Range	-5°F (-20°C) to 220°F (104°C)	-5°F (-20°C) to 220°F (104°C)	-5°F (-20°C) to 220°F (104°C)	15°F (-10°C) up to 200°F (93°C)	0°F (-18°C) up to 200°F (93°C)	0°F (-18°C) up to 170°F (77°C)
Typical Applications	MAXAR Blue's FEP liner is chemically inert to a broad range of commercial chemicals including: acids, chlorides, sulfates, bleach solutions and caustics, etc.	Some common chemicals handled by PVDF piping are: acetic acid, chlorine, hydrochloric acid, sodium hypochlorite, sulfuric acid etc. It's often used for pump parts, tank liners, and seals.	Our PFA dual laminate is inert to a broad range of chemicals and solvents, at higher temperatures.	Polypropylene liners are chemically inert to mineral acids, alkalis, salt solutions, alcohols, and strong caustic streams including potassium hydroxide and sodium hydroxide solutions.	Generally resistant to most acids, bases, oxidants and halogens.	Generally resistant to most acids, bases, oxidants and halogens.

- Notes:**
- The information in this chart is provided as general reference. The details of a user's specific process may have a profound effect on material selection. Please consult our Chemical Resistance Guide for more precise recommendations, available at RPSComposites.com/Company-Literature.
 - RPS Dual Laminate piping systems with a maximum continuous operating temperature above 180°F should be evaluated by RPS engineering to determine if the process conditions are acceptable.
 - Other liners, including HDPE (high density polyethylene) and ECTFE (ethylene chlorotrifluoroethylene), are available.

Corrosion and Abrasion Resistant Tanks and Vessels

- RPS is certified by ASME to fabricate FRP (fiberglass reinforced plastic) and dual laminate tanks and vessels to ASME RTP-1.
- Dual laminate liners include PVC, CPVC, PP, PVDF, ECTFE, FEP, PTFE, PE, and PFA.
- FRP vessels manufactured with premium resins that include polyester (INEOS Hetrion™), vinyl ester (INEOS Derakane™), and bisphenols.
- ASTM D3299, ASTM D4097 compliant.
- Pressure rating from full vacuum to 15 psig.
- Cylindrical vessels constructed via contact molding and filament winding; rectangular vessels via contact molding and vacuum infusion.
- Thermoplastic-lined dished and flat tops and bottoms are vacuum formed.
- Vessels constructed in various sizes to a maximum height/length of 60' and standard diameters up to 14'. Non-standard sizes and shapes available.
- Volume ranging from 100 to 330,000 imp gal.

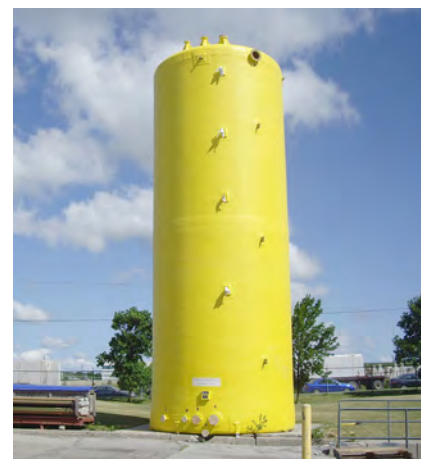


CPVC-lined chlorine drying tower

- External resin coating is pigmented and contains paraffin and ultraviolet absorbers to assure proper surface cure and inhibit ultraviolet light degradation.
- Minimum Barcol hardness of 90% of resin manufacturer's specified value.
- Ledges and face flanges, if required, are designed as integral structures.
- FRP surfacing veils include polyester (Nexus), 'C' veil, or carbon veil
- 'ECR' glass used exclusively



PP-lined phosphoric acid storage tanks



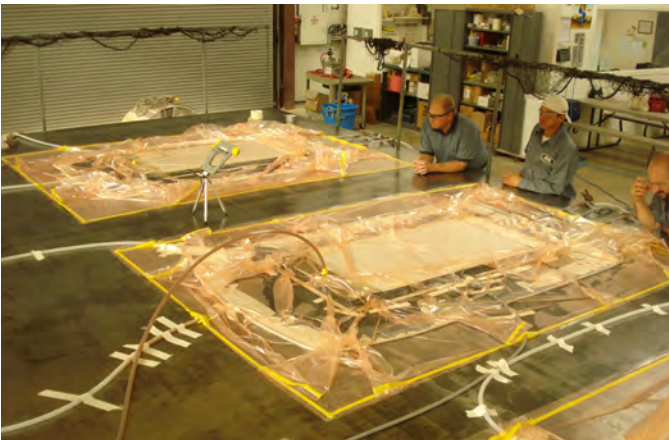
FRP chlorate tank

Specifications

- Configuration options:
 - ◆ open or closed tops
 - ◆ flat, cone, dished, skirted, or sloping bottoms
 - ◆ vertical or horizontal
 - ◆ cylindrical or rectangular
 - ◆ saddles optional; legs optional
- Various accessories also available (nozzles, manways, hold downs, vents, ladders, insulation, heat tracing, dip tubes, gauges, mixers, baffles, agitator support frames).
- Spray nozzles, feed headers, liquid distributors, packing support and other internals can be made from thermoplastic material upon request.

Quality Assurance

All vessels and tanks are manufactured under a formal and documented QA program in accordance with a recognized Quality Assurance Standard.



Vacuum Assisted Resin Infusion process

Applications	Industries
Acid cooling towers	Chlor-alkali
Chlorine drying towers	Chemical processing
Wet electrostatic precipitators (WESP)	High purity semiconductor
Storage tanks	Pulp & paper
Mixing tanks	Metals and mineral processing
Scrubbers	Water and wastewater treatment
Columns	High purity pharmaceutical
Custom vessels	High purity food & beverage
	Power and energy
	Petrochemical

RFQ Checklist

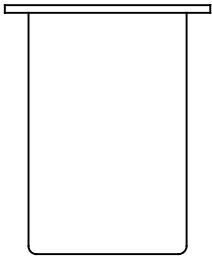
- Contact name, Company, email, phone number
- Delivery Zip/Postal code; delivery date
- Bid due date; budget or firm pricing
- Equipment name, configuration, dimensions
- Indoor or outdoor location; RTP-1 stamped or not
- Chemical service(s), concentration(s) % bw, sp. gr.
- Abrasive solids, if any, and % bw
- Liner material and thickness; required resin, if any
- Design temperature, internal and external design pressure
- Seismic zone, wind and snow loads
- Sizes / quantities of nozzles, manways, hold down lugs, lifting lugs
- Accessories (ladder, railing, internals, heat tracing, insulation)
- Secondary containment details (height; sp. gr. of other liquids)

Please go to RPSComposites.com/quote-request to complete a form or upload files.

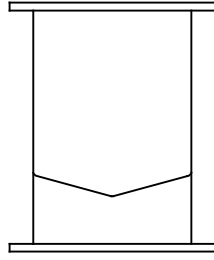


RPS Composites Inc.
 2175 Teston Rd.
 Maple, ON L6A 1R3
 Tel: (905) 553-4455
 Sales@RPSComposites.com
 RPSComposites.com

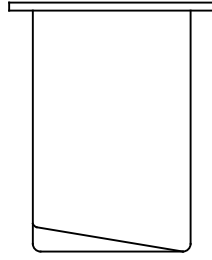
RPS Tank and Vessel Configurations



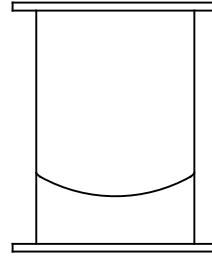
MODEL C-OVF
OPEN VERTICAL
FLAT BOTTOM



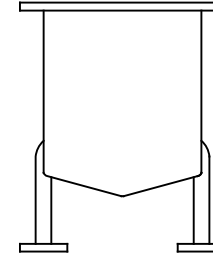
MODEL C-OVCS
OPEN VERTICAL
CONE SKIRTED



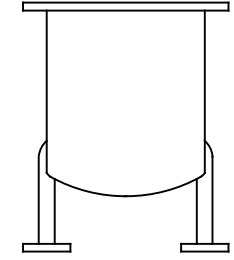
MODEL C-OVS
OPEN VERTICAL
SLOPING BOTTOM



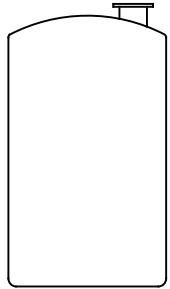
MODEL C-OVDS
OPEN VERTICAL
DISHED SKIRTED



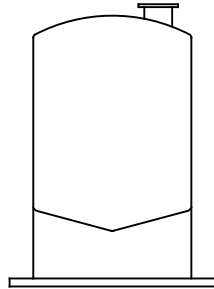
MODEL C-OVC
OPEN VERTICAL
CONE ON LEGS



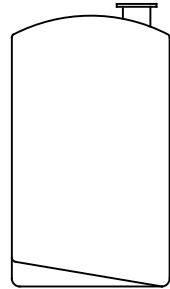
MODEL C-OV
OPEN VERTICAL
DISHED ON LEGS



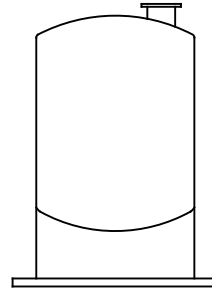
MODEL C-CVF
CLOSED VERTICAL
FLAT BOTTOM



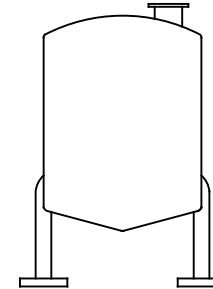
MODEL C-CVCS
CLOSED VERTICAL
CONE SKIRTED



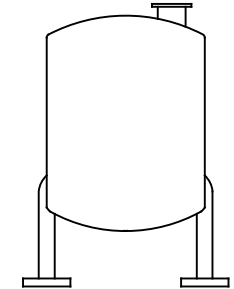
MODEL C-CVS
CLOSED VERTICAL
SLOPING BOTTOM



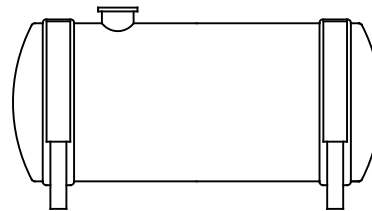
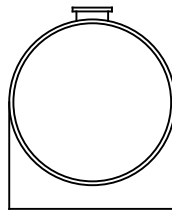
MODEL C-CVDS
CLOSED VERTICAL
DISHED SKIRTED



MODEL C-CVC
CLOSED VERTICAL
CONE ON LEGS



MODEL C-CV
CLOSED VERTICAL
DISHED ON LEGS



MODEL C-H
HORIZONTAL STORAGE

De-Risking Vessel Procurement with RTP-1 Certification



A Comparison of ASTM D3299/D4097, ASME RTP-1 design only, and ASME RTP-1 Certification

	ASTM D3299 and ASTM D4097 ¹	ASME RTP-1 Design Only ¹	ASME RTP-1 Design, Fabricate, Inspect & Stamp
	Any manufacturer can claim to build to ASTM standards; No verification required.	Any manufacturer that claims to design to RTP-1 may, or may not, be able to meet ASME's standard.	Only ASME RTP-1 Accredited manufacturers can design ² , fabricate, inspect, and stamp per RTP-1.
Certifying Organization	None	None	ASME
Compliance Oversight	None	None	Thorough compliance with ASME code. Mandatory recertification every 3 years.
Audits	Self-performed. No third-party verification	Self-performed. No third-party verification	Annual inspections and audits by ASME
QC Requirements:			
Designed by Registered Professional Engineer	No	Maybe	MANDATORY
Rigid Document Control	Unknown	Unknown	MANDATORY
Use of Qualified Laminators	No	No	MANDATORY
Use of Qualified Secondary Bonders	No	No	MANDATORY
Use of Qualified Thermoplastic Welders	No	No	MANDATORY
Shop Qualification Laminates	No	No	MANDATORY (every 5 years)
Bond Strength Requirements	No	No	MANDATORY
Identification and traceability of all constituent parts	Unknown	Unknown	MANDATORY
Fabrication Details per ASME RTP-1	No	Maybe	MANDATORY
Inspections of resin and glass	No	Maybe	MANDATORY
Raw Materials Certificate of Analysis	No	Maybe	MANDATORY
Final Review by Certified Individual	No	No	MANDATORY
Quality Control Manual Approved by ASME	No	No	MANDATORY
Shop Accredited by ASME	No	No	MANDATORY
Shop periodically audited by ASME	No	No	MANDATORY
Shop Hydrotest	Maybe	Maybe	MANDATORY
Proof Test	No	No	As per ASME RTP-1 Standard
ASME Nameplate & Stamp	No	No	MANDATORY

¹The requirements can also be specified by end user.

²Certified tanks/vessels can be designed by third parties who meet the necessary qualifications.

••
Stocked in multiple locations in the US and Canada

Standard 100 mil corrosion barrier

Complies with ASME NM.2

Complies with ASTM D5421, ASTM D6041

••

••
Typical Applications

Limestone slurry

Sludge

Gypsum slurry

Titanium dioxide slurry

Spent carbon slurry

Used in hundreds of installations in 20 countries around the world.

••

Specifications

Pressure Rating: 150 psi (10 BAR), testing per ASTM D2992

Maximum Test Pressure: 225 psi (15 BAR)

Temperature Range: -40°F (-40°C) to 180°F (82°C)

Resin: INEOS DERAKANE™ 411 (Bisphenol A Epoxy Vinyl Ester)

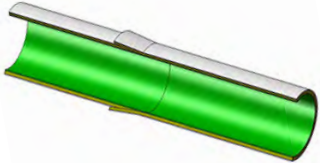
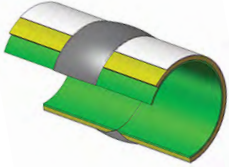
Surfacing Veil: C veil or Polyester (Nexus)

Glass: 'ECR' Glass

- All pipe, flanges, and fittings have a 100 mil thick corrosion / abrasion barrier comprising one layer of veil (chemical barrier) and two layers of chopped strand glass (anti-wicking barrier) in a specially formulated abrasion resistant resin matrix.
- Manufactured via combination of contact molding and filament winding. Available in sizes 1" - 120" diameter. Refer to our *Pipe Fitting and Dimensions Catalog* for dimensions.
- External resin coating is pigmented grey and contains paraffin and ultraviolet absorbers to assure proper surface cure and inhibit ultraviolet light degradation.
- Minimum Barcol hardness of 90% of resin manufacturer's specified value.
- Flanges available in either full face FRP or lap joint style. Drilling in accordance with ASME B16.5 Class 150.
- All pipe and fittings manufactured under a formal QA program based on Quality Assurance Standard ISO 9001:2015.
- Pipe and fittings shall be shop or field assembled using either RPS matching tapered adhesive joints for sizes 1" - 12" or butt joints, available in all sizes.



Specifications

Joining Systems	
Tapered Adhesive Joints	Butt & Wrap Joints
	
<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems 1" - 12" • Fittings are supplied with integral belled ends and pipe is supplied belled by plain end. Components are permanently bonded in the shop or field using RPS adhesive, formulated from the same type of resin used in fabrication of the pipe system liner. • The Tapered Adhesive joint requires less material without compromising strength and can be fabricated in half the time, resulting in significant savings on labor and installation costs. For the full list of benefits refer to <i>RPS Tapered Adhesive Joints - Benefits and Savings</i> found in the Company Literature section of our website. 	<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems, all diameters. • Pipe and fitting ends are sanded to prepare a good bonding surface. Components are aligned, "butted" together, and sealed with resin. A "wrap" is applied to permanently bond the components. The "wrap" is made up of layers of glass reinforcement saturated with resin. • A variety of butt joint designs are available depending on the service conditions. These include straight, tapered, and edge capped.
<p>Detailed joining instructions are available in our <i>Installation Manual</i> at rpscomposites.com/resources/company-literature</p>	



HPPE A-150 in service as CCR piping at a US power utility.



HPPE A-150 in service as FGD process pipe at a US power utility.

RPS A-150 Pipe Dimensions						
Pipe Size	Inside Diameter	Liner Thickness	Structure Thickness	Total Thickness	Outside Diameter	Weight
(in)	(in)	(in)	(in)	(in)	(in)	(lbs/ft)
1	1.00	0.11	0.08	0.19	1.38	0.5
1.5	1.50	0.11	0.08	0.19	1.88	0.9
2	2.00	0.11	0.08	0.19	2.38	1.1
3	3.00	0.11	0.08	0.19	3.38	1.6
4	4.00	0.11	0.095	0.205	4.41	2.3
6	6.00	0.11	0.13	0.24	6.48	4.1
8	8.00	0.11	0.17	0.28	8.56	6.3
10	10.00	0.11	0.21	0.32	10.64	8.9
12	12.00	0.11	0.26	0.37	12.74	12.4

A-150 Maximum Recommended Support Spacing at 150 psi				
NPS (in)	Single Span		Continuous Span	
	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	6.9	6.7	10.3	10
1.5	7.6	7.3	11.4	10.9
2	8.2	7.9	12.2	11.7
3	9.1	8.7	12.8	11.8
4	10.2	9.7	13.4	12.2
6	12.2	11.3	15.2	13.8
8	14.1	12.9	17.4	15.8
10	15.7	14.3	19.2	17.4
12	17.3	16.3	21.8	20

Pipe Supports

RPS offers a full line of pipe supports specifically designed to match RPS A-150 pipe.

Refer to the *RPS Pipe Supports Catalog* at rpscomposites.com/resources/company-literature.

Notes:

1. Based on DF = 6 and maximum deflection = 0.5"
2. Support spacings apply up to 150°F (65°C). At 180°F (82°C), derate spacings by factor of 0.9.
3. Loads include internal pressure and weight of pipe and contents.

Specifications

Collapse Pressure of A-150 Pipe		
NPS (in)	Collapse Pressure (psi)	
	150°F (65°C)	180°F (82°C)
1	1295	1166
1.5	512	461
2	252	227
3	88	79
4	66	60
6	54	48
8	52	47
10	51	46
12	57	51

Note:

For sustained exposure to external pressure (e.g. vacuum), a design factor of at least 4 should be used as required by ASME NM.2.

Thermal Expansion

For recommendations on accommodating thermal expansion, refer to *RPS Design Manual*. For information on conducting a pipe stress analysis of A-150 piping, refer to *RPS Doc. No. E--433*, available from our Engineering Department.



HPPE A-150 in service in a flue gas desulfurization process.

Sales@RPSComposites.com

1-800-343-9355

RPSComposites.com/resources/company-literature



••

Stocked in multiple locations in the US and Canada

Standard 100 mil corrosion barrier

Complies with ASME NM.2

Complies with ASTM D5421 and ASTM D6041

••

••

Typical Applications:

strong acids, brine solutions

pulping liquors, chlorinated solutions

oxidizing agents

••

Specifications

Resin: INEOS DERAKANE™ 510N (Brominated Epoxy Novolac Vinyl Ester)

Glass: 'ECR' Glass

Pressure Rating: 150 psi (10 BAR), testing per ASTM D1599

Maximum Test Pressure: 225 psi (15 BAR)

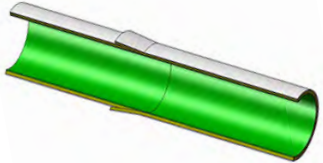
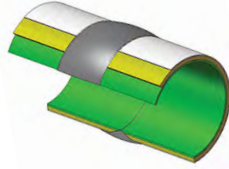
Surfacing Veil: Nexus

Temperature Range: -40°F (-40°C) to 200°F (93°C)



- All pipe, flanges, and fittings have a 100 mil corrosion barrier comprising one layer of veil (chemical barrier) and two layers of chopped strand glass (anti-wicking barrier).
- Manufactured via combination of contact molding and filament winding. Available in sizes 1" - 120" diameter. Refer to our *Pipe Fitting and Dimensions Catalog* for dimensions.
- External resin coating containing paraffin and ultraviolet absorbers to assure proper surface cure and inhibit ultraviolet light degradation.
- Minimum Barcol hardness of 90% of resin manufacturer's specified value.
- Flanges available in either full face FRP or lap joint style. Drilling in accordance with ASME B16.5 Class 150.
- All pipe and fittings manufactured under a formal QA program based on Quality Assurance Standard ISO 9001:2015.
- Pipe and fittings shall be shop or field assembled using either RPS matching tapered adhesive joints for sizes 1" - 12", or butt joints, available in all sizes.

Specifications

Joining Systems	
Tapered Adhesive Joints	Butt & Wrap Joints
	
<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems 1" - 12" • Fittings are supplied with integral belled ends and pipe is supplied belled by plain end. Components are permanently bonded in the shop or field using RPS adhesive, formulated from the same type of resin used in fabrication of the pipe system liner. • The Tapered Adhesive joint requires less material without compromising strength and can be fabricated in half the time, resulting in significant savings on labor and installation costs. For the full list of benefits refer to <i>RPS Tapered Adhesive Joints - Benefits and Savings</i> found in the Company Literature section of our website. 	<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems, all diameters. • Pipe and fitting ends are sanded to prepare a good bonding surface. Components are aligned, "butted" together, and sealed with resin. A "wrap" is applied to permanently bond the components. The "wrap" is made up of layers of glass reinforcement saturated with resin. • A variety of butt joint designs are available depending on the service conditions. These include straight, tapered, and edge capped.
<p>Detailed joining instructions are available in our <i>Installation Manual</i> at rpscomposites.com/resources/company-literature</p>	



RPS H-150 Pipe Dimensions						
Pipe Size	Inside Diameter	Liner Thickness	Structure Thickness	Total Thickness	Outside Diameter	Weight
(in)	(in)	(in)	(in)	(in)	(in)	(lbs/ft)
1	1.00	0.11	0.08	0.19	1.38	0.5
1.5	1.50	0.11	0.08	0.19	1.88	0.9
2	2.00	0.11	0.08	0.19	2.38	1.1
3	3.00	0.11	0.08	0.19	3.38	1.6
4	4.00	0.11	0.095	0.205	4.41	2.3
6	6.00	0.11	0.13	0.24	6.48	4.1
8	8.00	0.11	0.17	0.28	8.56	6.3
10	10.00	0.11	0.21	0.32	10.64	8.9
12	12.00	0.11	0.26	0.37	12.74	12.4

H-150 Maximum Recommended Support Spacing at 150 psi				
NPS (in)	Single Span		Continuous Span	
	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	6.9	6.7	10.3	10
1.5	7.6	7.3	11.4	10.9
2	8.2	7.9	12.2	11.7
3	9.1	8.7	12.8	11.8
4	10.2	9.7	13.4	12.2
6	12.2	11.3	15.2	13.8
8	14.1	12.9	17.4	15.8
10	15.7	14.3	19.2	17.4
12	17.3	16.3	21.8	20

Notes:

1. Based on DF = 6 and maximum deflection = 0.5"
2. Support spacings apply up to 180°F (82°C). At 200°F (93°C), derate spacings by factor of 0.9.
3. Loads include internal pressure and weight of pipe and contents.

Specifications

Collapse Pressure of H-150 Pipe		
NPS (in)	Collapse Pressure (psi)	
	180°F (82°C)	200°F (93°C)
1	1295	1230
1.5	512	487
2	252	240
3	88	84
4	66	63
6	54	51
8	52	49
10	51	49
12	57	54

Note:

For sustained exposure to external pressure (e.g. vacuum), a design factor of at least 4 should be used as required by ASME NM.2.

Pipe Supports

RPS offers a full line of pipe supports specifically designed to match RPS H-150 pipe. Refer to the *RPS Pipe Supports Catalog* at rpscomposites.com/resources/company-literature.

Thermal Expansion

For recommendations on accommodating thermal expansion, refer to *RPS Design Manual*. For information on conducting a pipe stress analysis of H-150 piping, refer to *RPS Doc. No. E-433*, available from our Engineering Department.



Sales@RPSComposites.com

1-800-343-9355

rpscomposites.com/resources/company-literature





H-150-200

High Temperature Corrosion Resistant
FRP Pipe and Fittings

••
Stocked in multiple locations in the US and Canada
Standard 200 mil corrosion barrier
Complies with ASME NM.2
Complies with ASTM D5421 and ASTM D6041
••

••
Typical Applications:
strong acids, brine solutions
pulping liquors, chlorinated solutions
oxidizing agents
••

Specifications

Resin: INEOS DERAKANE™ 510N (Brominated Epoxy Novolac Vinyl Ester)

Glass: 'ECR' Glass

Pressure Rating: 150 psi (10 BAR), testing per ASTM D1599

Maximum Test Pressure: 225 psi (15 BAR)

Surfacing Veil: C veil

Temperature Range: -40°F (-40°C) to 220°F (104°C)



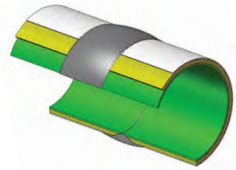
- H-150-200 piping systems with a continuous operating temperature above 210°F (99°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- All pipe, flanges, and fittings have a 200 mil corrosion barrier comprising two layers of veil (chemical barrier) and four layers of chopped strand glass (anti-wicking barrier).
- Manufactured via combination of contact molding and filament winding. Available in sizes 1" - 120" diameter. Refer to our *Pipe Fitting and Dimensions Catalog* for dimensions.
- External resin coating containing paraffin and ultraviolet absorbers to assure proper surface cure and inhibit ultraviolet light degradation.
- Minimum Barcol hardness of 90% of resin manufacturer's specified value.
- Flanges available in either full face FRP or lap joint style. Drilling in accordance with ASME B16.5 Class 150.
- All pipe and fittings manufactured under a formal QA program based on Quality Assurance Standard ISO 9001:2015.
- All pipe and fittings shall be shop or field assembled using straight butt joints.

™ Trademark, INEOS Composites or its subsidiaries, registered in various countries.



Specifications

Butt & Wrap Joints



- Available in all liner systems and pressure ratings.
- Pipe and fitting ends are sanded to prepare a good bonding surface. Components are aligned, “butted” together, and sealed with resin. A “wrap” is applied to permanently bond the components. The “wrap” is made up of layers of glass reinforcement saturated with resin.
- A variety of butt joint designs are available depending on the service conditions. These include straight, tapered, and edge capped.

Detailed joining instructions are available in our *Installation Manual* at rpscomposites.com/resources/company-literature



RPS H-150-200 Pipe Dimensions

Pipe Size	Inside Diameter	Liner Thickness	Structure Thickness	Total Thickness	Outside Diameter	Weight
(in)	(in)	(in)	(in)	(in)	(in)	(lbs/ft)
1	1.00	0.22	0.08	0.30	1.60	0.9
1.5	1.50	0.22	0.08	0.30	2.10	1.5
2	2.00	0.22	0.08	0.30	2.60	1.9
3	3.00	0.22	0.08	0.30	3.60	2.7
4	4.00	0.22	0.095	0.32	4.63	3.8
6	6.00	0.22	0.13	0.35	6.70	6.0
8	8.00	0.22	0.17	0.39	8.78	8.9
10	10.00	0.22	0.21	0.43	10.86	12.1
12	12.00	0.22	0.26	0.48	12.96	16.2

H-150-200 Maximum Recommended Support Spacing at 150 psi				
NPS (in)	Single Span		Continuous Span	
	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	6.9	6.7	10.3	10
1.5	7.6	7.3	11.4	10.9
2	8.2	7.9	12.2	11.7
3	9.1	8.7	12.8	11.8
4	10.2	9.7	13.4	12.2
6	12.2	11.3	15.2	13.8
8	14.1	12.9	17.4	15.8
10	15.7	14.3	19.2	17.4
12	17.3	16.3	21.8	20

Notes:

1. Based on $DF = 6$ and maximum deflection = 0.5"
2. Support spacings apply up to 180°F (82°C). At 220°F (104°C), derate spacings by factor of 0.9.
3. Loads include internal pressure and weight of pipe and contents.



Specifications

Collapse Pressure of H-150-200 Pipe		
NPS (in)	Collapse Pressure (psi)	
	180°F (82°C)	220°F (104°C)
1	1295	1166
1.5	512	461
2	252	227
3	88	79
4	66	60
6	54	48
8	52	47
10	51	46
12	57	51

Note:

For sustained exposure to external pressure (e.g. vacuum), a design factor of at least 4 should be used as required by ASME NM.2.

Pipe Supports

RPS offers a full line of pipe supports specifically designed to match RPS H-150-200 pipe. Refer to the *RPS Pipe Supports Catalog* at rpscomposites.com/resources/company-literature.

Thermal Expansion

For recommendations on accommodating thermal expansion, refer to *RPS Design Manual*. For information on conducting a pipe stress analysis of H-150-200 piping, refer to *RPS Doc. No. E-880*, available from our Engineering Department.



Sales@RPSComposites.com

1-800-343-9355

RPSComposites.com/resources/company-literature



••
Stocked in multiple locations in the US and Canada

Standard 100 mil corrosion barrier

Complies with ASME NM.2

Complies with ASTM D5421, ASTM D6041

••

••
Typical Applications

Acids

Industrial wastewater

Seawater

Bases

Brine solutions

Inorganic salts

Used in hundreds of installations in 20 countries around the world.

••

Specifications

Resin: INEOS DERA KANE 411™ (Bisphenol A Epoxy Vinyl Ester)

Glass: 'ECR' Glass

Pressure Rating: 150 psi (10 BAR), testing per ASTM D2992

Maximum Test Pressure: 225 psi (15 BAR)

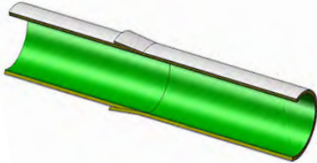
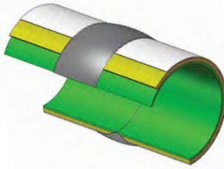
Temperature Range: -40°F (-40°C) to 180°F (82°C)

Surfacing Veil: Polyester (Nexus)

- All pipe, flanges, and fittings have a 100 mil thick corrosion barrier comprised of one layer of veil (chemical barrier) and two layers of chopped strand glass (anti-wicking barrier).
- Manufactured via combination of contact molding and filament winding. Available in sizes 1" - 120" diameter. Refer to our *Pipe Fitting and Dimensions Catalog* for dimensions.
- Minimum Barcol hardness of 90% of resin manufacturer's specified value.
- External resin coating containing paraffin and ultraviolet absorbers to assure proper surface cure and inhibit ultraviolet light degradation.
- Flanges available in either full face FRP or lap joint style. Drilling in accordance with ASME B16.5 Class 150.
- All pipe and fittings manufactured under a formal QA program based on Quality Assurance Standard ISO 9001:2015.
- Pipe and fittings shall be shop or field assembled using either RPS matching tapered adhesive joints for sizes 1" - 12", or butt joints, available in all sizes.



Specifications

Joining Systems	
Tapered Adhesive Joints	Butt & Wrap Joints
	
<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems 1" - 12" • Fittings are supplied with integral belled ends and pipe is supplied belled by plain end. Components are permanently bonded in the shop or field using RPS adhesive, formulated from the same type of resin used in fabrication of the pipe system liner. • The Tapered Adhesive joint requires less material without compromising strength and can be fabricated in half the time, resulting in significant savings on labor and installation costs. For the full list of benefits refer to <i>RPS Tapered Adhesive Joints - Benefits and Savings</i> found in the Company Literature section of our website. 	<ul style="list-style-type: none"> • Available with 100 mil lined 150 psi pipe systems, all diameters. • Pipe and fitting ends are sanded to prepare a good bonding surface. Components are aligned, "butted" together, and sealed with resin. A "wrap" is applied to permanently bond the components. The "wrap" is made up of layers of glass reinforcement saturated with resin. • A variety of butt joint designs are available depending on the service conditions. These include straight, tapered, and edge capped.
<p>Detailed joining instructions are available in our <i>Installation Manual</i> at rpscomposites.com/resources/company-literature</p>	



HPPE P-150 in service in a cooling water unit.



HPPE P-150 in service at a chemical processing plant.

RPS P-150 Pipe Dimensions						
Pipe Size	Inside Diameter	Liner Thickness	Structure Thickness	Total Thickness	Outside Diameter	Weight
(in)	(in)	(in)	(in)	(in)	(in)	(lbs/ft)
1	1.00	0.11	0.08	0.19	1.38	0.5
1.5	1.50	0.11	0.08	0.19	1.88	0.9
2	2.00	0.11	0.08	0.19	2.38	1.1
3	3.00	0.11	0.08	0.19	3.38	1.6
4	4.00	0.11	0.095	0.205	4.41	2.3
6	6.00	0.11	0.13	0.24	6.48	4.1
8	8.00	0.11	0.17	0.28	8.56	6.3
10	10.00	0.11	0.21	0.32	10.64	8.9
12	12.00	0.11	0.26	0.37	12.74	12.4

P-150 Maximum Recommended Support Spacing at 150 psi				
NPS (in)	Single Span		Continuous Span	
	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	6.9	6.7	10.3	10
1.5	7.6	7.3	11.4	10.9
2	8.2	7.9	12.2	11.7
3	9.1	8.7	12.8	11.8
4	10.2	9.7	13.4	12.2
6	12.2	11.3	15.2	13.8
8	14.1	12.9	17.4	15.8
10	15.7	14.3	19.2	17.4
12	17.3	16.3	21.8	20

Pipe Supports

RPS offers a full line of pipe supports specifically designed to match RPS P-150 pipe.

Refer to the *RPS Pipe Supports Catalog* at rpscomposites.com/resources/company-literature.

Notes:

1. Based on DF = 6 and maximum deflection = 0.5"
2. Support spacings apply up to 150°F (65°C). At 180°F (82°C), derate spacings by factor of 0.9.
3. Loads include internal pressure and weight of pipe and contents.

Specifications

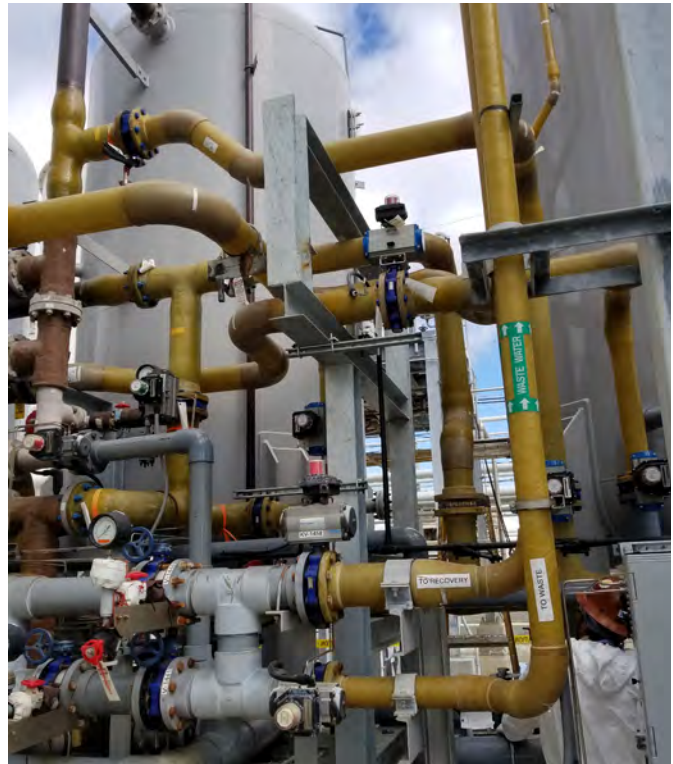
Collapse Pressure of P-150 Pipe		
NPS (in)	Collapse Pressure (psi)	
	150°F (65°C)	180°F (82°C)
1	1295	1166
1.5	512	461
2	252	227
3	88	79
4	66	60
6	54	48
8	52	47
10	51	46
12	57	51

Note:

For sustained exposure to external pressure (e.g. vacuum), a design factor of at least 4 should be used as required by ASME NM.2.

Thermal Expansion

For recommendations on accommodating thermal expansion, refer to *RPS Design Manual*. For information on conducting a pipe stress analysis of P-150 piping, refer to *RPS Doc. No. E--433*, available from our Engineering Department.



HPPE P-150 in service at an acid recovery plant.

Sales@RPSComposites.com

1-800-343-9355

RPSComposites.com/resources/company-literature



AA-SERIES Slurry Spray Piping



Specifications

Erosion and Corrosion Resistant Pipe Systems

Pressure Rating: 100 psi*

Temperature Range: -40°F (-40°C) to 180°F (82°C)

Maximum Test Pressure: 1.5 x Rating

Complies with ASTM D5421 and ASTM D6041

Pipe and Fittings

a. Manufacturing Process

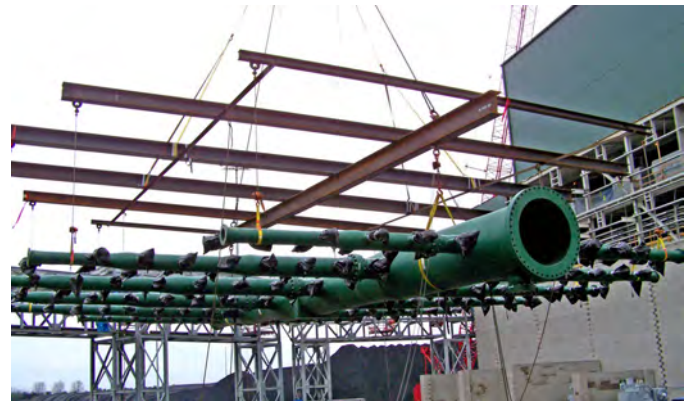
- Combination of contact molding and filament winding

b. Resin

- INEOS DERAKANE 411™ (Bisphenol A Epoxy Vinyl Ester)

c. Reinforcement

- Surfacing Veil: Polyester (Nexus) or 'C' Veil
- Glass: 'ECR' Glass



d. Construction

- All pipe and fittings have a 100 mil thick, erosion/corrosion, interior & exterior barrier comprised of one layer of veil (chemical barrier) and two layers of chopped strand glass (anti-wicking barrier) in a specially formulated erosion resistant resin matrix.

e. Curing

- Minimum Barcol hardness of 90% of resin manufacturer's specified value.

f. Flanges

- Flanges shall be full face FRP style. Drilling shall be in accordance with ANSI B16.5 Class 150. Flanges shall have a liner of the same construction as pipe and fittings and be qualified in accordance with ASTM D5421.

* Spray headers can be custom-designed to system requirements

™ Trademark, INEOS Composites or its subsidiaries, registered in various countries.

Specifications

g. Joints

o Pipe

Joints are matching tapered adhesive or butt type, and designed to provide equivalent strength to the pipe being joined.

o Branches

All branch connections and outlets have a molded internal radius.

o Spray Nozzles

Spray nozzles are joined to pipe by proven means of attachment, i.e. flanged, bonded, or mechanical joint.

h. Sizes

AA-series pipe is available in sizes 1" - 60" diameter.

i. Quality Assurance

All pipe and fittings manufactured under a formal QA program based on Quality Assurance Standard ISO 9001:2015.



RPS Composites Inc.

8375 Zeigler Blvd.
Mobile, AL 36689
Tel: (251) 445-4411
Fax: (251) 633-3318
Sales@RPSComposites.com
RPSComposites.com

Wet FGD Slurry Guidelines



Guidelines

Our HPPE A-150 and AA-Series pipe will provide excellent long-term service under the conditions listed below. Please contact RPS for recommendations where conditions are outside these guidelines.

Absorber Recycle Slurry:

10 - 20% Solids by Weight

Particle Size = mean 40 – 70 microns
= 97.5% < 150 microns
= 100% < 200 microns

Velocity: 3.0 - 3.5m/sec. (10 - 12 ft./sec.)

Limestone Slurry:

30 - 35% Solids by Weight

Particle Size = mean 40 – 70 microns
= 97.5% < 150 microns
= 100% < 200 microns

Velocity: 2.5 - 3.0 m/sec. (8 - 10 ft./sec.)

Gypsum Slurry:

35 - 50% Solids by Weight

Particle Size = 100% < 200 microns

Velocity: 2.5 - 3.0 m/sec. (8 - 10 ft./sec.)

Type 'B' Taper Tool (1"-12")*



*Please specify purchase or rental

Extra Items

1" Mandrel
1 1/2" Mandrel
2" Mandrel
3" Mandrel
4" Mandrel
6" Mandrel
Grinding Wheels

Ready to order?
Call us at the number below.

A30-30 Enhanced Abrasion Resistance Kit



For adding enhanced abrasion resistance to existing abrasion liners; can also be used to repair damaged abrasion liners.

Kit Size (gm/oz)	Sq. Ft. Coverage @ 1/8"
700/24	1.0
1400/48	2.0
2800/96	3.0

12 Month Shelf life; also available in bulk

P1500 Vinyl Ester Adhesive Kit



For bonding P-150 and A-150 Pipe, Fittings, Saddles and Thrust Collars

Kit Size

Single Kit (P1500-1)
Double Kit (P1500-2)

Approximate number of bonds per kit:

Pipe Size	P1500-1	P1500-2
1"	6	12
1 1/2"	6	12
2"	6	12
3"	5	10
4"	4	8
6"	2	4
8"	1	2
10"	1	2
12"	1	2

12 Month Shelf Life

H1500 Novolac Vinyl Ester Adhesive Kit



For bonding H-150 Pipe, Fittings, Saddles and Thrust Collars

Kit Size

Single Kit (H1500-1)
Double Kit (H1500-2)

Approximate number of bonds per kit:

Pipe Size	H1500-1	H1500-2
1"	6	12
1 1/2"	6	12
2"	6	12
3"	5	10
4"	4	8
6"	2	4
8"	1	2
10"	1	2
12"	1	2

6 Month Shelf Life

Pipe Strap Wrench



Item

48" strap wrench
48" extra strap

Interior Heating Collars



Size

1"
1 1/2"
2"
3"

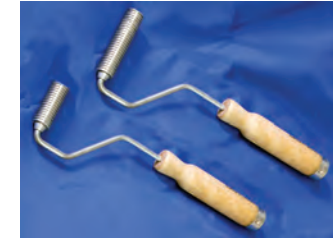
Overlap Heating Collars



Size

1" - 2"
3" - 6"
8" - 12"

Aluminum Rollers



Size

1" x 3"
1" x 6"

Pipe Clamps (set)



Size

1 1/2"
2"
3"
4"
6"
8"
10"
12"

'A' Liner Repair Paste Kit



For performing repairs to interior or exterior abrasion resistant liners.

Kit Size (gm/oz)	Sq. Ft. Coverage @ 1/8"
400/14	0.8
800/28	1.6
1600/56	3.4

12 Month Shelf life; also available in bulk

Butt Joint Kits (150 psi) (Individual Wrap Kits)



When ordering, specify 'A' or 'P' sizes 1" through 48". Other pressure ratings and sizes available.

3 Month Shelf Life; also available in bulk.

Ready to order?
Call us at the number below.

Seamless MAXAR™ Blue Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' MAXAR Blue piping products (seamless FEP/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: MAXAR Blue liners are Fluorinated Ethylene Propylene (FEP) Teflon®, seamless through 20" diameter. This fluoropolymer meets the requirements of ASTM D2116 Type III and may include less than 1% inorganic pigment for identification. A partial list of physical properties follows:

PROPERTY	VALUE	TEST
Specific Gravity	2.13-2.15	ASTM D-792
Tensile Strength	3800-4100 PSI	ASTM D-638
Elongation	280-330%	ASTM D-638

- 2.2 Bonding Layer: A knit fiberglass fabric is melt-bonded and partially embedded into the O.D. surface of the FEP liner using a proprietary process. Bond strength between the FEP liner and reinforced vinyl ester structure as measured by ASTM D1781 – Climbing Drum Peel Test for Adhesives, is a minimum of 50 in*lb/in.
- 2.3 Outer Structure: The bonded FEP liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSIONS	TOLERANCES
Pipe Spools	Length	±1/8"
	Bolt hole alignment	±1/16"
	Flange alignment with pipe centerline	±1/32" (1" thru 4") ±3/64" (6">)
	Flanges	All dimensions except thickness tolerance
Fittings	Face to centerline	±1/8"
ID/OD Radius		±1/8" (1" thru 10") ±1/4" (12" thru 20")

- 3.4 1.5" - 4" flanges can be attached to MAXAR Blue pipe in the shop or in the field using the MAXARFLEX pipe spooling kit. The MAXARFLEX pipe spooling kit provides the ability to fabricate pipe spools in the field. Flanges are bonded to pipe using a high performance epoxy adhesive (3M DP420NS). This method of flange attachment preserves the bonded liner and does not require thermoplastic welding.

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 MAXAR Blue liner material is suitable for operating temperatures from -5°F (-20°C) to 220°F (104°C). MAXAR piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- 4.2 Pressure Ranges: MAXAR Blue is suitable for continuous operation from full vacuum to 150 PSI for 1 1/2" diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1.
- 4.3 Continuous full vacuum services require a bonded flare.
- 4.4 Thermal Expansion: the Coefficient of Thermal expansion for MAXAR Blue pipe is ~1.7 x 10⁻⁵in/in/°F when operating within the temperature range specified in subsection 4.1.

Seamless MAXAR Blue Specifications

- 4.5 Chemical Resistance (liner): MAXAR Blue's FEP-Teflon® liner is chemically inert to a broad range of commercial chemicals including the following:

All acids including hydrofluoric, hydrochloric, sulfuric, and aqua regia

All chlorides – organic and inorganic

All sulfates – organic and inorganic

All bleach solutions

All solvents, all caustics, all phenols, all peroxides

- 4.6 Chemical Resistance: MAXAR Blue's vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.7 Gas Permeation: RPS' bonding technology eliminates air gaps between the FEP liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between MAXAR Blue's FEP liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.8 Insulation Qualities: MAXAR Blue's vinyl ester structure yields a heat conduction factor (k) of ~ 1.5 Btu*in/FT²/hr/°F. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained MAXAR Systems.
- 4.9 Heat Tracing: MAXAR Blue's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated MAXAR Blue systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **RPS recommends Garlock Stress Saver 370.**
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Stress Saver 370 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.

- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
- C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.

7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft.lb.)
1 ½"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard MAXAR Blue products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards, ASTM Standards, OSHA Regulations and qualified piping and safety engineers.

Piping Specification

SERVICES:

As specified by user or RPS Composites.

MATERIAL:

MAXAR Blue as provided by RPS Composites: dual laminate, seamless FEP Teflon® liner with bonded fiberglass reinforced vinyl ester structure.

SIZE/RATING:

1 ½" – 12"	Full Vacuum	150 PSI	-5 to 220°F
14" – 24"	Full Vacuum	100 PSI	-5 to 220°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

INSTRUMENT CONNECTIONS:

Use full size tee, reducing tees, or stub-ins

FLANGES:

All flanges drilling pattern per ASME B16.5 Class 150 dimensions (except thickness)

- **Fixed:** Full face flanges to be fabricated on pipe by manufacturer. 1.5" - 4" flanges can be fabricated on pipe in the field using the MAXARFLEX pipe spooling kit. Pipe liner to be flared over face of flange to inside of bolt holes.
- **Lap Joint:** Stub end with loose ring fabricated on pipe by pipe manufacturer. Pipe liner to be flared over stub face to outside diameter of stub.
- **Blinds:** Flat faced FRP with 90 mil. min. thickness FEP Teflon® liner bonded to face.

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock Stress Saver® 370 gasket material is comparable to MAXAR Blue liner material.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 ½" thru 6"Ø if preferred.

WELDING:

Assembly of MAXAR Blue piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by flow fusion or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

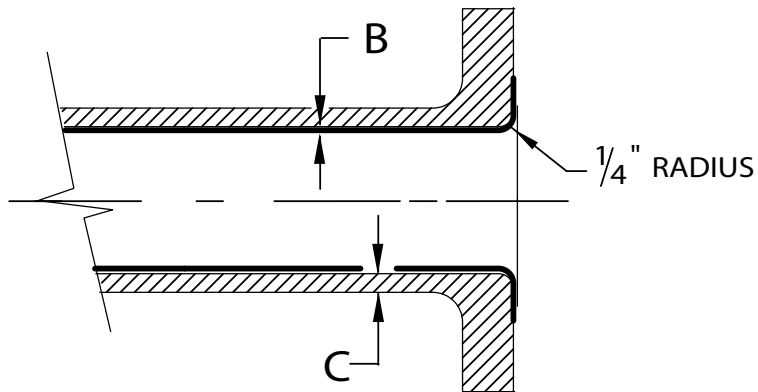
JOINTS:

Butt and wrap per ASTM D6041.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools; minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer. 1.5" - 4" piping can be field fabricated using the MAXARFLEX pipe spooling kit.
3. One inch (1") piping is available in short spools only (24" or less).
4. MAXAR Blue piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

Standard MAXAR Blue Pipe Dimensions



Nom. Dia.	B (Liner Thickness)	C (F.W. Thickness)
1	0.07	.15
1 1/2	0.08	.15
2	0.08	.17
3	0.09	.21
4	0.1	.21
6	0.1	.21
8	0.1	.25
10	0.1	.36
12	0.1	.39
14	0.1	.39
16	0.1	.39
18	0.1	.43
20	0.1	.46

Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	Pipe per foot	Flange
1	.6	1.0
1 1/2	1.4	1.3
2	1.7	2.0
3	2.5	4.0
4	3.4	1.5
6	5.6	7.0
8	8.3	11.5
10	12.8	15.0
12	16.6	24.0
14	17	27
16	21	35
18	26	37
20	31	49

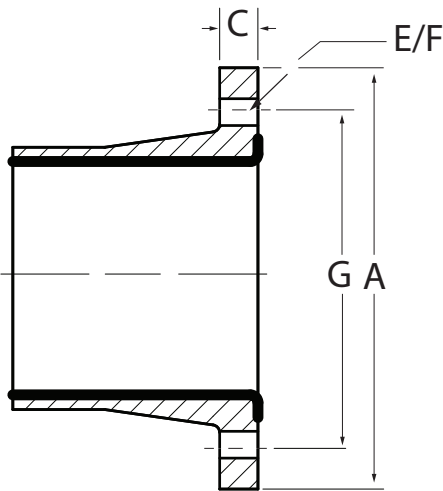
Notes:

1. See page 7 for fitting dimensions
2. See page 6 for flange dimensions
3. Please consult with RPS Composites for additional dimensional information on the MAXAR Blue Product

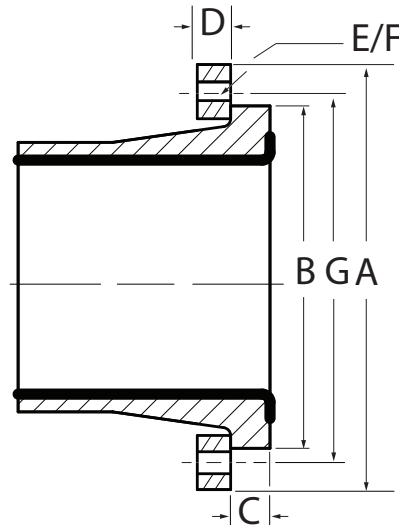
Seamless MAXAR Blue Specifications

Standard MAXAR Blue Flange Dimensions

Standard Flange



Lap Joint Flange

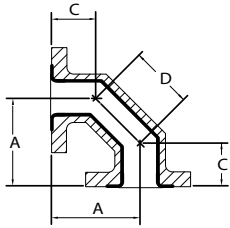


Nom Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Note 1
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

Notes:

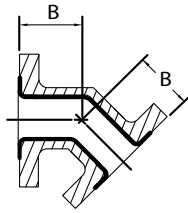
1. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.
2. Bonded flares required for full vacuum.

MAXAR Fitting Dimensions



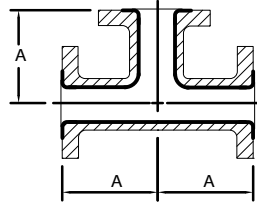
90° Elbow

See Note 1 & 3



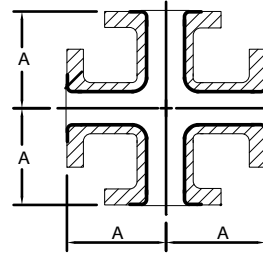
45° Elbow

See Note 1 & 3



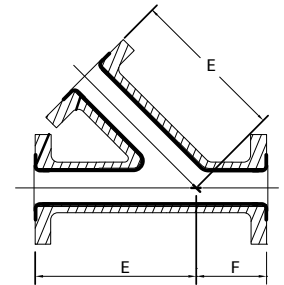
Tee

See Note 1 & 3



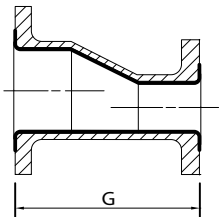
Cross

See Note 3

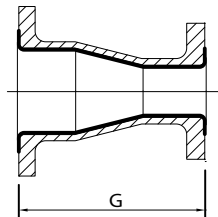


45° Lateral

See Note 3



Eccentric Reducer



Concentric Reducer

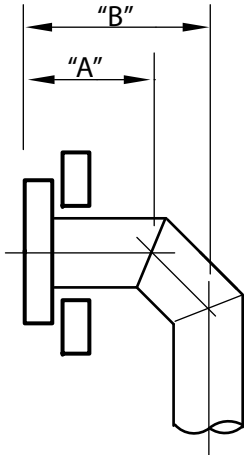
Nom. Dia.	A	B	C	D	E	F	G
1 1/2	4	2 1/4	2 1/2	2 1/8	7	2	5
2	4 1/2	2 1/2	2 3/4	2 1/2	8	2 1/2	5
3	5 1/2	3	3 1/4	3 3/16	10	3	6
4	6 1/2	4	3 7/8	3 11/16	12	3	7
6	8	5	4 1/2	4 15/16	14 1/2	3 1/2	9
8	9	5 1/2	5	5 5/8	17 1/2	4 1/2	11
10	11	6 1/2	6 1/4	6 11/16	20 1/2	5	12
12	12	7 1/2	7	7 1/16	24 1/2	5 1/2	14
14	21	8 3/4	8 3/4	17 1/4	30	12	12
16	24	10	10	19 3/4	32	14	12
18	27	11 1/4	11 1/4	22 1/4	36	14	12
20	30	12 1/2	12 1/2	24 3/4	38	16	12
24	36	15	15	29 3/4	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with standard dimensions. Contact RPS Composites for details.

Seamless MAXAR Blue Specifications

Minimum Length Between First Transition Point and First Flange



Nom. Dia.	A		B	
	Standard	Van Stone	Standard	Van Stone
1	2 1/2"	3 1/2"	4	5
1 1/2	2 1/2	3 1/2	4	5
2	2 3/4	4	4 1/2	5 3/4
3	3 1/4	4 1/2	5 1/2	6 3/4
4	3 7/8	5 1/4	6 1/2	7 7/8
6	4 1/2	6 1/4	8	9 3/4
8	5	7	9	11
10	6 1/4	8 1/4	11	13
12	7	9 1/4	12	14 1/4
14	8 3/4	11	21	23 1/4
16	10	12 3/8	24	26 3/8
18	11 1/4	13 3/4	27	29 1/2
20	12 1/2	15 1/4	30	32 3/4
24	15	17 7/8	36	38 7/8

RPS Composites Inc.
 8375 Zeigler Blvd.
 Mobile, AL 36689
 Tel: (251) 445-4411
 Fax: (251) 633-3318
 Sales@RPSComposites.com
 RPSComposites.com



Seamless MAXAR™ Red Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' MAXAR Red piping products (seamless PVDF/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: MAXAR Red liners are Polyvinylidene Fluoride (PVDF) resin, seamless to 12". This resin meets the requirements of ASTM D5575 and may include less than 1% inorganic pigment for identification. A partial list of physical properties follows:

PROPERTY	VALUE	TEST
Specific Gravity	1.76	ASTM D-792
Tensile Strength	>5000 PSI	ASTM D-638
Elongation	40%	ASTM D-638

- 2.2 Bonding Layer: A knit fiberglass fabric is melt-bonded and partially embedded into the O.D. surface of the PVDF liner using a proprietary process. Bond strength between the PVDF liner and reinforced vinyl ester structure as measured by ASTM D1781 – Climbing Drum Peel Test for Adhesives, is a minimum of 50 in*lb/in.
- 2.3 Outer Structure: The bonded PVDF liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe Spools	Length	±1/8"
	Bolt hole alignment	±1/16"
	Flange alignment (with pipe centerline)	±1/32" (1" thru 4") ±3/64" (6">)
Flange	All dimensions except thickness	ASME B16.5
Fittings	Face to centerline	±1/8"
	Flange alignment (with pipe centerline)	±1/32" (1" thru 4") ±3/64" (6">)
ID/OD Radius		±1/16" (1" thru 6") ±1/8" (8" thru 14") ±1/4" (16" thru 24")

- 3.4 1.5" - 4" flanges can be attached to MAXAR Red pipe in the shop or in the field using the MAXARFLEX pipe spooling kit. The MAXARFLEX pipe spooling kit provides the ability to fabricate pipe spools in the field. Flanges are bonded to pipe using a high performance epoxy adhesive (3M DP420NS). This method of flange attachment preserves the bonded liner and does not require thermoplastic welding.

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 MAXAR Red liner material is suitable for operating temperatures from -5°F (-20°C) to 220°F (104°C). MAXAR piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- 4.2 Pressure Ranges: MAXAR Red is suitable for continuous operation from full vacuum for 150 PSI for 1 1/2" diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1

Seamless MAXAR Red Specifications

- 4.3 Thermal Expansion: the Coefficient of Thermal expansion for MAXAR Red pipe is $\sim 1.7 \times 10^{-5}$ in/in/°F when operating within the temperature range specified in subsection 4.1.
- 4.4 Chemical Resistance (liner): MAXAR Red's PVDF liner is chemically inert to a broad range of commercial chemicals including the following:
- All acids including hydrofluoric, hydrochloric, sulfuric, and hydrobromic
 - All chlorides – organic and inorganic
 - All sulfates – organic and inorganic
 - All bleach solutions
 - All solvents, all caustics, all phenols, all peroxides
- 4.5 Chemical Resistance: MAXAR Red's vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.6 Gas Permeation: RPS' bonding technology eliminates air gaps between the PVDF liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between MAXAR Red's PVDF liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.7 Insulation Qualities: MAXAR Red's vinyl ester structure yields a heat conduction factor (k) of ~ 1.5 Btu*in/FT²/hr/°F. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained PVDF/FRP Systems.
- 4.8 Heat Tracing: MAXAR Red's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated MAXAR Red systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **RPS recommends Garlock Stress Saver 370.**
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Stress Saver 370 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.

- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
- C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.

7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft.lb.)
1 1/2"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard MAXAR Red products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards, ASTM Standards, OSHA Regulations and qualified piping and safety engineers.



Seamless MAXAR Red Specifications

Piping Specification

SERVICES:

As specified by user or RPS Composites.

MATERIAL:

MAXAR Red as provided by RPS Composites: dual laminate, seamless PVDF liner with bonded fiberglass reinforced vinyl ester structure.

SIZE/RATING:

1 ½" – 12"	Full Vacuum	150 PSI	-5 to 220°F
14" – 24"	Full Vacuum	100 PSI	-5 to 220°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

BRANCH CONNECTIONS:

Use full size or reducing tees

INSTRUMENT CONNECTIONS:

Use tee

FLANGES:

All flanges: drilling pattern per ASME B16.5 Class 150 dimensions (except thickness).

Blinds: Flat faced FRP with PVDF liner bonded to face.

Fixed: Full face flanges to be fabricated on pipe spools by pipe manufacturer.

Lap Joint: Stub end with loose ring fabricated on pipe by pipe manufacturer.

Fixed or Lap Joint flanges available as:

- A. Flared over face of flange to the inside of the bolt holes.
- B. Fabricated with flat sheet welded and bonded to face.
- C. Molded weld neck stub flanges, if available, connected by either hot plate fusion welding or hot air hand welding, reinforced with FRP structure.

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock Stress Saver® 370 gasket material is comparable to MAXAR Red liner material.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 ½" thru 6"Ø if preferred.

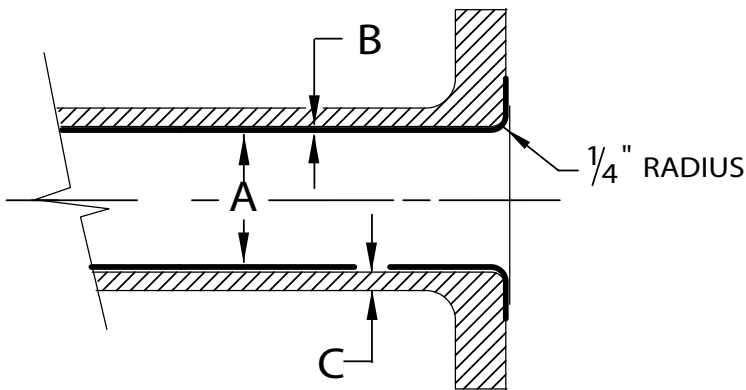
WELDING:

Assembly of MAXAR Red piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by flow fusion, hot plate, or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer
3. One inch (1") piping is available in short spools only (24" or less).
4. MAXAR Red piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

Pipe and Fittings Dimensions, Pipe and Fitting Weights



Nom. Dia.	A (I.D.)	B (Liner Thickness)	C (F.W. Thickness)
1	0.875	0.08	0.15
1 1/2	1.49	0.08	0.15
2	2.0	0.08	0.17
3	3.0	0.09	0.21
4	4.0	0.10	0.21
6	6.0	0.10	0.21
8	8.0	0.10	0.25
10	9.875	0.10	0.36
12	11.875	0.10	0.40
>12		min of 0.10	design to 150 psi

Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	Pipe per foot	Flange
1	.6	1.0
1 1/2	1.4	1.3
2	1.7	2.0
3	2.5	4.0
4	3.4	1.5
6	5.6	7.0
8	8.3	11.5
10	12.8	15.0
12	16.6	24.0

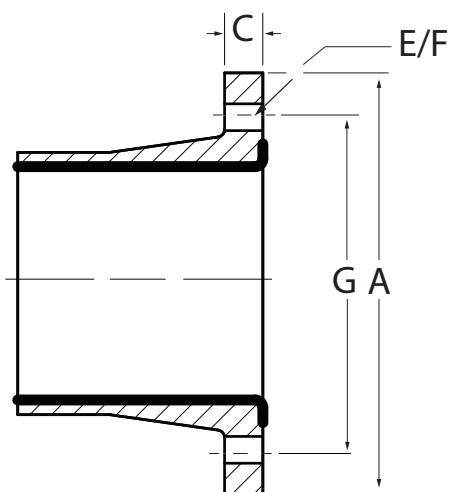
Note:

1. Please consult with RPS Composites for additional dimensional information on the MAXAR Red Product.

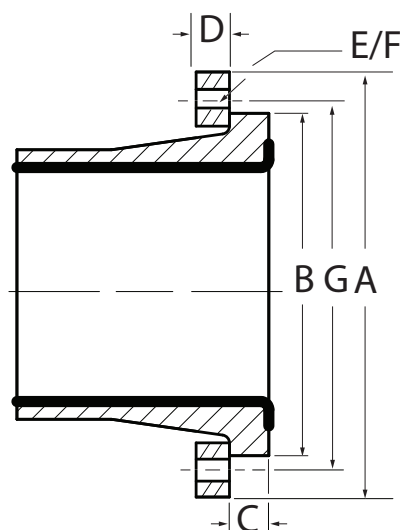
Seamless MAXAR Red Specifications

Standard Flange Dimensions

Standard Flange



Lap Joint Flange

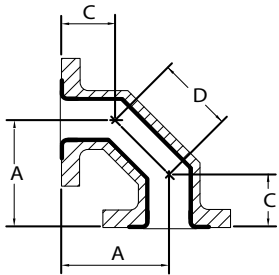


Nom. Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Notes 1 and 2
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

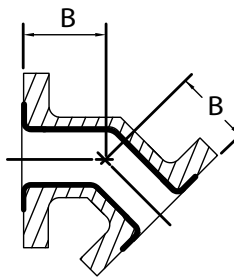
Notes:

1. Dimensions shown are for all flanges and includes thermoplastic flange face where applicable.
2. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.
3. Flared PVDF liner may not seat to face until bolt up.

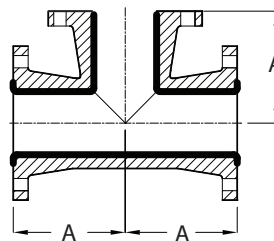
Fittings Dimensions



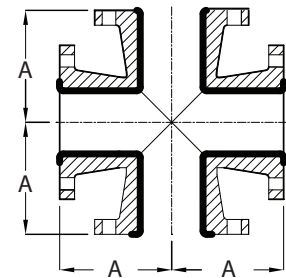
90° Elbow
See Note 1 & 3



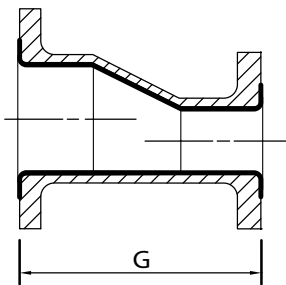
45° Elbow
See Note 1 & 3



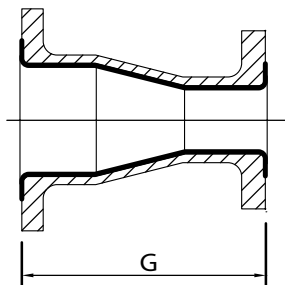
Tee
See Note 1 & 3



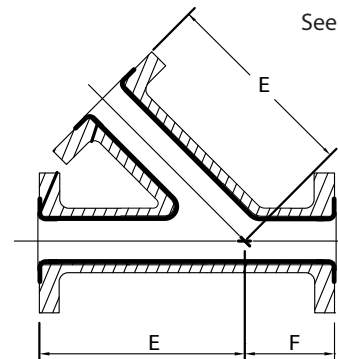
Cross
See Note 3



Eccentric Reducer



Concentric Reducer



45° Lateral
See Note 3

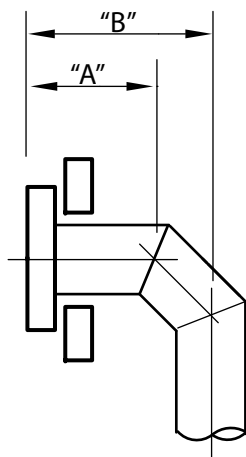
Nom. Dia.	A	B	C	D	E	F	G
1 1/2	4	2 1/4	2 1/2	2 1/8	7	2	5
2	4 1/2	2 1/2	2 3/4	2 1/2	8	2 1/2	5
3	5 1/2	3	3 1/4	3 3/16	10	3	6
4	6 1/2	4	3 7/8	3 11/16	12	3	7
6	8	5	4 1/2	4 15/16	14 1/2	3 1/2	9
8	9	5 1/2	5	5 5/8	17 1/2	4 1/2	11
10	11	6 1/2	6 1/4	6 11/16	20 1/2	5	12
12	12	7 1/2	7	7 1/16	24 1/2	5 1/2	14
14	21	8 3/4	8 3/4	17 1/4	30	12	12
16	24	10	10	19 3/4	32	14	12
18	27	11 1/4	11 1/4	22 1/4	36	14	12
20	30	12 1/2	12 1/2	24 3/4	38	16	12
24	36	15	15	29 3/4	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with non-standard dimensions. Contact RPS Composites for details.

Seamless MAXAR Red Specifications

Minimum Length Between First Transition Point and First Flange



Nom. Dia.	A		B	
	Standard	Van Stone	Standard	Van Stone
1	2 1/2"	3 1/2"	4	5
1 1/2	2 1/2	3 1/2	4	5
2	2 3/4	4	4 1/2	5 3/4
3	3 1/4	4 1/2	5 1/2	6 3/4
4	3 7/8	5 1/4	6 1/2	7 7/8
6	4 1/2	6 1/4	8	9 3/4
8	5	7	9	11
10	6 1/4	8 1/4	11	13
12	7	9 1/4	12	14 1/4
14	8 3/4	11	21	23 1/4
16	10	12 3/8	24	26 3/8
18	11 1/4	13 3/4	27	29 1/2
20	12 1/2	15 1/4	30	32 3/4
24	15	17 7/8	36	38 7/8

RPS Composites Inc.
 8375 Zeigler Blvd.
 Mobile, AL 36689
 Tel: (251) 445-4411
 Fax: (251) 633-3318
 Sales@RPSComposites.com
 RPSComposites.com



Seamless MAXAR™ White Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' MAXAR White piping products (seamless PFA/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: MAXAR White liners are Perfluoroalkoxy (PFA) Teflon®, seamless through 10" diameter. This fluoropolymer meets the requirements of ASTM D3307 and may include less than 1% inorganic pigment for identification. A partial list of physical properties follows:

PROPERTY	VALUE	TEST
Specific Gravity	2.12 - 2.17	ASTM D-792
Tensile Strength	3100 - 4500 PSI	ASTM D-638
Elongation	280% - 360%	ASTM D-638

- 2.2 Bonding Layer: A knit fiberglass fabric is melt-bonded and partially embedded into the O.D. surface of the PFA liner using a proprietary process. Bond strength between the PFA liner and reinforced vinyl ester structure as measured by ASTM D1781 – Climbing Drum Peel Test for Adhesives, is a minimum of 50 in*lb/in.
- 2.3 Outer Structure: The bonded PFA liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSIONS	TOLERANCES
Pipe Spools	Length	±1/8"
	Bolt hole alignment	±1/16"
	Flange alignment with pipe centerline	±1/32" (1" thru 4") ±3/64" (6">)
	Flanges	All dimensions except thickness tolerance
Fittings	Face to centerline	±1/8"
ID/OD Radius		±1/8" (1" thru 10") ±1/4" (12" thru 20")

- 3.4 1.5" - 4" flanges can be attached to MAXAR White pipe in the shop or in the field using the MAXAR/FLEX pipe spooling kit. The MAXAR/FLEX pipe spooling kit provides the ability to fabricate pipe spools in the field. Flanges are bonded to pipe using a high performance epoxy adhesive (3M DP420NS). This method of flange attachment preserves the bonded liner and does not require thermoplastic welding.

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 MAXAR White liner material is suitable for operating temperatures from -5°F (-20°C) to 220°F (104°C). MAXAR piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- 4.2 Pressure Ranges: MAXAR White is suitable for continuous operation from full vacuum to 150 PSI for 1 1/2" diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1
- 4.3 Continuous full vacuum services require a bonded flare.
- 4.4 Thermal Expansion: the Coefficient of Thermal expansion for MAXAR White pipe is $\sim 1.7 \times 10^{-5}$ in/in/°F when operating within the temperature range specified in subsection 4.1.

Seamless MAXAR White Specifications

- 4.5 Chemical Resistance (liner): MAXAR White's PFA-Teflon® liner is chemically inert to a broad range of commercial chemicals including the following:

All acids including hydrofluoric, hydrochloric, sulfuric, and aqua regia

All chlorides – organic and inorganic

All sulfates – organic and inorganic

All bleach solutions

All solvents, all caustics, all phenols, all peroxides

- 4.6 Chemical Resistance: MAXAR White's vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.7 Gas Permeation: RPS' bonding technology eliminates air gaps between the PFA liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between MAXAR White's PFA liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.8 Insulation Qualities: MAXAR White's vinyl ester structure yields a heat conduction factor (k) of ~ 1.5 Btu*in/FT²/hr/°F. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained MAXAR Systems.
- 4.9 Heat Tracing: MAXAR White's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated MAXAR White systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **RPS recommends Garlock Stress Saver® 370.**
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Stress Saver® 370 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.

- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
- C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.

7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft.lb.)
1 ½"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard MAXAR White products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards. ASTM Standards, OSHA Regulations and qualified piping and safety engineers.

Piping Specification

SERVICES:

As specified by user or RPS Composites.

MATERIAL:

MAXAR White as provided by RPS Composites: dual laminate, seamless PFA Teflon® liner with bonded fiberglass reinforced vinyl ester structure.

SIZE/RATING:

1 ½" – 12"	Full Vacuum	150 PSI	-5 to 220°F
14" – 24"	Full Vacuum	100 PSI	-5 to 220°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

INSTRUMENT CONNECTIONS:

Use full size tee, reducing tees, or stub-ins

FLANGES:

All flanges drilling pattern per ASME B16.5 Class 150 dimensions (except thickness)

- **Fixed:** Full face flanges to be fabricated on pipe by manufacturer. 1.5" - 4" flanges can be fabricated on pipe in the field using the MAXARFLEX pipe spooling kit. Pipe liner to be flared over face of flange to inside of bolt holes.
- **Lap Joint:** Stub end with loose ring fabricated on pipe by pipe manufacturer. Pipe liner to be flared over stub face to outside diameter of stub.
- **Blinds:** Flat faced FRP with 90 mil. min. thickness PFA Teflon® liner bonded to face.

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock Stress Saver® 370 gasket material is comparable to MAXAR White liner material.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 ½" thru 6"Ø if preferred.

WELDING:

Assembly of MAXAR White piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by flow fusion or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

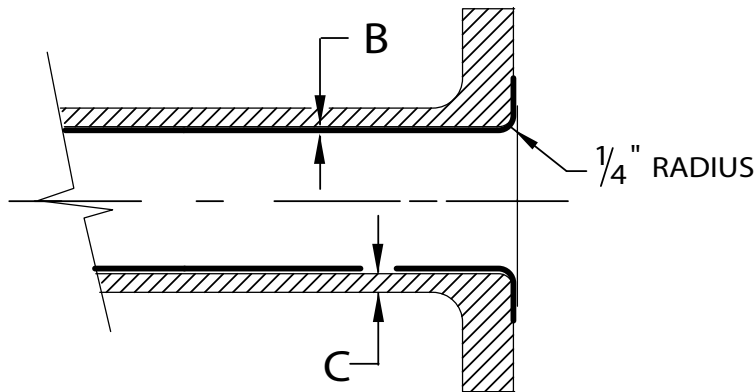
JOINTS:

Butt and wrap per ASTM D6041.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools; minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer. 1.5" - 4" piping can be field fabricated using the MAXARFLEX pipe spooling kit.
3. One inch (1") piping is available in short spools only (24" or less).
4. MAXAR White piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

Standard MAXAR White Pipe Dimensions



Nom. Dia.	B (Liner Thickness)	C (F.W. Thickness)
1	0.07	.15
1 1/2	0.08	.15
2	0.08	.17
3	0.09	.21
4	0.1	.21
6	0.1	.21
8	0.1	.25
10	0.1	.36
12	0.1	.39
14	0.1	.39
16	0.1	.39
18	0.1	.43
20	0.1	.46

Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	Pipe per foot	Flange
1	.6	1.0
1 1/2	1.4	1.3
2	1.7	2.0
3	2.5	4.0
4	3.4	1.5
6	5.6	7.0
8	8.3	11.5
10	12.8	15.0
12	16.6	24.0
14	17	27
16	21	35
18	26	37
20	31	49

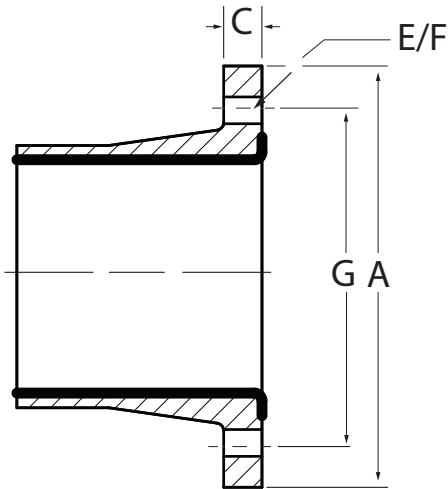
Notes:

1. See page 7 for fitting dimensions
2. See page 6 for flange dimensions
3. Please consult with RPS Composites for additional dimensional information on the MAXAR White Product

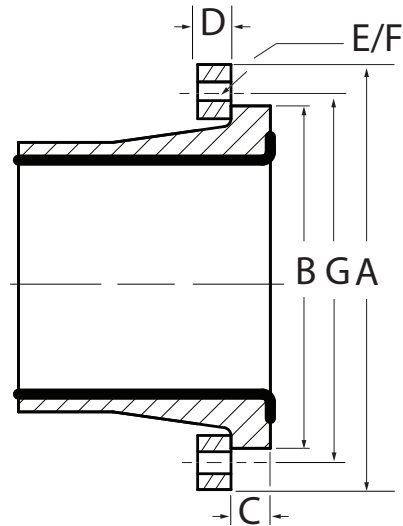
Seamless MAXAR White Specifications

Standard MAXAR White Flange Dimensions

Standard Flange



Lap Joint Flange

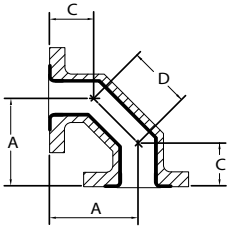


Nom Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Note 1
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

Notes:

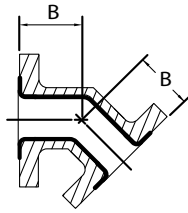
1. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.
2. Bonded flares required for full vacuum.

MAXAR Fitting Dimensions



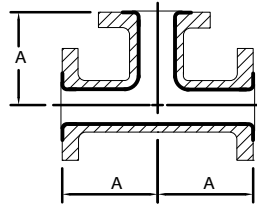
90° Elbow

See Note 1 & 3



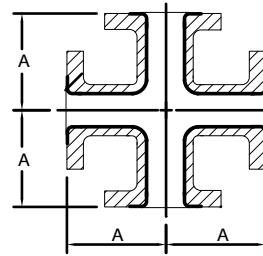
45° Elbow

See Note 1 & 3



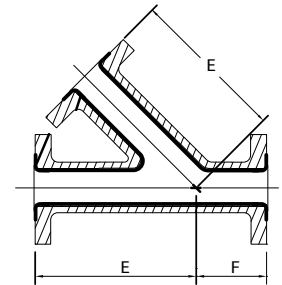
Tee

See Note 1 & 3



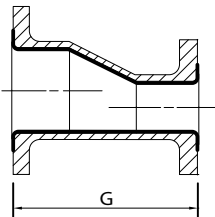
Cross

See Note 3

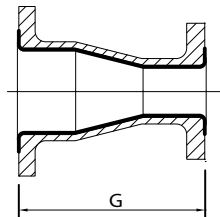


45° Lateral

See Note 3



Eccentric Reducer



Concentric Reducer

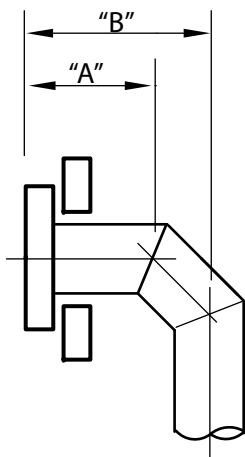
Nom. Dia.	A	B	C	D	E	F	G
1 1/2	4	2 1/4	2 1/2	2 1/8	7	2	5
2	4 1/2	2 1/2	2 3/4	2 1/2	8	2 1/2	5
3	5 1/2	3	3 1/4	3 3/16	10	3	6
4	6 1/2	4	3 7/8	3 11/16	12	3	7
6	8	5	4 1/2	4 15/16	14 1/2	3 1/2	9
8	9	5 1/2	5	5 5/8	17 1/2	4 1/2	11
10	11	6 1/2	6 1/4	6 11/16	20 1/2	5	12
12	12	7 1/2	7	7 1/16	24 1/2	5 1/2	14
14	21	8 3/4	8 3/4	17 1/4	30	12	12
16	24	10	10	19 3/4	32	14	12
18	27	11 1/4	11 1/4	22 1/4	36	14	12
20	30	12 1/2	12 1/2	24 3/4	38	16	12
24	36	15	15	29 3/4	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with standard dimensions. Contact RPS Composites for details.

Seamless MAXAR White Specifications

Minimum Length Between First Transition Point and First Flange



Nom. Dia.	A		B	
	Standard	Van Stone	Standard	Van Stone
1	2 1/2"	3 1/2"	4	5
1 1/2	2 1/2	3 1/2	4	5
2	2 3/4	4	4 1/2	5 3/4
3	3 1/4	4 1/2	5 1/2	6 3/4
4	3 7/8	5 1/4	6 1/2	7 7/8
6	4 1/2	6 1/4	8	9 3/4
8	5	7	9	11
10	6 1/4	8 1/4	11	13
12	7	9 1/4	12	14 1/4
14	8 3/4	11	21	23 1/4
16	10	12 3/8	24	26 3/8
18	11 1/4	13 3/4	27	29 1/2
20	12 1/2	15 1/4	30	32 3/4
24	15	17 7/8	36	38 7/8

RPS Composites Inc.
 8375 Zeigler Blvd.
 Mobile, AL 36689
 Tel: (251) 445-4411
 Fax: (251) 633-3318
 Sales@RPSComposites.com
 RPSComposites.com



Seamless PP/FRP Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' PP/FRP piping products (seamless PP/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: PP liners are seamless through to 20" dia. Only virgin PP is used in the extrusion of liners. This resin meets the requirements of ASTM D-4101 and may include less than 1% inorganic pigment for identification. A partial list of the physical properties is below:

PROPERTY	PP/FRP VALUE	TEST
Specific Gravity	.90 - .91	ASTM D-792
Tensile Strength	4,500	ASTM D-638

- 2.2 Bonding Layer: A knit fiberglass tape is melt-bonded and partially embedded into the O.D. surface of the PP liner using a proprietary process. Bond strength between the PP liner and reinforced vinyl ester structure as measured by ASTM D1781 – Climbing Drum Peel Test for Adhesives, is a minimum of 35 in*lb/in.
- 2.3 Outer Structure: The bonded PP liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSIONS	TOLERANCES
Pipe Spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment (with pipe centerline)	± 1/32" (1" thru 4") ± 3/64" (6">)
Flanges	All dimensions except thickness	ASME B16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment (with pipe centerline)	± 1/32" (1" thru 4")
ID/OD Radius		1/4" ± 1/16"

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 PP/FRP liner material is suitable for operating temperatures from 15°F (-10°C) up to 200°F (93°C). PP/FRP piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- 4.2 Pressure Ranges: PP/FRP is suitable for continuous operation from full vacuum for 150 PSI for 1" diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1
- 4.3 Thermal Expansion: the Coefficient of Thermal expansion for PP/FRP pipe is $\sim 1.7 \times 10^{-5}$ in/in/°F when operating within the temperature range specified in subsection 4.1.
- 4.4 Chemical Resistance (liner): PP/FRP's liner is chemically inert to a broad range of commercial chemicals including the following:
- Mineral acids
 - Alkalies
 - Salt solutions
 - Alcohols

Seamless PP/FRP Specifications

- 4.5 Chemical Resistance: PP/FRP's vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.6 Gas Permeation: RPS' bonding technology eliminates air gaps between the PP liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between PP/FRP's liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.7 Insulation Qualities: PP/FRP's vinyl ester structure yields a heat conduction factor (k) of $\sim 1.5 \text{ Btu}\cdot\text{in}/\text{FT}^2/\text{hr}/^\circ\text{F}$. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained PP/FRP's Systems.
- 4.8 Heat Tracing: PP/FRP's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated PP/FRP's systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Support for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **GASKET MUST BE USED IN RPS' PP/FRP PIPING SYSTEM.** Recommended gaskets are elastomeric materials of 55-70 durometer suitable for the intended chemical service.
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

- 7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Envelon Style 3565 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.
- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
 - B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
 - C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.
- 7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft)
1 1/2"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard PP/FRP products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards, ASTM Standards, OSHA Regulations and qualified piping and safety engineers.

Piping Specification

SERVICES:

As specified by user or RPS Composites

MATERIAL:

PP/FRP as provided by RPS Composites dual laminate, seamless PP liner with bonded fiberglass reinforced vinyl Ester structure.

SIZE/RATING:

1 1/2" – 12"	Full Vacuum	150 psi	15°F to 200°F
14" – 24"	Full Vacuum	100 psi	15°F to 200°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

BRANCH CONNECTIONS:

Use full size or reducing tees

INSTRUMENT CONNECTIONS:

Use tee

FLANGES:

All flanges: drilling pattern per ASME B16.5 Class 150 dimensions (except thickness).

Blinds: Flat faced FRP with PP liner bonded to face.

Fixed: Full face flanges to be fabricated on pipe spools by pipe manufacturer.

Lap Joint: Stub end with loose ring fabricated on pipe by pipe manufacturer.

Fixed or Lap Joint flanges available as:

- A. Molded weld neck stub flanges, if available, connected with either hot plate fusion welding or hot air hand welding, reinforced with FRP structure.
- B. Flat plate bonded and welded to face of flange, reinforced with FRP structure.

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock™, Envelon™ 3565 gasket material is comparable to PP/FRP's liner material. Ring type or full face. 1/16" min. – 1/8" max. thick.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 1/2" thru 6"Ø if preferred.

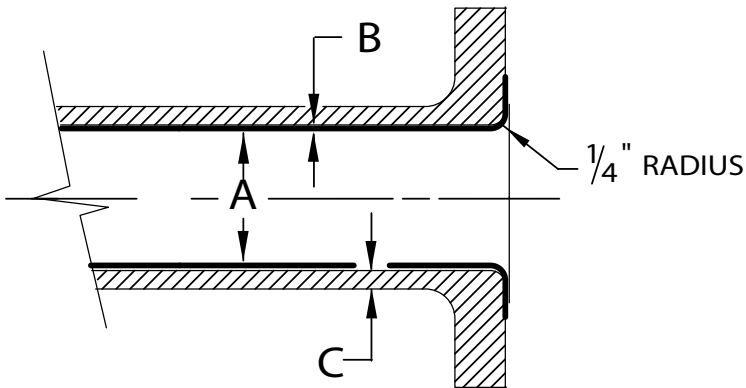
WELDING:

Assembly of PP/FRP piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by flow fusion, hot plate, extrusion, or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools; minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer
3. One inch (1") piping is available in short spools only (24" or less).
4. PP/FRP piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

Pipe and Fittings Dimensions, Pipe and Fitting Weights



Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	A (I.D.)	B (Liner Thickness)	C (F.W. Thickness)
1	1.00	.114	.15
1 1/2	1.60	.181	.15
2	2.02	.228	.17
3	2.90	.323	.21
4	4.06	.134	.21
6	5.90	.193	.21
8	7.40	.244	.25
10	9.24	.303	.36
12	11.63	.382	.39
14	13.12	.429	.39
16	14.78	.484	.39
18	16.63	.543	.43
20	18.46	.602	.46

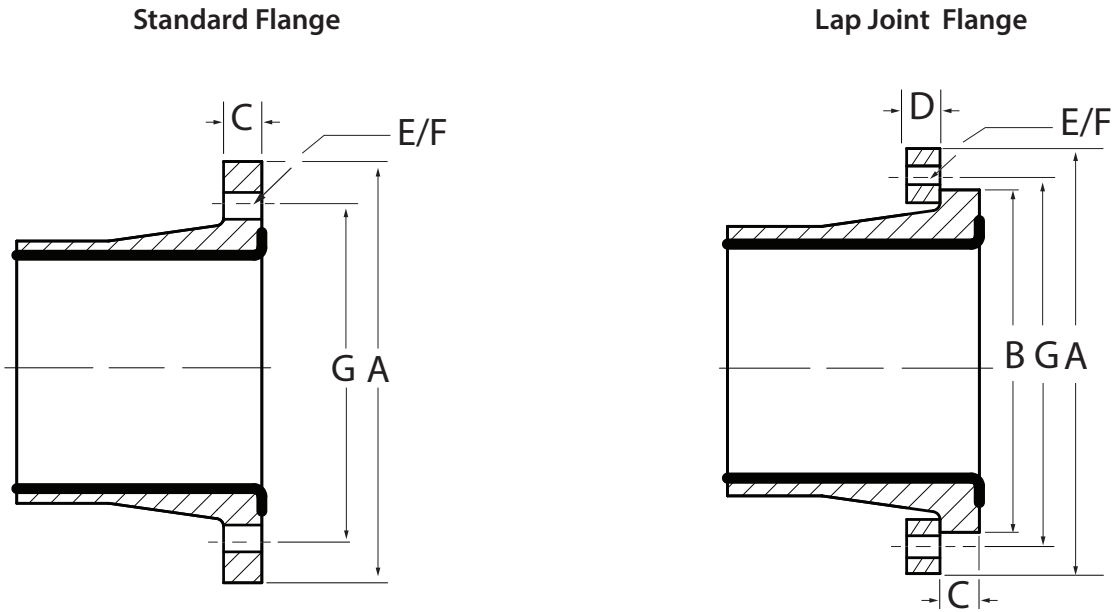
Nom. Dia.	Pipe per foot	Flange	10' Spool	20' Spool
1	.6	1.0	N/A	N/A
1 1/2	1.4	1.3	17	31
2	1.7	2.0	21	38
3	2.5	4.0	33	59
4	3.4	1.5	43	77
6	5.6	7.0	70	126
8	8.3	11.5	106	189
10	12.8	15.0	158	286
12	16.6	24.0	214	380
14	17	27	224	394
16	21	35	280	490
18	26	37	334	594
20	31	49	408	718
24	40	65	530	980

Note:

1. Please consult with RPS Composites for additional dimensional information on the PP/FRP Product

Seamless PP/FRP Specifications

Standard Flange Dimensions

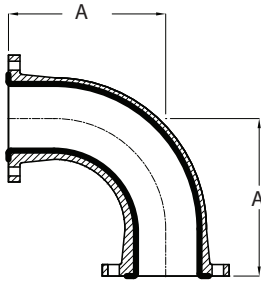


Nom Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Notes 1 and 3
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

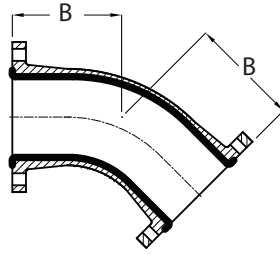
Notes

1. For all PP/FRP add appropriate liner thickness to get bolt lengths. Thickness may vary.
2. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.

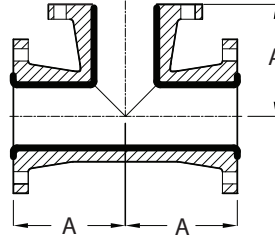
Fittings Dimensions



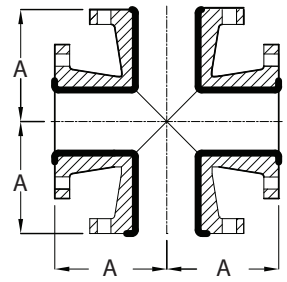
90° Elbow
See Note 1 & 3



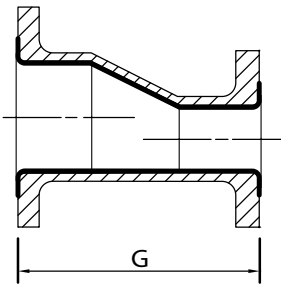
45° Elbow
See Note 1 & 3



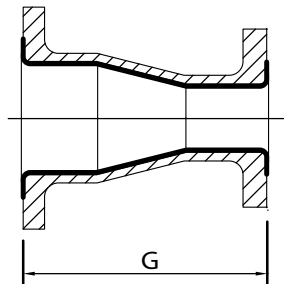
Tee
See Note 1 & 3



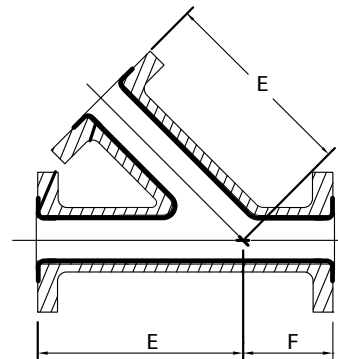
Cross
See Note 3



Eccentric Reducer



Concentric Reducer



45° Lateral
See Note 3

Nom. Dia.	A	B	E	F	G
1 1/2	4	2 1/4	7	2	5
2	4 1/2	2 1/2	8	2 1/2	5
3	5 1/2	3	10	3	6
4	6 1/2	4	12	3	7
6	8	5	14 1/2	3 1/2	9
8	9	5 1/2	17 1/2	4 1/2	11
10	11	6 1/2	20 1/2	5	12
12	12	7 1/2	24 1/2	5 1/2	14
14	21	8 3/4	30	12	12
16	24	10	32	14	12
18	27	11 1/4	36	14	12
20	30	12 1/2	38	16	12
24	36	15	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with non-standard dimensions. Contact RPS Composites for details.

Seamless PP/FRP Specifications

RPS Composites Inc.

8375 Zeigler Blvd.
Mobile, AL 36689
Tel: (251) 445-4411
Fax: (251) 633-3318
Sales@RPSComposites.com
RPSComposites.com



Seamless CPVC/FRP Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' CPVC/FRP piping products (seamless CPVC/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: CPVC liners are seamless. Only virgin CPVC is used in the extrusion of liners. This resin meets the requirements of ASTM D-1784 and may include less than 1% inorganic pigment for identification. A partial list of the physical properties is below:

CPVC/FRP	VALUE	TEST
Specific Gravity	1.47	ASTM D-792
Tensile Strength	7,300	ASTM D-638

- 2.2 Bonding: Bonding of the CPVC liner to the FRP structure results in a chemical linking of the structure to the liner. The shear strength of the bond as measured per BS 4994 B-10 is 1015 psi minimum.
- 2.3 Outer Structure: The bonded CPVC liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe Spools	Length	$\pm 1/8''$
	Bolt hole alignment	$\pm 1/16''$
	Flange alignment (with pipe centerline)	$\pm 1/32''$ (1" thru 4") $\pm 3/64''$ (6" >)
Flanges	All dimensions except thickness	ASME B16.5
Fittings	Face to centerline	$\pm 1/8''$
	Flange alignment (with pipe centerline)	$\pm 1/32''$ (1" thru 4") $\pm 3/64''$ (6" >)
	ID/OD Radius	$1/4'' \pm 1/16''$

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 CPVC/FRP liner material is suitable for operating temperatures from 0°F (-18°C) up to 200°F (93°C). CPVC/FRP piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.
- 4.2 Pressure Ranges: CPVC/FRP is suitable for continuous operation from full vacuum for 150 PSI for 1 diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1
- 4.3 Thermal Expansion: the Coefficient of Thermal expansion for CPVC/FRP pipe is $\sim 1.7 \times 10^{-5}$ in/in/°F when operating within the temperature range specified in subsection 4.1.
- 4.4 Chemical Resistance (liner): the CPVC liner is chemically inert to a broad range of commercial chemicals including the following:
- Mineral acids
 - Alkalies
 - Salt solutions
 - Alcohols

Seamless CPVC/FRP Specifications

- 4.5 Chemical Resistance: the CPVC/FRP vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.6 Gas Permeation: RPS' bonding technology eliminates air gaps between the CPVC liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between the liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.7 Insulation Qualities: CPVC/FRP's vinyl ester structure yields a heat conduction factor (k) of ~ 1.5 Btu*in/FT²/hr/°F. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained CPVC/FRP Systems.
- 4.8 Heat Tracing: CPVC/FRP's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated CPVC/FRP systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **GASKET MUST BE USED IN RPS' CPVC/FRP PIPING SYSTEM.** Recommended gaskets are elastomeric materials of 55-70 durometer suitable for the intended chemical service.
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Envelon Style 3565 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.

- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
- C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.

7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft)
1 1/2"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard CPVC/FRP products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards. ASTM Standards, OSHA Regulations and qualified piping and safety engineers.

Piping Specification

SERVICES:

As specified by user or RPS Composites.

MATERIAL:

CPVC/FRP as provided by RPS Composites dual laminate, seamless CPVC liner with bonded fiberglass reinforced vinyl ester structure.

SIZE/RATING:

1 ½" – 12"	Full Vacuum	150 PSI	0 to 200°F
14" – 24"	Full Vacuum	100 PSI	0 to 200°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

BRANCH CONNECTIONS:

Use full size or reducing tees

INSTRUMENT CONNECTIONS:

Use tee

FLANGES:

All flanges: drilling pattern per ASME B16.5 Class 150 dimensions (except thickness).

Blinds: Flat faced FRP with CPVC liner bonded to face.

Fixed: Full face flanges to be fabricated on pipe spools by pipe manufacturer.

Lap Joint: Stub end with loose ring fabricated on pipe by pipe manufacturer.

Fixed or Lap Joint flanges available as:

- A. Solvent socket weld where available
- B. Fabricated with flat sheet welded and bonded to face
- C. Flared over face of flange to the inside of the bolt holes

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock™, Envelon™ 3565 gasket material is comparable to CPVC/FRP liner material. Ring type or full face. 1/16" min. – 1/8" max. thick.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 ½" thru 6"Ø if preferred.

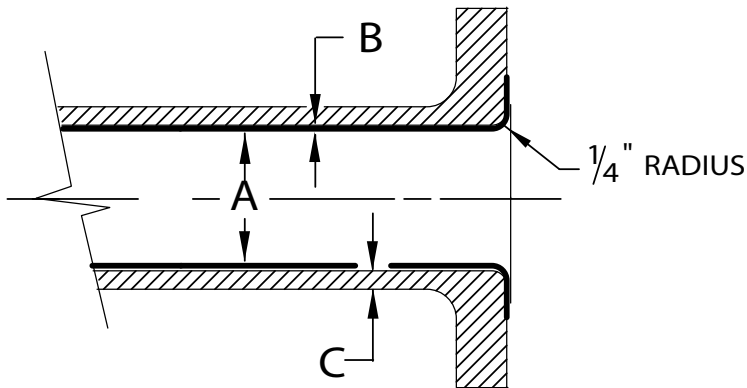
WELDING:

Assembly of CPVC/FRP piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by solvent, hot plate, or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer
3. One inch (1") piping is available in short spools only (24" or less).
4. CPVC/FRP piping systems with a continuous operating temperature above 180°F (82°C) should be evaluated by RPS engineering to determine if the process conditions are acceptable.

Pipe and Fittings Dimensions, Pipe and Fitting Weights



Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	A (I.D.)	B (Liner Thickness)	C (F.W. Thickness)
1	.96	.18	.15
1 1/2	1.50	.20	.15
2	1.94	.22	.17
3	2.90	.30	.21
4	3.83	.34	.21
6	6.07	.28	.21
8	7.98	.32	.25
10	10.02	.37	.36
12	11.938	.41	.39
14	13.124	.44	.39
16	15.000	.50	.39
18	17.828	.17	.43
20	19.80	.20	.46
24	23.77	.23	.50

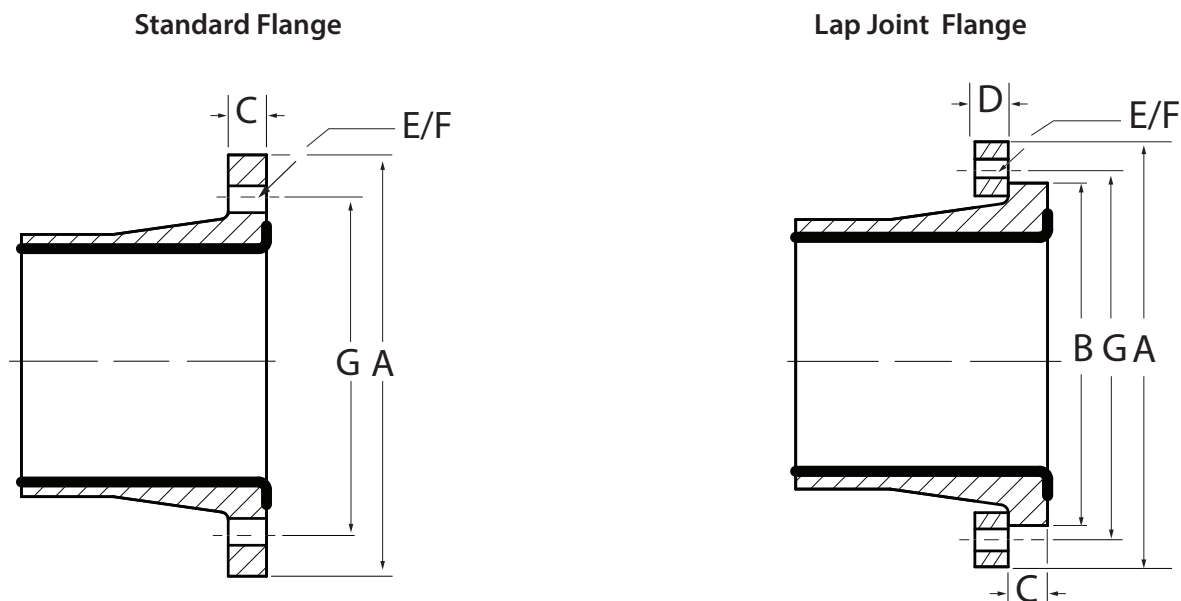
Nom. Dia.	Pipe per foot	Flange
1	.7	1.0
1 1/2	1.5	1.3
2	1.9	2.0
3	3.0	4.0
4	4.0	4.5
6	7.3	7.0
8	11.1	11.5
10	17.3	15.0
12	23.0	24.0
14	25.0	27.0
16	32.0	35.0
18	38.0	37.0
20	48.0	49.0
24	64.0	65.0

Note:

1. Please consult with RPS Composites for additional dimensional information on the CPVC/FRP Product

Seamless CPVC/FRP Specifications

Standard Flange Dimensions

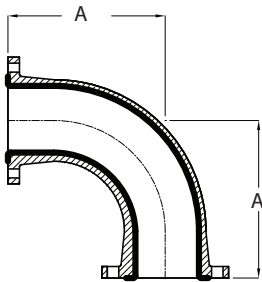


Nom. Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Notes 1 and 3
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

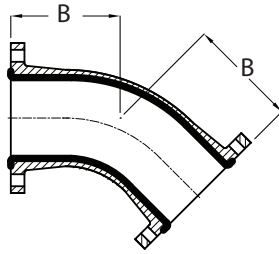
Notes:

1. For all CPVC/FRP add appropriate liner thickness to get bolt lengths. Thickness may vary.
2. Flared chlorinated polyvinyl chloride liner may not seat to face of flange until bolt up.
3. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.

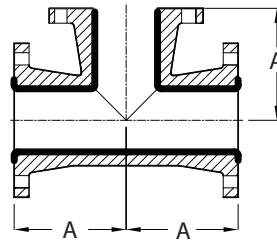
Fitting Dimensions



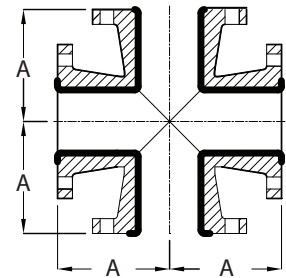
90° Elbow
See Note 1 & 3



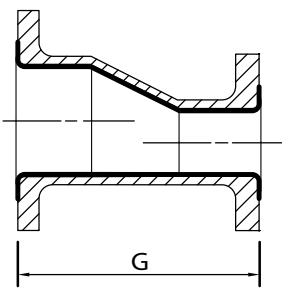
45° Elbow
See Note 1 & 3



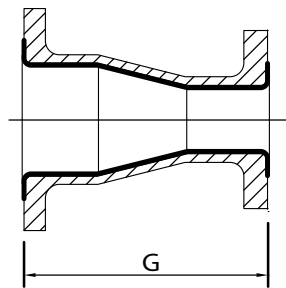
Tee
See Note 1 & 3



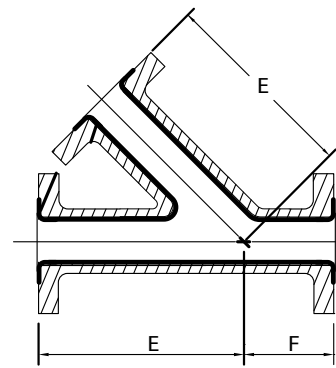
Cross
See Note 3



Eccentric Reducer



Concentric Reducer



45° Lateral
See Note 3

Nom. Dia.	A	B	E	F	G
1 1/2	4	2 1/4	7	2	5
2	4 1/2	2 1/2	8	2 1/2	5
3	5 1/2	3	10	3	6
4	6 1/2	4	12	3	7
6	8	5	14 1/2	3 1/2	9
8	9	5 1/2	17 1/2	4 1/2	11
10	11	6 1/2	20 1/2	5	12
12	12	7 1/2	24 1/2	5 1/2	14
14	21	8 3/4	30	12	12
16	24	10	32	14	12
18	27	11 1/4	36	14	12
20	30	12 1/2	38	16	12
24	36	15	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with non-standard dimensions. Contact RPS Composites for details.

Seamless CPVC/FRP Specifications

RPS Composites Inc.

8375 Zeigler Blvd.
Mobile, AL 36689
Tel: (251) 445-4411
Fax: (251) 633-3318
Sales@RPSComposites.com
RPSComposites.com



Seamless PVC/FRP Dual Laminate Pipe and Fittings



1. SCOPE

This specification provides design information applicable to RPS Composites' PVC/FRP piping products (seamless PVC/FRP dual laminate). Standard manufacturing specifications and dimensions are provided, however, custom specifications and designs can be tailored for unique requirements. Consult RPS Composites for more information.

2. MATERIALS

- 2.1 Liner: PVC liners are seamless. Only virgin PVC is used in the extrusion of liners. This resin meets the requirements of ASTM D-1784 and may include less than 1% inorganic pigment for identification. A partial list of the physical properties is below:

PROPERTY	PVC VALUE	TEST
Specific Gravity	1.38	ASTM D-792
Tensile Strength	7,700	ASTM D-638

- 2.2 Bonding: Bonding of the PVC liner to the FRP structure results in a chemical linking of the structure to the liner. The shear strength of the bond as measured per BS 4994 B-10 is 1015 psi minimum.
- 2.3 Outer Structure: The bonded PVC liner is reinforced by filament wound (standard) or hand lay-up vinyl ester fiberglass structure yielding a totally bonded dual laminate. Hand lay-up construction when performed is per ASTM C582 Type II, Grade V. Only premium grade vinyl ester resins are used with glass reinforcement and UV stabilized exterior gel coat.

3. DESIGN AND FABRICATION DETAILS

- 3.1 All dimensional drawings included in this specification are suitable for use in the design of pipe systems. Tolerances in subparagraph 3.3 should be considered in design.
- 3.2 Flanges for pipe spools and fittings shall have an internal diameter, outer diameter bolt circle, hole diameter and number of boltholes in accordance with ASME B16.5 Class 150, unless otherwise specified.

- 3.3 Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe Spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment	± 1/32" (1" thru 4")
	(with pipe centerline)	± 3/64" (6" >)
Flanges	All dimensions except thickness	ASME B16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment	± 1/32" (1" thru 4")
	(with pipe centerline)	± 3/64" (6" >)
ID/OD Radius		1/4" ± 1/16"

4. APPLICATION AND OPERATIONAL PARAMETERS

- 4.1 PVC/FRP liner material is suitable for operating temperatures from 0°F (-18°C) up to 170°F (77°C).
- 4.2 Pressure Ranges: PVC/FRP is suitable for continuous operation from full vacuum for 150 PSI for 1" diameter through 12" diameter and full vacuum to 100 PSI for 14" diameter through 24" diameter when operating within the temperature range specified in subsection 4.1
- 4.3 Thermal Expansion: the Coefficient of Thermal expansion for PVC/FRP pipe is $\sim 1.7 \times 10^{-5}$ in/in/°F when operating within the temperature range specified in subsection 4.1.
- 4.4 Chemical Resistance (liner): PVC/FRP's liner is chemically inert to a broad range of commercial chemicals including the following:
- Mineral acids
 - Alkalies
 - Salt solutions
 - Alcohols

Seamless PVC/FRP Specifications

- 4.5 Chemical Resistance: PVC/FRP's vinyl ester structure is inherently corrosion resistant. This typically allows open air or direct burial installation in harsh chemical environments with no additional protection. Gel coat exterior contains UV stabilizer. Fire retardant protection is available. For specific environments, consult RPS Composites.
- 4.6 Gas Permeation: RPS' bonding technology eliminates air gaps between the PVC liner and vinyl ester structure. This eliminates condensation between the liner and structure which is a common problem in lined steel pipe. Since these gases/liquids are not trapped between PVC/FRP's liner and vinyl ester structure, no weep holes are required and internal corrosion of the structure is eliminated.
- 4.7 Insulation Qualities: PVC/FRP's vinyl ester structure yields a heat conduction factor (k) of ~ 1.5 Btu*in/FT²/hr/°F. Check dimensional data for structure thickness. If additional thermal protection is necessary, contact RPS for details on Heat Traceable, Pre-insulated and/or Dual Contained PVC/FRP Systems.
- 4.8 Heat Tracing: PVC/FRP's vinyl ester structure is capable of handling dry heat trace applications up to 180°F. On pre-insulated PVC/FRP systems, channels can be provided for heat trace wire. Contact RPS Composites for more information.

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gauges, nicks, or inclusion of foreign particles.
- 5.2 Completed fittings shall be subjected to a 10,000-volt, non-destructive, electrostatic spark test to detect pinholes. This test is to be performed by RPS Composites only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

- 6.1 The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
- 6.2 All spools and fittings shall be packed to provide necessary protection during handling, shipping, and storage.

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from RPS Composites or supplied by customer. Supports should have a minimum 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports.
- 7.2 Support spacing: Support spacing can vary depending on actual service conditions and piping configuration. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping with special consideration given where components such as flanges and valves impose concentrated loads. Where calculations are not made, suggested maximum spacing of supports are given in the table on page 3. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects (ANSI B31.1). In addition, Appendix III, Non-Mandatory Rules for Nonmetallic Piping of ANSI B31.1 should be taken into consideration. The values listed in the table are based on maximum operating conditions but do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc.
- 7.3 Gaskets: **GASKET MUST BE USED IN RPS' PVC/FRP PIPING SYSTEM.** Recommended gaskets are elastomeric materials of 55-70 durometer suitable for the intended chemical service.
- 7.4 Bolts: Size and grade per ASME specification. SAE washers shall be used on all flanged fittings. Standard hex nuts shall be used on fittings 1 1/2" diameter through 6" diameter. Fittings 8" and up can accommodate heavy hex nuts if preferred.

7.5 Torquing Procedure: The following procedure will insure that the necessary forces are applied to seat Envelon Style 3565 gaskets using the torque values of subsection 7.6. When other gasket materials are used, they should not exceed 70 durometer to assure proper seating.

- A. Lubricate all bolts and nuts with a suitable lubricant, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until appropriate torque values are met as specified in the Maximum Bolt Torque table under subsection 7.6.
- C. After 24-30 hours, a temperature cycle, or a pressure cycle, torque for each bolt shall be checked. Those below the minimum are to be re-torqued to the values listed in subsection 7.6.

7.6 Bolt Torque: Clamping forces between flanges can vary greatly depending on whether or not lubricated bolts are used when torquing bolts. The values listed in the table assume that bolts are lubricated.

Pipe Size	Max. Pipe Support Spacing (ft)	Max. Bolt Torque (ft)
1 1/2"	6.0	15
2"	6.0	25
3"	8.0	25
4"	8.5	25
6"	10.5	40
8"	11.5	60
10"	13.0	70
12"	14.0	80
14"	14.0	80
16"	15.0	90
18"	17.0	90
20"	19.0	100
24"	22.0	100

8. WARRANTY

All standard PVC/FRP products are warranted for one (1) year from being placed in service or 18 months from delivery. Consult RPS Composites for warranty information concerning customized parts or systems.

9. WAIVER

- 9.1 Every effort has been made to ensure that the information provided in this specification is accurate. Changes or updates may occur without notice.
- 9.2 This specification does not purport to address any personnel safety issues associated with handling, installing, and operating pressure or vacuum pipe systems. For specific information regarding these issues, refer to applicable ASME/ANSI Codes and Standards. ASTM Standards, OSHA Regulations and qualified piping and safety engineers.

Piping Specification

SERVICES:

As specified by user or RPS Composites.

MATERIAL:

PVC/FRP as provided by RPS Composites dual laminate, seamless PVC liner with bonded fiberglass reinforced vinyl Ester structure.

SIZE/RATING:

1 ½" – 12"	Full Vacuum	150 psi	0 to 170°F
14" – 24"	Full Vacuum	100 psi	0 to 170°F

PIPE:

150# flanged spools 20'-0" standard length

FITTINGS:

Flanged, ASME B16.5 Class 150 Dimensions.

BRANCH CONNECTIONS:

Use full size or reducing tees

INSTRUMENT CONNECTIONS:

Use tee

FLANGES:

All flanges: drilling pattern per ASME B16.5 Class 150 dimensions (except thickness).

Blinds: Flat faced FRP with PVC liner bonded to face.

Fixed: Full face flanges to be fabricated on pipe spools by pipe manufacturer.

Lap Joint: Stub end with loose ring fabricated on pipe by pipe manufacturer.

Fixed or Lap Joint flanges available as:

- A. Solvent socket weld where available
- B. Fabricated with flat sheet welded and bonded to face
- C. Flared over face of flange to the inside of the bolt holes.

GASKETS:

Gasket material suitable for intended service conditions. Consult gasket manufacturer for recommendation. Garlock™, Envelon™ 3565 gasket material is comparable to PVC/FRP liner material. Ring type or full face. 1/16" min. – 1/8" max. thick.

BOLTING:

Alloy steel machine bolts or studs with (2) SAE washers and standard nuts 1 ½" thru 6"Ø if preferred.

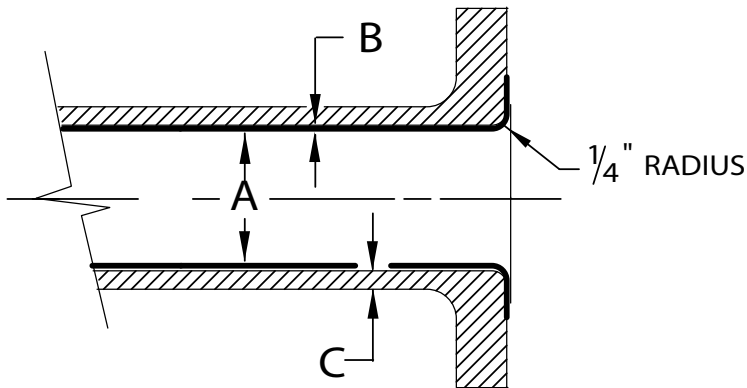
WELDING:

Assembly of PVC/FRP piping components is accomplished by welding the liner sections and then laminating the components together. The liner weld is accomplished by solvent, hot plate, or hot gas welding. Welds are spark tested to detect pinholes prior to laminating.

NOTES:

1. Instrument connections (including vents and drains) may be fabricated directly into pipe spools minimum size is 1" diameter.
2. Piping may be shop fabricated or field welded by manufacturer
3. One inch (1") piping is available in short spools only (24" or less).

Pipe and Fittings Dimensions, Pipe and Fitting Weights



Approximate Weight of Pipe and Fittings (lbs.)

Nom. Dia.	A (I.D.)	B (Liner Thickness)	C (F.W. Thickness)
1	.96	.18	.15
1 1/2	1.50	.20	.15
2	1.94	.22	.17
3	2.90	.30	.21
4	3.83	.34	.21
6	6.07	.28	.21
8	7.98	.32	.25
10	10.02	.37	.36
12	11.938	.41	.39
14	13.124	.44	.39
16	15.000	.50	.39
18	17.828	.17	.43
20	19.80	.20	.46
24	23.77	.23	.50

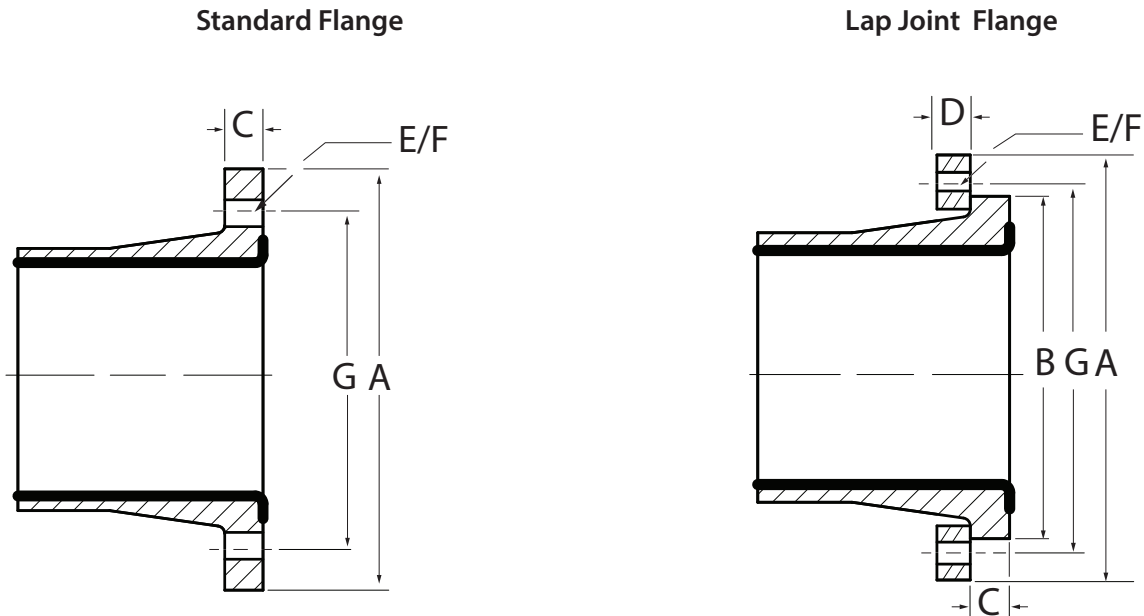
Nom. Dia.	Pipe per foot	Flange
1	.7	1.0
1 1/2	1.5	1.3
2	1.9	2.0
3	3.0	4.0
4	4.0	4.5
6	7.3	7.0
8	11.1	11.5
10	17.3	15.0
12	23.0	24.0
14	25.0	27.0
16	32.0	35.0
18	38.0	37.0
20	48.0	49.0
24	64.0	65.0

Note:

1. Please consult with RPS Composites for additional dimensional information on the PVC/FRP Product

Seamless PVC/FRP Specifications

Standard Flange Dimensions

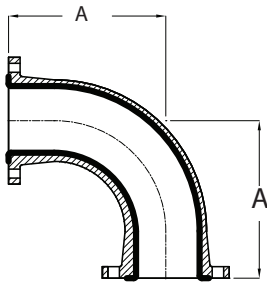


Nom. Size	A O.D. Flange	B O.D. Stub End	C Flg/Stub Thickness	D Lap Jt. Thickness	E No. Holes	F Hole Size	G Bolt Circle	Bolt Size See Notes 1 and 3
1	4 1/4	2 1/2	1	1	4	5/8	3 1/8	1/2
1 1/2	5	3 1/4	1	1	4	5/8	3 7/8	1/2
2	6	4	1 1/8	1 1/4	4	3/4	4 3/4	5/8
3	7 1/2	5 1/4	1 1/8	1 1/4	4	3/4	6	5/8
4	9	6 3/4	1 1/4	1 3/8	8	3/4	7 1/2	5/8
6	11	8 5/8	1 1/2	1 3/4	8	7/8	9 1/2	3/4
8	13 1/2	10 7/8	1 3/4	2	8	7/8	11 3/4	3/4
10	16	13 1/4	1 3/4	2	12	1	14 1/4	7/8
12	19	16	2	2 1/4	12	1	17	7/8
14	21	17 5/8	2	2 1/4	12	1 1/8	18 3/4	1
16	23 1/2	20 1/8	2 1/8	2 3/8	16	1 1/8	21 1/4	1
18	25	21 1/2	2 1/4	2 1/2	16	1 1/4	22 3/4	1 1/8
20	27 1/2	23 3/4	2 1/2	2 3/4	20	1 1/4	25	1 1/8
24	32	28 1/8	2 5/8	2 7/8	20	1 3/8	29 1/2	1 1/4

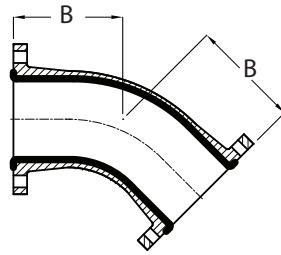
Notes:

1. For all PVC/FRP add appropriate liner thickness to get bolt lengths. Thickness may vary.
2. Flared polyvinyl chloride liner may not seat to face of flange until bolt up.
3. For bolt lengths when using lap joint flanges, add lap joint flange thickness to length shown.

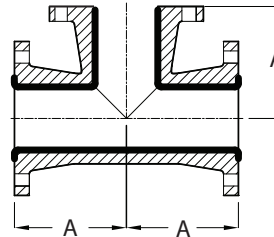
Fittings Dimensions



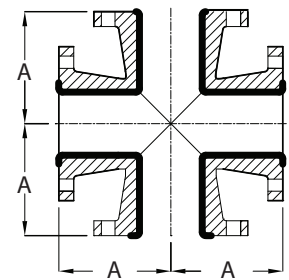
90° Elbow
See Note 1 & 3



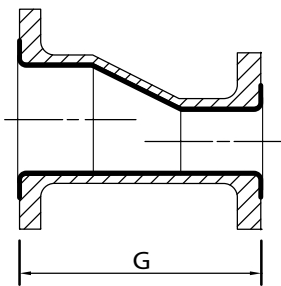
45° Elbow
See Note 1 & 3



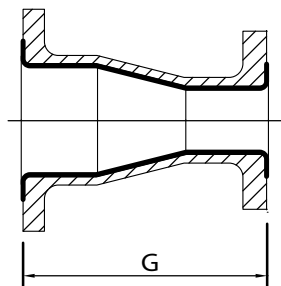
Tee
See Note 1 & 3



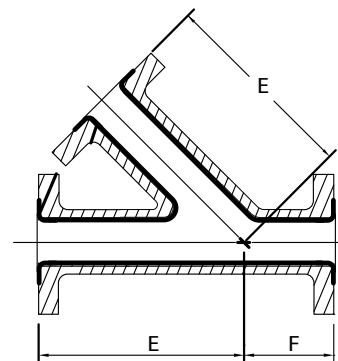
Cross
See Note 3



Eccentric Reducer



Concentric Reducer



45° Lateral
See Note 3

Nom. Dia.	A	B	E	F	G
1 1/2	4	2 1/4	7	2	5
2	4 1/2	2 1/2	8	2 1/2	5
3	5 1/2	3	10	3	6
4	6 1/2	4	12	3	7
6	8	5	14 1/2	3 1/2	9
8	9	5 1/2	17 1/2	4 1/2	11
10	11	6 1/2	20 1/2	5	12
12	12	7 1/2	24 1/2	5 1/2	14
14	21	8 3/4	30	12	12
16	24	10	32	14	12
18	27	11 1/4	36	14	12
20	30	12 1/2	38	16	12
24	36	15	42	18	15

Notes

1. See page 6 for flange dimensions.
2. See page 5 for wall and liner thicknesses.
3. Tees, crosses and laterals are also available with reducing branch connections. Dimensions are same as full size.
4. Fittings are also available with non-standard dimensions. Contact RPS Composites for details.

Seamless PVC/FRP Specifications

RPS Composites Inc.

8375 Zeigler Blvd.

Mobile, AL 36689

Tel: (251) 445-4411

Fax: (251) 633-3318

Sales@RPSComposites.com

RPSComposites.com



Dual Laminate vs. Lined Steel



Advantages of Dual Laminate Piping

Dual Laminate pipe systems incorporate a thermoplastic liner in an FRP structure combining the enhanced corrosion resistance of thermoplastics with the higher strength and load carrying capabilities of FRP. Dual Laminate pipe offers many advantages over lined steel piping from intrinsic fabrication methods to overall atmospheric corrosion resistance. Consider these critical advantages:

- 1) **Longer Life:** All steel contains iron and carbon, and the iron will react easily with oxygen and other gases and liquids in your system. The internal and external corrosion resistance of dual laminate will extend piping system life 3x-5x over steel.
- 2) **Maintenance Free:** Steel pipe is susceptible to deformation and metal loss defects. It demands a pipeline integrity and rehabilitation plan that can include blast cleaning, re-painting, geometry inspections, ultrasound assessment, and more.
- 3) **No venting and collection system:** The RPS dual laminate system bonds the liner to the frp layers, which eliminates the need for weep holes and vents. Lined steel requires weep holes and a collection system so that permeant can escape the pipe, and be safely disposed of, thereby introducing additional life cycle costs.
- 4) **Liner options:** Dual Laminate can utilize most thermoplastic liners including vinyls (PVC, CPVC), olefins (PP, HDPE), and fluoropolymers (FEP, PVDF):

Typical Thermoplastic Materials for Use in Lined Piping Systems

Thermoplastics	IUPAC	Dual Laminate	Lined Steel
Fluorinated Ethylene Propylene	FEP	X	X
Perfluoroalkoxy	PFA	X	X
Polytetrafluoroethylene	PTFE		X
Ethylene Tetrafluoroethylene	ETFE	X	X
Ethylene Chlorotrifluoro Ethylene	ECTFE	X	
Polyvinylidene Fluoride	PVDF	X	X
Polypropylene	PP	X	X
Polyvinylchloride	PVC	X	
Chlorinated Polyvinylchloride	CPVC	X	

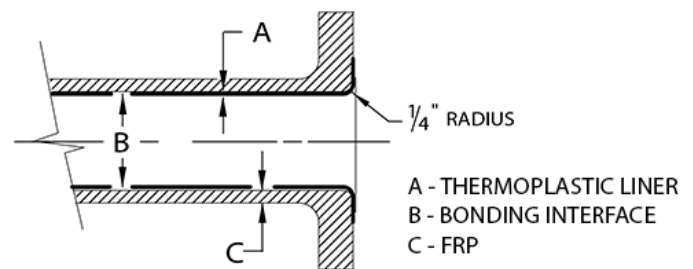
Fabrication Advantages

In dual laminate construction, the liner is BONDED to the FRP structural casing whereas lined steel has a “loose” or swagged liner leaving thermoplastic growing at 3x rate of steel structure.

Mechanically Bonded Format:

- A) Bonding greatly reduces the risk of mechanical damage by redistributing the concentration of stresses.
- B) Bonded pipe can withstand higher temperatures, vacuum and differential coefficients of thermal expansion.
- C) Dual Laminate can be rated to Full Vacuum at elevated temperatures and diameters.

See basic schematic of dual laminate construction below:



Minimally flanged installation for sulphuric acid in service since 1996.

Advantages of Dual Laminate Piping

Eliminates Flanges

Dual laminate piping systems will give you the option to reduce or eliminate flanged connections in your system. Dual Laminate offers 3 types of installations:

- 1) **Flanged:** All spools and fittings are flanged according to ANSI dimensions and specifications.
- 2) **Minimally Flanged:** Reduce the number of flanges by 40%-60% relying on all shop joints and retaining "bolt up" parts in field
- 3) **"Flangeless" construction:** All flanges are eliminated with exception of connections at valves, instrumentation, etc.

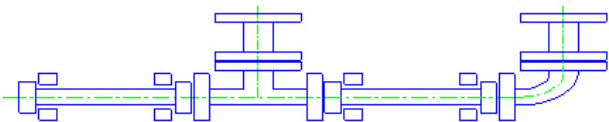
All 3 systems provide various advantages for installation depending on client needs and preferences.

Benefits of Flangeless Systems:

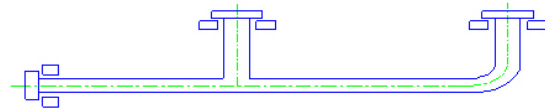
- cost savings in materials and labor
- faster installation
- reduced system weight
- fewer failure points
- streamlined profile
- no gaskets or flange protection required
- no risk of over-torquing or re-torquing
- fewer parts requiring mapping, assessment and maintenance

Following is a conventional flanges vs. minimally flanged drawing.

ANSI Flanged Design



RPS Minimally Flanged Design



Installation Advantages

- 1) **Less Weight:** Dual Laminate pipe is $\frac{1}{4}$ the weight of steel. This greatly reduces labor, time, and machinery required to install piping systems.
- 2) **Fewer Flanges:** Fewer flanges means less time and money spent on installation.
- 3) **No Painting:** Dual Laminate comes with UV resistant gel-coat which can be specified in various colors to match your service requirements.



Installed system for hypochlorite in service since 2000.

RPS Composites Inc.

740 Main Street
P.O. Box 299

Mahone Bay, Nova Scotia
Canada B0J 2E0

Tel: (902) 624.8383 | (800) 343.9355

Fax: (902) 624.6395

www.rpscomposites.com



MAXARFLEX™ Delivers

Maintenance crews and mechanical contractors want the ability to fabricate dual laminate pipe spools where and when they need them, especially in emergency situations. They also want a product that requires no thermoplastic welding.

With MAXARFLEX™ your team can take back control of the work and timing, and be up and running again in as little as 90 minutes.

Building on 35 years of successful application of our dual laminate MAXAR™ piping products, our MAXARFLEX™ system preserves the integrity of our bonded, seamless thermoplastic liner and enables pipe sectioning and re-spooling, all without the specialized expertise of a composites technician.

What's Included

When you order MAXARFLEX™ you'll receive all the tools required to section and replace your own spools in-house.

How it Works

1. Your maintenance team identifies a section of lined steel or lined FRP that needs replacing.
2. Workers retrieve replacement MAXAR™ pipe from inventory and prepare the end(s) with the MAXARFLEX™ tooling kit.
3. With the skyving tool they remove the outer FRP, and install a new RPS DuoForm flange.
4. They trim and flare the liner.
5. Repeat for the other end, if necessary, and place into service.



“This innovative product will revolutionize the dual laminate piping industry through its ease of use and the flexibility it gives back to the end user.”

Compare the Benefits

MAXARFLEX™ is an improved direct replacement for **lined steel** piping systems:

Product Features	Benefits to You	MAXARFLEX™	Lined Steel
Seamless bonded liner	Full vacuum rating. Eliminates liner failures, particularly in thermal cycling applications. No need for weep holes and the subsequent potential for highly corrosive leaks.	✓	
Lined steel fitting dimensions	Bolt in replacement of corroded or failing lined steel fittings.	✓	✓
Corrosion resistant FRP structure	No external painting or coating required.	✓	
Light weight — less than one third the weight of carbon steel pipe	Safer to handle, faster to install	✓	
Inventory of standard pipe and fittings	Reduced down time	✓	✓
Lap joint flanges available	Flexibility in bolt hole alignment, faster installation	✓	✓
Multiple liner materials available (FEP, PVDF, PFA)	Optimizing cost and performance	✓	✓
Inherently corrosion resistant throughout	Lower life cycle costs	✓	
Easily field fabricated	Lower installed cost	✓	✓

RPS Composites' DuoForm flanges are bonded with high strength epoxy adhesive and have been successfully tested to ASTM D4024.

Pipe and fittings can be customized with various liners including FEP, PVDF, and PFA.

MAXARFLEX™ can be used with 1½", 2", 3", and 4" dia. pipe.

RPS technicians are available for training.

For more information, installation videos, and to order, go to www.rpscomposites.com/MaxarFlex

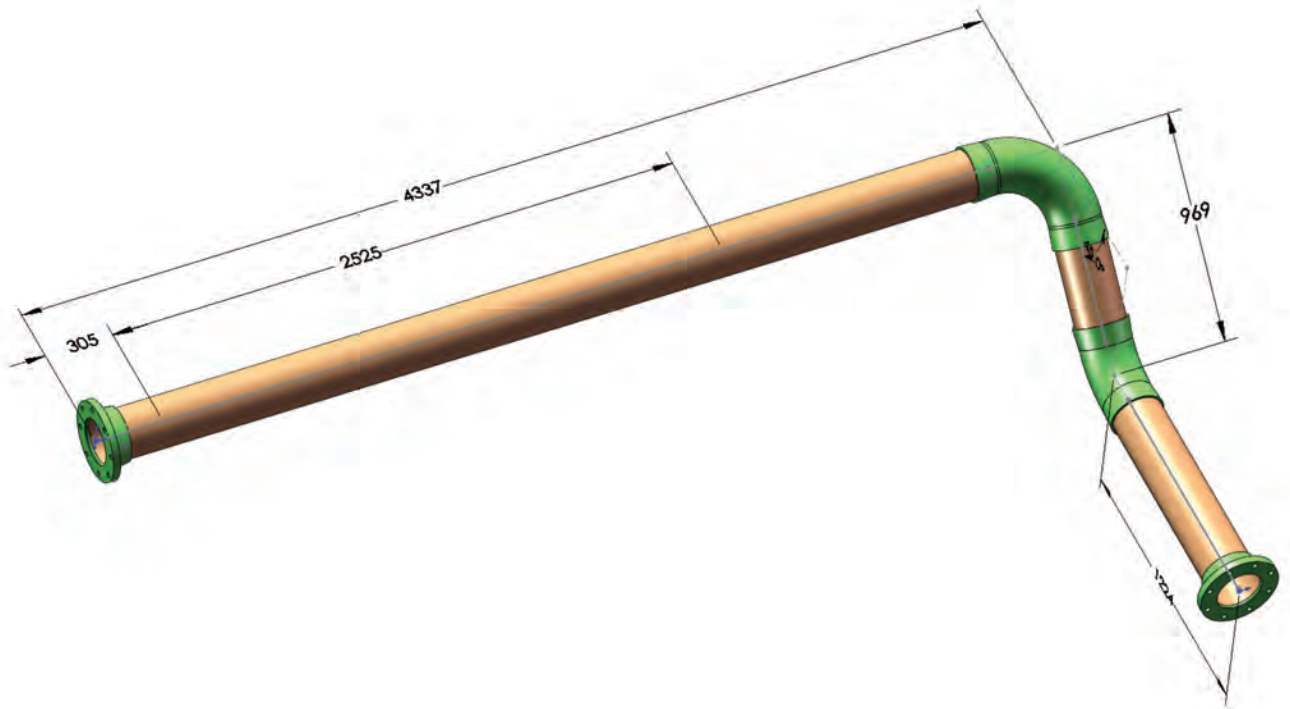


RPS DuoForm flanges can withstand up to 4 times the recommended sealing torque.

RPS Composites Inc.
8375 Zeigler Blvd.
Mobile, AL 36608
Tel: (251) 445-4411
Fax: (251) 633-3318
www.rpscomposites.com



RPS Pipe Fitting & Dimensions



Engineered Composite Solutions

HPPE P-150 Corrosion Resistant FRP

HPPE A-150 Corrosion and Abrasion Resistant FRP

HPPE H-150 Corrosion Resistant and High Temperature Resistant FRP

Fitting and Dimensions

PURPOSE & INTENDED USE

This Dimensional Catalogue has been prepared by RPS and is supplied for the purchaser's assistance. It should be used by all those designing or installing RPS HPPE FRP products*. Please note that dimensions can be changed without notice. Contact RPS for current information.

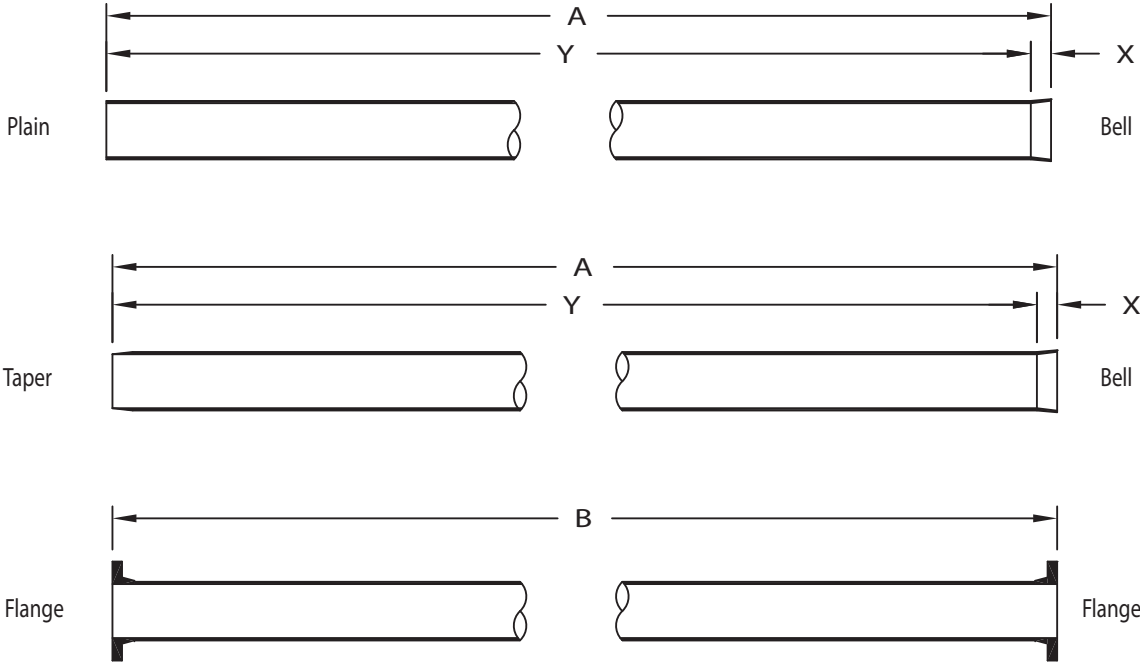
TABLE OF CONTENTS

SECTION	Page	SECTION	Page
Belled Pipe	3	Length for Stub-In Branches	19
Plain End Pipe	4	Gussets	20
Belled Flanges	5	Belled Laterals	21
Plain End Flanges	6	Plain End Laterals	22
Min. Flange Thickness for Plain End Flanges	7	Belled Concentric Reducers	23
Lap Joint Flange	8	Belled Eccentric Reducers	24
Flange Gasket	9	Plain End Concentric Reducers	25
Belled Elbows	10	Plain End Eccentric Reducers	26
Plain End Elbows	11	Belled Fittings	27
Belled Short Radius Elbows	12	ANSI Tee, Reducing Tee, Cross, Lateral & Concentric Reducers	28
Belled 30° & 60° Elbows	13	Application of Pipe Fabrication Tolerances	29
Plain 30° & 60° Elbows	14	Fabrication Tolerances	30
Belled Tees & Crosses	15	Manufacturing Tolerances	31
Plain End Tees & Crosses	16		
Belled Reducing Tees	17		
Plain End Reducing Tees	18		

* HPPE P-150, HPPE A-150, HPPE H-150 only. For dimensions of Dual Laminate (DL) piping, refer to DL Product Bulletins, for dimensions of custom piping, please contact your RPS advisor.

Fitting and Dimensions

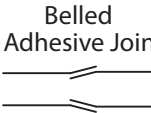
BELLED PIPE



Pipe Dia.	I.D.	A	B	Y	X	WEIGHT (lb./ft.)
1"	1.00"	8'-6"	8'-6"	8'-4 5/8"	1 3/8"	0.5
1 1/2"	1.50"	11'-6"	10'-0"	11'-4 5/8"	1 3/8"	0.7
2"	2.00"	21'-6"	20'-0"	21'-4 5/8"	1 3/8"	1.0
3"	3.00"	21'-6"	20'-0"	21'-4 5/8"	1 3/8"	1.4
4"	4.00"	21'-6"	20'-0"	21'-4 5/8"	1 3/8"	1.9
5"	5.00"	20'-6"	20'-0"	20'-4 1/4"	1 3/4"	2.7
6"	6.00"	21'-6"	20'-0"	21'-4 1/4"	1 3/4"	3.5
8"	8.00"	24'-6"	20'-0"	24'-2 7/16"	3 9/16"	5.6
10"	10.00"	20'-6"	20'-0"	20'-1 7/8"	4 1/8"	8.2
12"	12.00"	21'-6"	20'-0"	21'-1 1/8"	4 7/8"	11.2

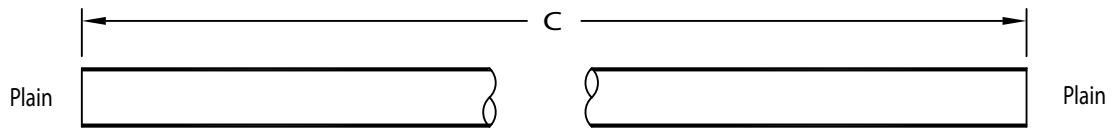
Pipe orders will be shipped as a combination of standard and random lengths. Shipments will consist of at least 80% standard lengths and up to 20% random lengths. Random lengths will not deviate from standard by more than 20%.

Standard and random length will be shipped with Bell x Plain ends, except the last "make-up" length which will be shipped with plain ends.



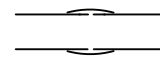
Fitting and Dimensions

PLAIN END PIPE



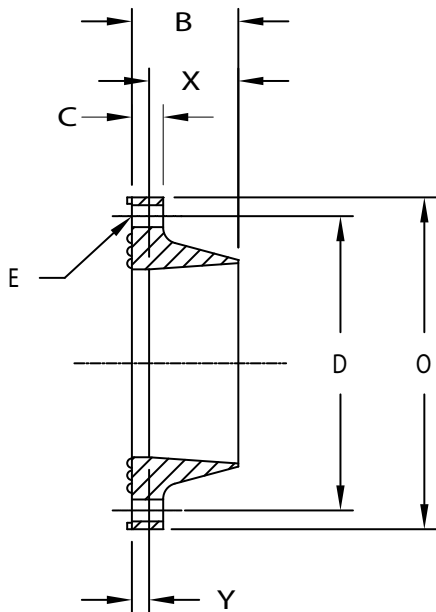
Pipe Dia.	I.D.	C	WEIGHT (lb./ft.)
1"	1.00"	8'-6"	0.5
1 1/2"	1.50"	11'-6"	0.7
2"	2.00"	21'-6"	1.0
3"	3.00"	21'-6"	1.4
4"	4.00"	21'-6"	1.9
5"	5.00"	20'-6"	2.7
6"	6.00"	21'-6"	3.5
8"	8.00"	24'-6"	5.6
10"	10.00"	20'-6"	8.2
12"	12.00"	21'-6"	11.2
14"	14.00"	23'-0"	13.3
16"	16.25"	20'-0" / 39'-4"	17.2
18"	18.25"	20'-0"	21.2
20"	20.25"	20'-0"	25.5
24"	24.00"	39'-2"	34.8
30"	29.53"	39'-3"	51.0
36"	35.43"	39'-3"	71.8
40"	39.37"	39'-4"	87.6
42"	42.00"	39'-4"	99.0
48"	48.25"	39'-1"	128.9
54"	54.00"	39'-8"	159.9
60"	60.00"	39'-8"	195.8
72"	72.00"	20'-0"	278.5
78"	78.00"	40'-0"	325.3
90"	90.00"	40'-0"	429.8
96"	96.00"	60'-0"	487.5
120"	120.00"	40'-0"	754.6

Butt Joint

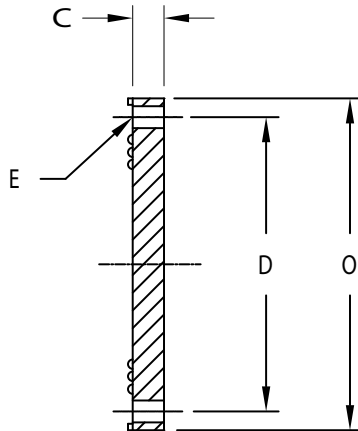


Fitting and Dimensions

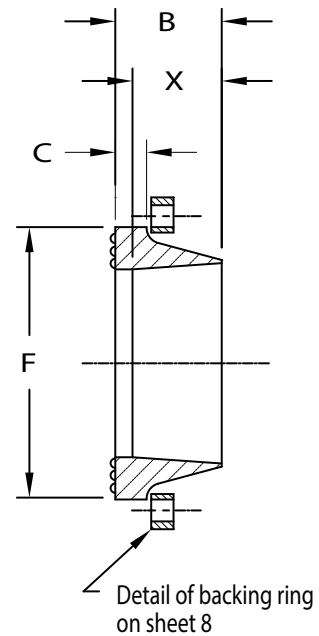
BELLED FLANGES



Flange
(Also available with backing ring - see note)



Blind Flange

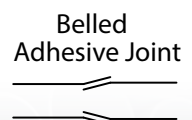


Lap Joint Flange

Pipe Dia	I.D.	B	C	Y	X	D	O	E # holes	E hole Ø	F
1"	1.00"	1 5/8"	7/8"	1/4"	1 3/8"	3 1/8"	4 1/4"	4	5/8"	2 1/2"
1 1/2"	1.50"	1 5/8"	7/8"	1/4"	1 3/8"	3 7/8"	5"	4	5/8"	3 1/4"
2"	2.00"	1 11/16"	7/8"	5/16"	1 3/8"	4 3/4"	6"	4	3/4"	4"
3"	3.00"	1 13/16"	7/8"	7/16"	1 3/8"	6"	7 1/2"	4	3/4"	5 1/4"
4"	4.00"	1 15/16"	15/16"	9/16"	1 3/8"	7 1/2"	9"	8	3/4"	6 3/4"
5"	5.00"	2 3/8"	1 1/16"	5/8"	1 3/4"	8 1/2"	10"	8	7/8"	7 5/8"
6"	6.00"	2 7/16"	1 1/16"	11/16"	1 3/4"	9 1/2"	11"	8	7/8"	8 5/8"
8"	8.00"	4 1/4"	1 1/4"	11/16"	3 9/16"	11 3/4"	13 3/4"	8	7/8"	10 7/8"
10"	10.00"	5"	1 7/16"	7/8"	4 1/8"	14 1/4"	16 1/4"	12	1"	13 1/4"
12"	12.00"	5 3/4"	1 3/4"	7/8"	4 7/8"	17"	19 1/4"	12	1"	16"

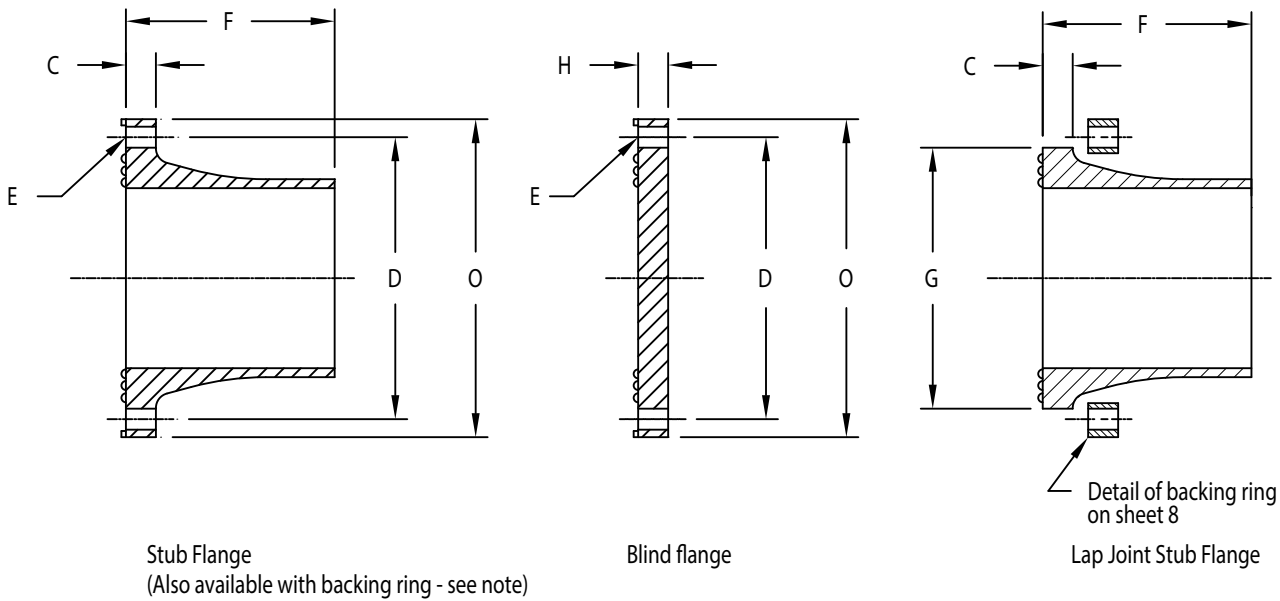
Note: When bolting FRP flanges to expansion joints with tie rods a steel backing ring is recommended behind the full face flange (see pg 8.). For 8"-12" flanges a back-faced flange must be specified (Standard 8"-12" flanges are spot faced for washers).

When attaching flange plate supports to flanges, back-faced flanges must be specified for 8"-12".



Fitting and Dimensions

PLAIN END FLANGES



Pipe Dia	I.D.	D	O	E # holes	E hole Ø	F	G	C	H
1"	1.00"	3 1/8"	4 1/4"	4	5/8"	6"	2 1/2"	7/8"	7/8"
1 1/2"	1.50"	3 7/8"	5"	4	5/8"	6"	3 1/4"	7/8"	7/8"
2"	2.00"	4 3/4"	6"	4	3/4"	6"	4"	7/8"	7/8"
3"	3.00"	6"	7 1/2"	4	3/4"	6"	5 1/4"	7/8"	7/8"
4"	4.00"	7 1/2"	9"	8	3/4"	6"	6 3/4"	15/16"	15/16"
5"	5.00"	8 1/2"	10"	8	7/8"	8"	7 5/8"	1 1/16"	1 1/16"
6"	6.00"	9 1/2"	11"	8	7/8"	8"	8 5/8"	1 1/16"	1 1/16"
8"	8.00"	11 3/4"	13 3/4"	8	7/8"	8"	10 7/8"	1 1/4"	1 1/4"
10"	10.00"	14 1/4"	16 1/4"	12	1"	10"	13 1/4"	1 7/16"	1 7/16"
12"	12.00"	17"	19 1/4"	12	1"	10"	16"	1 3/4"	1 3/4"
14"	14.00"	18 3/4"	21"	12	1 1/8"	12"	17 5/8"	1 7/8"	1 7/8"
16"	16.25"	21 1/4"	23 1/2"	16	1 1/8"	12"	20 1/8"	2 1/4"	2 1/4"
18"	18.00"	22 3/4"	25"	16	1 1/4"	14"	21 1/2"	2 1/4"	2 1/4"
20"	20.25"	25"	27 1/2"	20	1 1/4"	14"	23 3/4"	2 3/8"	2 3/8"
24"	24.00"	29 1/2"	32"	20	1 3/8"	16"	28 1/8"	2 3/4"	2 3/4"
30"	29.53"	36"	38 3/4"	28	1 3/8"	20"	34 5/8"	3 1/8"	3 1/2"
36"	35.43"	42 3/4"	46"	32	1 5/8"	22"	41 1/8"	3 5/8"	4 1/8"
42"	42.00"	49 1/2"	53"	36	1 5/8"	24"	47 7/8"	4 1/8"	4 3/4"
48"	48.25"	56"	59 1/2"	44	1 5/8"	26"	54 3/8"	4 5/8"	5 1/2"
54"	54.00"	62 3/4"	66 1/4"	44	1 7/8"	30"	60 3/4"	5 1/16"	6"
60"	60.00"	69 1/4"	73"	52	1 7/8"	32"	67 1/4"	5 5/8"	6 3/4"

Note: When bolting FRP flanges to expansion joints with tie rods a steel backing ring is recommended behind the full face flange (see pg. 8). In this case a back-faced flange must be specified. (Standard stub flanges are spot faced for washers).

When attaching flange plate supports to flanges, back-faced flanges must be specified.



Fitting and Dimensions

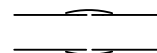
MINIMUM FLANGE THICKNESS FOR PLAIN END FLANGES

Pipe Dia	Minimum Flange Thickness at Design Pressure (inches)					
	25 PSI	50 PSI	75 PSI	100 PSI	125 PSI	150 PSI
8"	0.56	0.75	0.88	1.00	1.13	1.25
10"	0.69	0.88	1.06	1.19	1.31	1.44
12"	0.75	1.00	1.25	1.44	1.63	1.75
14"	0.81	1.06	1.31	1.50	1.75	1.88
16"	0.88	1.19	1.44	1.63	1.88	2.25
18"	0.94	1.25	1.50	1.75	2.00	2.25
20"	1.00	1.31	1.63	1.88	2.25	2.38
24"	1.13	1.50	1.88	2.31	2.50	2.75
30"	1.38	1.88	2.38	2.63	2.94	3.13
36"	1.75	2.13	2.63	2.88	3.25	3.63
42"	2.00	2.63	3.13	3.50	3.88	4.13
48"	2.25	2.94	3.44	3.81	4.25	4.63
54"	2.50	3.00	3.75	4.13	4.63	5.06
60"	2.75	3.31	4.00	4.63	5.13	5.63

Notes:

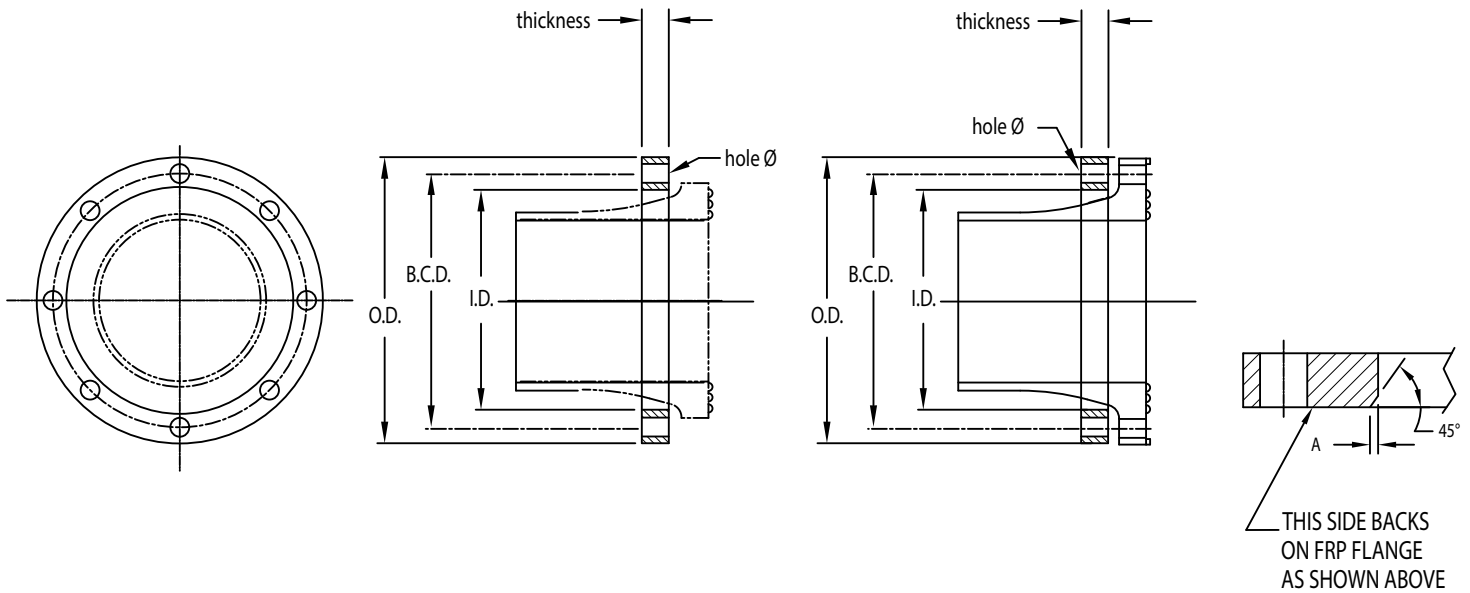
- 1) Flange thickness only suitable when drilling is according ASME B16.5 for Class 150 steel flanges (sizes 8" thru 24") or ASME B16.47 Series A Class 150 for 26" and larger.
- 2) Thickness does not include sealing rings.
- 3) Washer type required 8" thru 48" inclusive, use ANSI B18.22 1-1965, R1975 TYPE A, plain washer, narrow series (SAE) 54" thru 60" inclusive, use ANSI B18.22.1-1965, R1975 TYPE B, plain washer, narrow series.

Butt Joint



Fitting and Dimensions

LAP JOINT AND FULL FACE FLANGE BACKING RINGS



Pipe Dia	thk	O.D.	I.D.	B.C.D.	# hole	hole Ø	A
1"	0.50	4.25	2.13	3.13	4	0.63	-
1 1/2"	0.63	5.00	2.88	3.88	4	0.63	-
2"	0.69	6.00	3.35	4.75	4	0.75	-
3"	0.88	7.50	4.50	6.00	4	0.75	-
4"	0.88	9.00	5.63	7.50	8	0.75	-
5"	0.88	10.00	7.13	8.50	8	0.88	-
6"	0.94	11.00	8.13	9.50	8	0.88	-
8"	1.06	13.50	10.00	11.75	8	0.88	0.25
10"	1.13	16.00	12.25	14.25	12	1.00	0.13
12"	1.19	19.00	14.75	17.00	12	1.00	0.25
14"	1.31	21.00	16.75	18.75	12	1.13	0.13
16"	1.38	23.50	19.38	21.25	16	1.13	0.25
18"	1.50	25.00	20.75	22.75	16	1.25	0.13
20"	1.63	27.50	23.00	25.00	20	1.25	0.13
24"	1.81	32.00	27.38	29.50	20	1.38	0.19
30"	2.88	38.75	33.81	36.00	28	1.38	0.13
36"	3.50	46.00	40.25	42.75	32	1.63	0.25
42"	3.75	53.00	47.00	49.50	36	1.63	0.13
48"	4.19	59.50	53.38	56.00	44	1.63	0.13
54"	4.69	66.25	59.63	62.75	44	1.88	0.13
60"	5.13	73.00	66.00	69.25	52	1.88	0.13

For full face backing rings only. (See note)

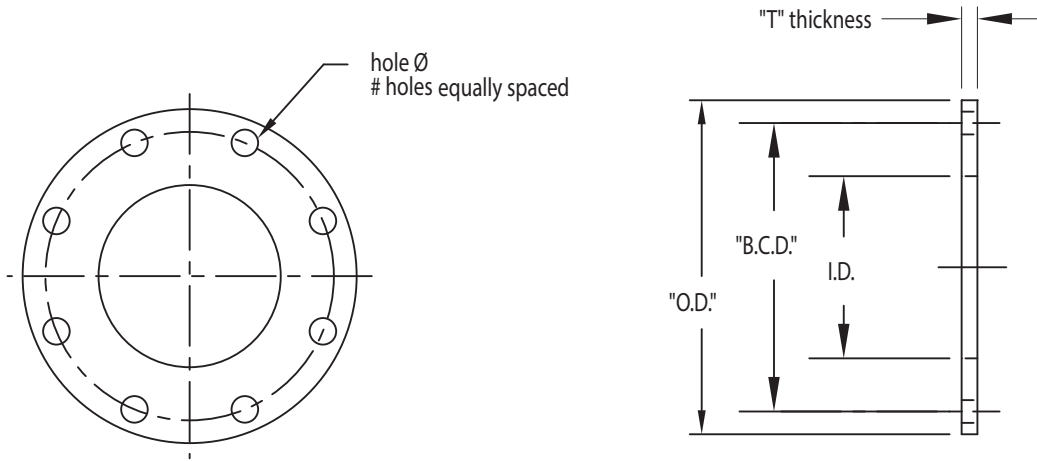
Thickness is suitable for 150 psi

Material: ASTM A-105, CSA G40.21 44W or Ductile Iron (Add 0.06 to thickness if Ductile Iron)

Note: See notes pages 5 & 6 for requirements for flange back-face when using full face flanges with backing ring

Fitting and Dimensions

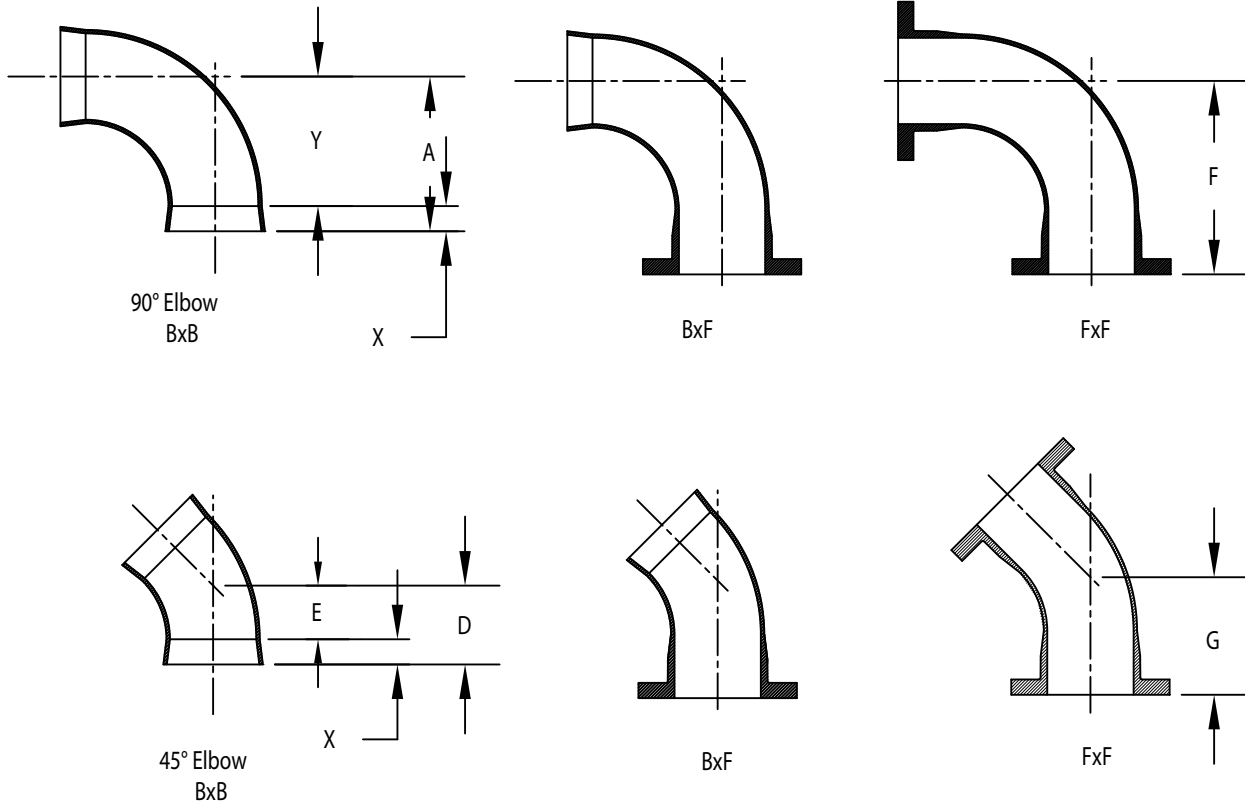
FLANGE GASKET



Pipe Dia	I.D.	O.D.	B.C.D.	# holes	hole Ø	T
1"	1.25"	4.25	3.125	4	0.625	0.125
1 1/2"	1.75	5.00	3.875	4	0.625	0.125
2"	2.25	6.00	4.75	4	0.75	0.125
3"	3.25	7.50	6.00	4	0.75	0.125
4"	4.25	9.00	7.50	8	0.75	0.125
5"	5.25	10.00	8.50	8	0.875	0.125
6"	6.25	11.00	9.50	8	0.875	0.125
8"	8.25	13.50	11.75	8	0.875	0.188
10"	10.25	16.00	14.25	12	1.000	0.188
12"	12.25	19.00	17.00	12	1.000	0.188
14"	14.25	21.00	18.75	12	1.125	0.188
16"	16.50	23.50	21.25	16	1.125	0.188
18"	18.25	25.00	22.75	16	1.250	0.188
20"	20.50	27.50	25.00	20	1.250	0.250
24"	24.25	32.00	29.50	20	1.375	0.250
30"	29.75	38.75	36.00	28	1.375	0.250
36"	35.75	46.00	42.75	32	1.625	0.250
42"	42.25	53.00	49.50	36	1.625	0.250
48"	48.50	59.50	56.00	44	1.625	0.250
54"	54.25	66.25	62.75	44	1.875	0.250
60"	60.25	73.00	69.25	52	1.875	0.250

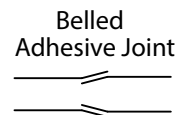
Fitting and Dimensions

BELLED ELBOWS



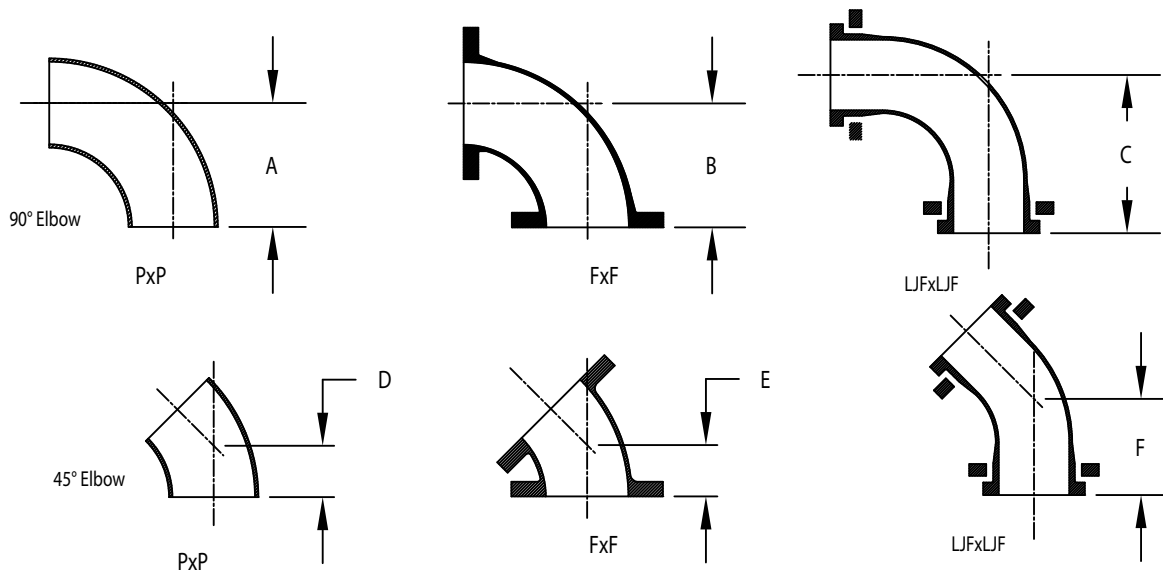
Pipe Dia	A	D	Y	E	X	F	G
2"	5 1/2"	2 3/4"	4 1/8"	1 3/8"	1 3/8"	7 7/16"	4 11/16"
3"	7 1/2"	3 1/2"	6 1/8"	2 1/8"	1 3/8"	9 9/16"	5 9/16"
4"	7 1/2"	3 3/8"	6 1/8"	2"	1 3/8"	9 11/16"	5 9/16"
5"	9 1/2"	4 15/16"	7 3/4"	3 3/16"	1 3/4"	12 1/8"	7 13/16"
6"	10 3/4"	5"	9"	3 1/4"	1 3/4"	13 7/16"	7 11/16"
8"	16"	9"	12 7/16"	5 7/16"	3 9/16"	20 3/4"	13 3/4"
10"	19 1/2"	10 3/4"	15 3/8"	6 5/8"	4 1/8"	25"	16 1/4"
12"	23 1/4"	12 3/4"	18 3/8"	7 7/8"	4 7/8"	29 1/2"	19"

Dimensions also apply to lap joint flanged elbows
Refer to Page 12 for 1" and 1 1/2" elbows



Fitting and Dimensions

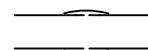
PLAIN END ELBOWS



Pipe Dia	A	B	C	D	E	F
1"	4"	4"	4"	4"	4"	4"
1 1/2"	4"	4"	4"	4"	4"	4"
2"	4"	4 7/8"	5 9/16"	1 5/8"	2 1/2"	3 3/16"
3"	6"	6 7/8"	7 3/4"	2 1/2"	3 3/8"	4 1/4"
4"	6"	6 15/16"	7 13/16"	2 1/2"	3 7/16"	4 5/16"
5"	7 1/2"	8 9/16"	9 7/16"	2 15/16"	4"	4 7/8"
6"	9"	10 1/16"	11"	3 3/4"	4 13/16"	5 3/4"
8"	12"	13 1/4"	14 5/16"	5"	6 1/4"	7 5/16"
10"	15"	16 7/16"	17 9/16"	6 1/4"	7 11/16"	8 13/16"
12"	18"	19 3/4"	20 15/16"	7 1/2"	9 1/4"	10 7/16"
14"	21"	22 7/8"	24 3/16"	8 3/4"	10 5/8"	11 15/16"
16"	24"	26 1/4"	27 5/8"	10"	12 1/4"	13 5/8"
18"	27"	29 1/4"	30 3/4"	11 1/4"	13 1/2"	15"
20"	30"	32 3/8"	34"	12 1/2"	14 7/8"	16 1/2"
24"	36"	38 3/4"	40 9/16"	15"	17 3/4"	19 9/16"
30"	44 5/16"	47 7/16"	50 5/16"	18 3/8"	21 1/2"	24 3/8"
36"	53 1/8"	56 3/4"	60 1/4"	22"	25 5/8"	29 1/8"
42"	63"	67 1/8"	70 7/8"	26"	30 1/8"	33 7/8"
48"	72"	76 5/8"	80 13/16"	30"	34 5/8"	38 13/16"
54"	81"	86 1/16"	90 3/4"	33 9/16"	38 5/8"	43 5/16"
60"	90"	95 5/8"	100 3/4"	37 1/4"	42 7/8"	48"

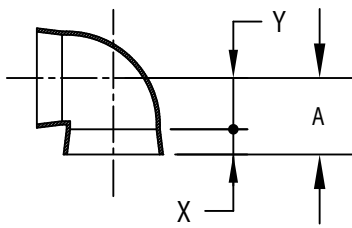
1" & 1 1/2" elbows do not have an inside radius
 Combinations of plain and flanged ends available as required

Butt Joint

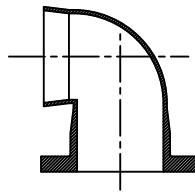


Fitting and Dimensions

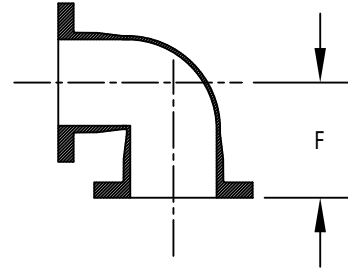
BELLED SHORT RADIUS ELBOWS



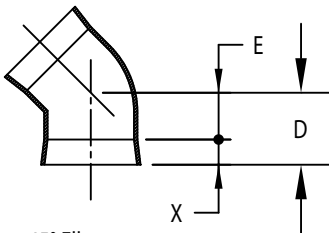
90° Elbow
BxB



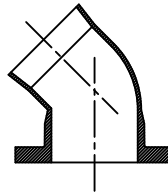
BxF



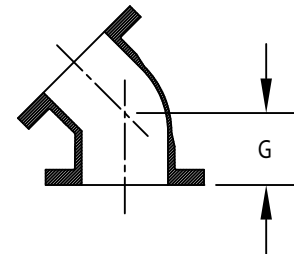
FxF



45° Elbow
BxB



BxF

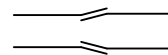


FxF

Pipe Dia	A	D	Y	E	X	F	G
1"	2 1/4"	2"	7/8"	5/8"	1 3/8"	4"	3 3/4"
1 1/2"	2 5/8"	2 1/4"	1 1/4"	7/8"	1 3/8"	4 1/2"	4 1/8"
2"	2 9/16"	2 3/4"	1 3/16"	1 3/8"	1 3/8"	4 1/2"	4 11/16"
3"	3 7/16"	3 1/2"	2 1/16"	2 1/8"	1 3/8"	5 1/2"	3"
4"	4 5/16"	3 3/8"	2 15/16"	2"	1 3/8"	6 1/2"	4"
6"	5 5/16"	5"	3 9/16"	3 1/4"	1 3/4"	8"	5"

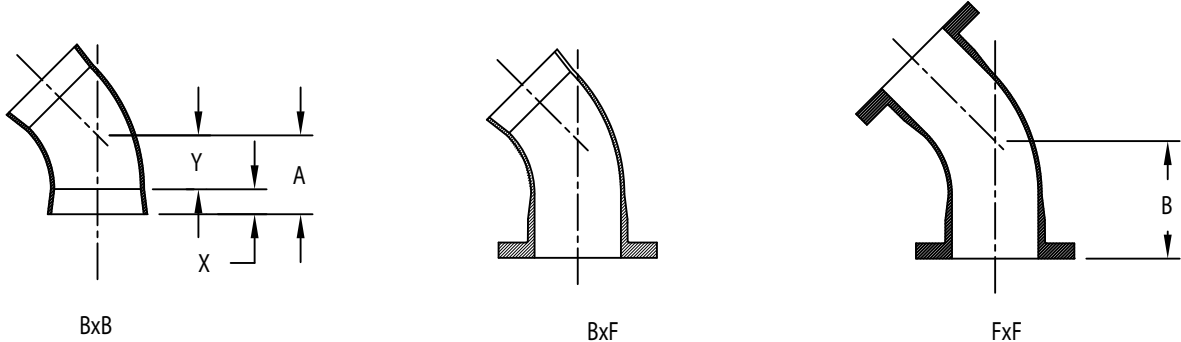
- Elbows do not have an inside radius
- Short radius elbows not recommended for slurry service
- Short radius belled elbows are not available for field installation
- Lap joint flanged elbows are not available

Belled
Adhesive Joint



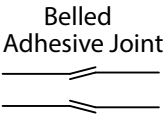
Fitting and Dimensions

BELLED 30° & 60° ELBOWS



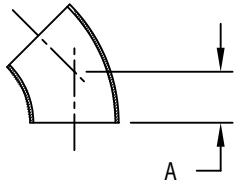
Pipe Dia	Angle	'A'	'B'	'X'	'Y'
1"	30°	4"	4"	1 3/8"	2 5/8"
	60°	4"	4"	1 3/8"	2 5/8"
1 1/2"	30°	4"	4"	1 3/8"	2 5/8"
	60°	4"	4"	1 3/8"	2 5/8"
2"	30°	2 9/16"	4 1/2"	1 3/8"	1 3/16"
	60°	3 13/16"	5 3/4"	1 3/8"	2 7/16"
3"	30°	3 1/8"	5 3/16"	1 3/8"	1 3/4"
	60°	5"	7"	1 3/8"	3 5/8"
4"	30°	3 1/8"	5 5/16"	1 3/8"	1 3/4"
	60°	5"	7 3/16"	1 3/8"	3 5/8"
5"	30°	3 13/16"	6 7/16"	1 3/4"	2 1/16"
	60°	6 3/16"	8 13/16"	1 3/4"	4 7/16"
6"	30°	4 3/16"	6 7/8"	1 3/4"	2 7/16"
	60°	6 15/16"	9 5/8"	1 3/4"	5 3/16"
8"	30°	7 3/16"	11 15/16"	3 9/16"	3 5/8"
	60°	10 15/16"	15 11/16"	3 9/16"	7 3/8"
10"	30°	8 1/2"	14"	4 1/8"	4 3/8"
	60°	13 3/16"	18 11/16"	4 1/8"	9 1/16"
12"	30°	10 1/16"	16 5/16"	4 7/8"	5 3/16"
	60°	15 5/8"	21 7/8"	4 7/8"	10 3/4"

1" & 1 1/2" elbows do not have an inside radius
 Dimensions also apply to lap joint flanged elbows

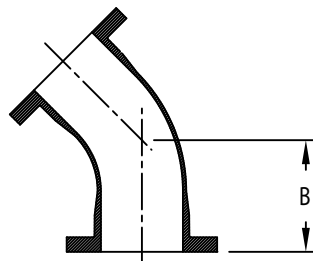


Fitting and Dimensions

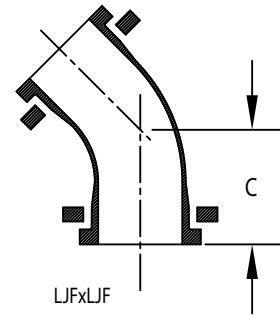
PLAIN END 30° & 60° ELBOWS



PxP



FxF



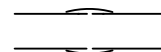
LJF x LJF

Pipe Dia	Angle	'A'	'B'	'C'
1"	30°	4"	4"	4"
	60°	4"	4"	4"
1 1/2"	30°	4"	4"	4"
	60°	4"	4"	4"
2"	30°	1 1/16"	1 15/16"	2 5/8"
	60°	2 5/16"	3 3/16"	3 7/8"
3"	30°	1 5/8"	2 1/2"	3 3/8"
	60°	3 7/16"	4 5/16"	5 3/16"
4"	30°	1 5/8"	2 9/16"	3 7/16"
	60°	3 7/16"	4 3/8"	5 1/4"
5"	30°	2"	3 1/16"	3 15/16"
	60°	4 5/16"	5 3/8"	6 1/4"
6"	30°	2 7/16"	3 1/2"	4 7/16"
	60°	5 3/16"	6 1/4"	7 3/16"
8"	30°	3 1/4"	4 1/2"	5 9/16"
	60°	6 15/16"	8 3/16"	9 1/4"
10"	30°	4"	5 7/16"	6 9/16"
	60°	8 11/16"	10 1/8"	11 1/4"
12"	30°	4 13/16"	6 9/16"	7 3/4"
	60°	10 3/8"	12 1/8"	13 5/16"

Pipe Dia	Angle	'A'	'B'	'C'
14"	30°	5 5/8"	7 1/2"	8 13/16"
	60°	12 1/8"	14"	15 5/16"
16"	30°	6 7/16"	8 11/16"	10 1/16"
	60°	13 7/8"	16 1/8"	17 1/2"
18"	30°	7 1/4"	9 1/2"	11"
	60°	15 9/16"	17 13/16"	19 5/16"
20"	30°	8 1/16"	10 7/16"	12 1/16"
	60°	17 5/16"	19 11/16"	21 5/16"
24"	30°	9 5/8"	12 3/8"	14 3/16"
	60°	20 13/16"	23 9/16"	25 3/8"
30"	30°	11 7/8"	15"	17 7/8"
	60°	25 9/16"	28 11/16"	31 9/16"
36"	30°	14 1/4"	17 7/8"	21 3/8"
	60°	30 11/16"	34 5/16"	37 13/16"
42"	30°	16 7/8"	21"	24 3/4"
	60°	36 3/8"	40 1/2"	44 1/4"
48"	30°	19 5/16"	23 15/16"	28 1/8"
	60°	41 9/16"	46 3/16"	50 3/8"
54"	30°	21 11/16"	26 3/4"	31 7/16"
	60°	46 3/4"	51 13/16"	56 1/2"
60"	30°	24 1/8"	29 3/4"	34 7/8"
	60°	51 15/16"	57 9/16"	62 11/16"

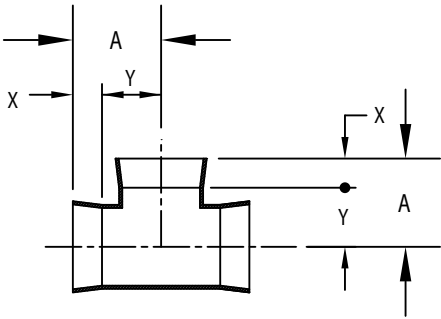
1" & 1 1/2" elbows do not have an inside radius.
Combinations of plain and flanged ends available as required.

Butt Joint

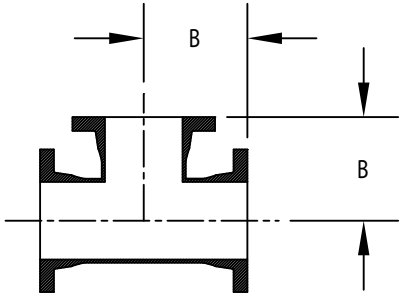


Fitting and Dimensions

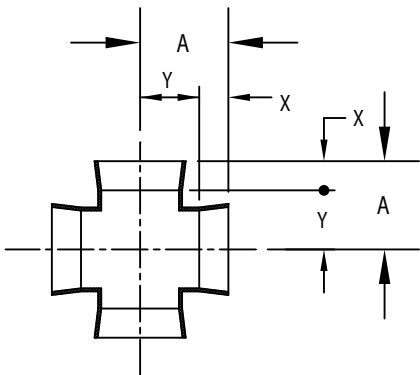
BELLED TEES & CROSSES



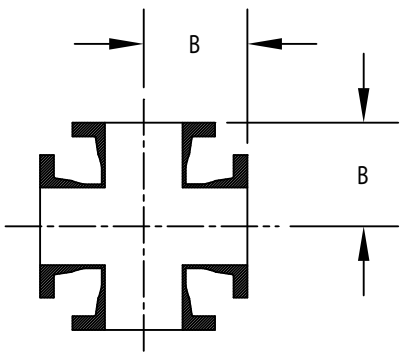
Tee BxBxB



FxFxF



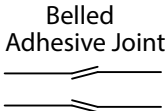
Cross BxBxBxB



FxFxFxF

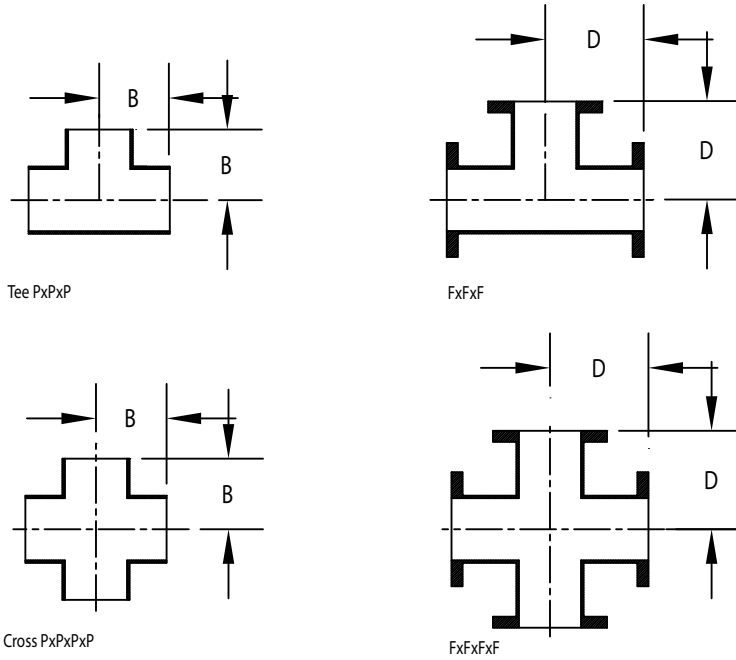
Pipe Dia	A	B	Y	X
1"	2 1/4"	4"	7/8"	1 3/8"
1 1/2"	2 5/8"	4 1/2"	1 1/4"	1 3/8"
2"	2 9/16"	4 1/2"	1 3/16"	1 3/8"
3"	3 7/16"	5 1/2"	2 1/16"	1 3/8"
4"	4 5/16"	6 1/2"	2 15/16"	1 3/8"
5"	6 9/16"	9 3/16"	4 13/16"	1 3/4"
6"	6 13/16"	9 1/2"	5 1/16"	1 3/4"
8"	10"	14 3/4"	6 7/16"	3 9/16"
10"	11 3/4"	17 1/4"	7 5/8"	4 1/8"
12"	13 3/4"	20"	8 7/8"	4 7/8"

Dimensions also apply to lap joint flanged tees & crosses
 Combinations of belled ends & flanged ends available as required



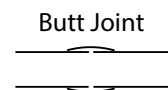
Fitting and Dimensions

PLAIN END TEES & CROSSES



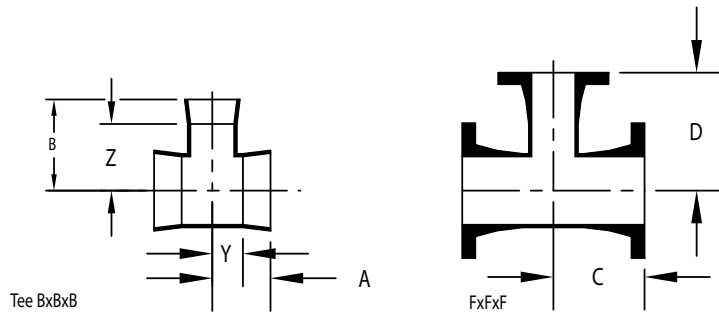
Pipe Dia	B	D
1"	6"	6"
1 1/2"	6"	6"
2"	6"	6"
3"	7"	7"
4"	8"	8"
5"	10"	10"
6"	10"	10"
8"	12"	12"
10"	14"	14"
12"	16"	16"
14"	18"	18 5/16"
16"	20"	20 7/8"
18"	21"	22 5/8"
20"	22"	25"
24"	24"	29 1/8"
30"	30"	36 1/4"
36"	36"	42 1/2"
42"	40"	46 7/8"
48"	46"	56 1/2"
54"	52"	65 3/8"
60"	56"	74 1/4"

Dimensions also apply to lap joint flanged tees & crosses
 Combinations of plain ends & flanged ends available as required



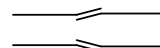
Fitting and Dimensions

BELLED REDUCING TEES* (MOLDED) AND REDUCING BRANCHES* (MOLDED)



Pipe Dia	A	B	C	D	Y	Z
1 1/2" x 1 1/2" x 1"	2 5/8"	4 1/8"	4 1/2"	5 7/8"	1 1/4"	2 3/4"
2" x 2" x 1 1/2"	2 9/16"	4 3/8"	4 1/2"	6 1/4"	1 3/16"	3"
2" x 2" x 1"	2 9/16"	4 3/8"	4 1/2"	6 1/8"	1 3/16"	3"
3" x 3" x 2"	3 7/16"	4 7/8"	5 1/2"	6 13/16"	2 1/16"	3 1/2"
3" x 3" x 1 1/2"	3 7/16"	4 7/8"	5 1/2"	6 3/4"	2 1/16"	3 1/2"
3" x 3" x 1"	3 7/16"	4 7/8"	5 1/2"	6 5/8"	2 1/16"	3 1/2"
4" x 4" x 3"	4 5/16"	5 7/8"	6 1/2"	7 15/16"	2 15/16"	4 1/2"
4" x 4" x 2"	4 5/16"	5 3/8"	6 1/2"	7 5/16"	2 15/16"	4"
4" x 4" x 1 1/2"	4 5/16"	5 3/8"	6 1/2"	7 1/4"	2 15/16"	4"
4" x 4" x 1"	4 5/16"	5 3/8"	6 1/2"	7 1/8"	2 15/16"	4"
5" x 5" x 4"	6 9/16"	6 3/8"	9 3/16"	8 9/16"	4 13/16"	5"
5" x 5" x 3"	6 9/16"	6 3/8"	9 3/16"	8 7/16"	4 13/16"	5"
5" x 5" x 2"	6 9/16"	6"	9 3/16"	7 15/16"	4 13/16"	4 5/8"
5" x 5" x 1 1/2"	6 9/16"	6"	9 3/16"	7 7/8"	4 13/16"	4 5/8"
5" x 5" x 1"	6 9/16"	5 7/8"	9 3/16"	7 5/8"	4 13/16"	4 1/2"
6" x 6" x 4"	6 13/16"	6 7/8"	9 1/2"	9 1/16"	5 1/16"	5 1/2"
6" x 6" x 3"	6 13/16"	6 7/8"	9 1/2"	8 15/16"	5 1/16"	5 1/2"
6" x 6" x 2"	6 13/16"	6 3/8"	9 1/2"	8 5/16"	5 1/16"	5"
6" x 6" x 1 1/2"	6 13/16"	6 3/8"	9 1/2"	8 1/4"	5 1/16"	5"
6" x 6" x 1"	6 13/16"	6 3/8"	9 1/2"	8 1/8"	5 1/16"	5"
8" x 8" x 6"	10"	7 13/16"	14 3/4"	10 1/2"	6 7/16"	6 1/16"
8" x 8" x 4"	10"	7 13/16"	14 3/4"	10"	6 7/16"	6 7/16"
8" x 8" x 3"	10"	7 7/8"	14 3/4"	9 15/16"	6 7/16"	6 1/2"
8" x 8" x 2"	10"	7 5/8"	14 3/4"	9 9/16"	6 7/16"	6 1/4"
8" x 8" x 1 1/2"	10"	7 9/16"	14 3/4"	9 7/16"	6 7/16"	6 3/16"
8" x 8" x 1"	10"	7 7/16"	14 3/4"	9 3/16"	6 7/16"	6 1/16"
10" x 10" x 8"	11 3/4"	9 3/4"	17 1/4"	14 1/2"	7 5/8"	6 3/16"
10" x 10" x 6"	11 3/4"	9 3/4"	17 1/4"	12 7/16"	7 5/8"	8"
10" x 10" x 4"	11 3/4"	8 7/8"	17 1/4"	11 1/16"	7 5/8"	7 1/2"
10" x 10" x 3"	11 3/4"	8 7/8"	17 1/4"	10 15/16"	7 5/8"	7 1/2"
10" x 10" x 2"	11 3/4"	8 5/8"	17 1/4"	10 9/16"	7 5/8"	8 1/4"
10" x 10" x 1 1/2"	11 3/4"	8 9/16"	17 1/4"	10 7/16"	7 5/8"	8 3/16"
10" x 10" x 1"	11 3/4"	8 3/8"	17 1/4"	10 1/8"	7 5/8"	7"
12" x 12" x 10"	13 3/4"	13 3/4"	20"	19 1/4"	8 7/8"	9 5/8"
12" x 12" x 8"	13 3/4"	11 3/4"	20"	16 1/2"	8 7/8"	8 3/16"
12" x 12" x 6"	13 3/4"	10 3/4"	20"	13 7/16"	8 7/8"	9"
12" x 12" x 4"	13 3/4"	9 7/8"	20"	12 1/16"	8 7/8"	8 1/2"
12" x 12" x 3"	13 3/4"	9 7/8"	20"	11 15/16"	8 7/8"	8 1/2"
12" x 12" x 2"	13 3/4"	9 11/16"	20"	11 5/8"	8 7/8"	8 5/16"
12" x 12" x 1 1/2"	13 3/4"	9 5/8"	20"	11 1/2"	8 7/8"	8 1/4"
12" x 12" x 1"	13 3/4"	9 1/2"	20"	11 1/4"	8 7/8"	8 1/8"

Belled
Adhesive Joint



Dimensions also apply lap joint flanged tees

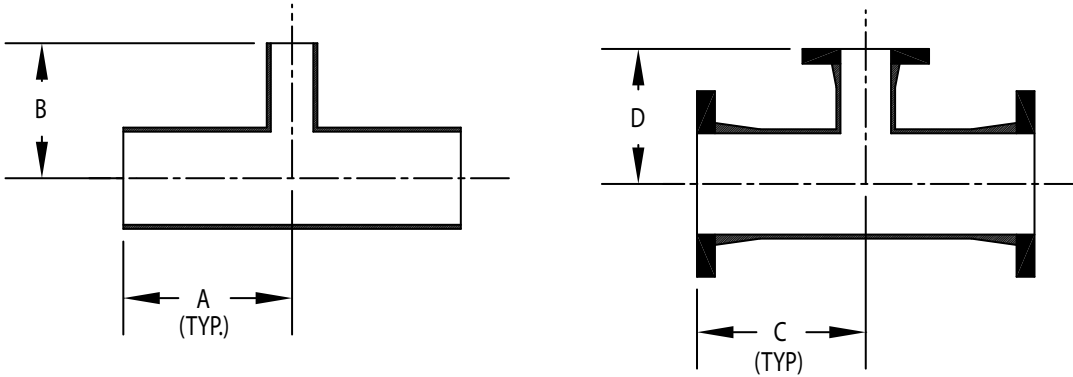
Combinations of belled ends & flanged ends available as required

*Reducing Tee = Ratio of branch diameter to run pipe diameter ≥ 0.66

Reducing Branch = Ratio of branch diameter to run pipe diameter < 0.66

Fitting and Dimensions

PLAIN END REDUCING TEE* (FABRICATED)



Reducing Tee PxPxP

FxFxF

Pipe Dia	A	B	C	D
1 1/2"x1 1/2"x1"	6"	6"	6"	6"
2"x2"x1 1/2"	6"	6"	6"	6"
3"x3"x2"	7"	6"	7"	6"
4"x4"x3"	8"	7"	8"	7"
6"x6"x4"	10"	8"	10"	8"
8"x8"x6"	12"	10"	12"	10"
10"x10"x8"	14"	12"	14"	12"
12"x12"x10"	16"	15"	16"	15"
12"x12"x8"	16"	13"	16"	13"

Dimensions also apply to lap joint flanged tees

Combinations of plain ends & flanged ends available as required

Refer to Page 19 for Reducing Branches

*Reducing Tee = Ratio of branch diameter to run pipe diameter ≥ 0.66

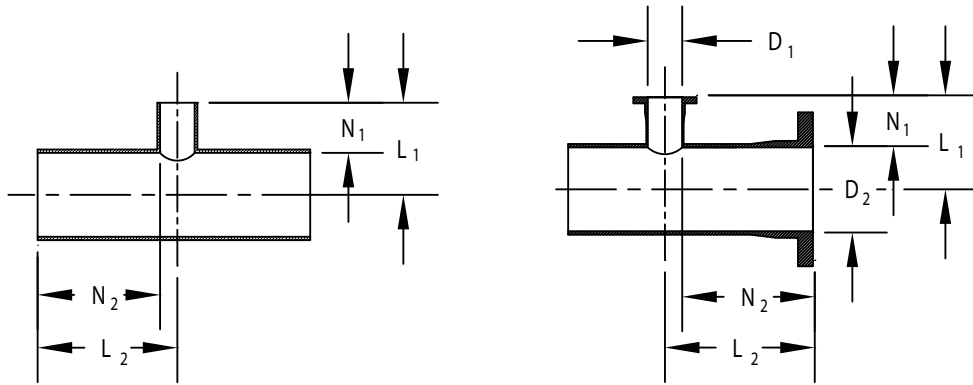
Reducing Branch = Ratio of branch diameter to run pipe diameter < 0.66

Butt Joint



Fitting and Dimensions

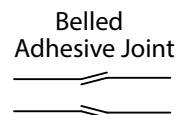
STANDARD LENGTH FOR FABRICATED REDUCING BRANCHES (STUB-IN BRANCHES)



To calculate L_1
 Read nozzle length N_1 for nozzle inside diameter D_1
 then $L_1 = N_1 + 0.5 D_2$
 Read mainline length N_2 for mainline inside diameter D_2
 The same procedure is used for calculating L_2
 $L_2 = N_2 + 0.5 D_1$

Inside Diameter	Nozzle Length
D	N
1"	5"
1 1/2"	5"
2"	5"
3"	5 1/2"
4"	6"
5"	7 1/2"
6"	7 1/2"
8"	9"
10"	10 1/2"
12"	12"
14"	15"
16"	16"
18"	16 1/2"
20"	18"
24"	21"
30"	24 1/2"
36"	28 1/2"
40"	32"
42"	33 1/2"
48"	38"
54"	42 1/2"
60"	47"

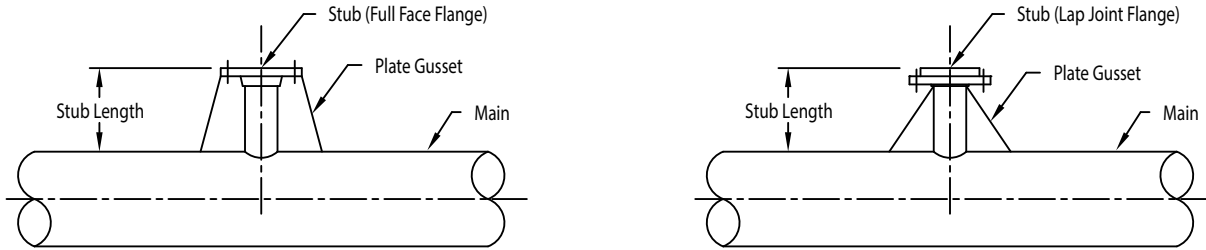
* Add 2" to N when stub-in is on a thick laminate.



Applies to belled, plain & flanged ends
 For a Lap Joint end, add backing ring thickness, per Page 8

Fitting and Dimensions

GUSSETS



Standard gussets are supplied only for Flanged stubs as defined in the following table:

		Main Diameter																				
		1"	1 1/2"	2"	3"	4"	5"	6"	8"	10"	12"	≥ 14"										
Branch Diameter	1"	Gussets Required																				
	1 1/2"																					
2"																						
3"																						
4"																						
5"																						
6"	Gussets not Required																					
≥ 8"																						

Note: Standard gussets are not supplied for stubs exceeding the lengths stated below. Stubs in excess of these lengths should be supported independently.

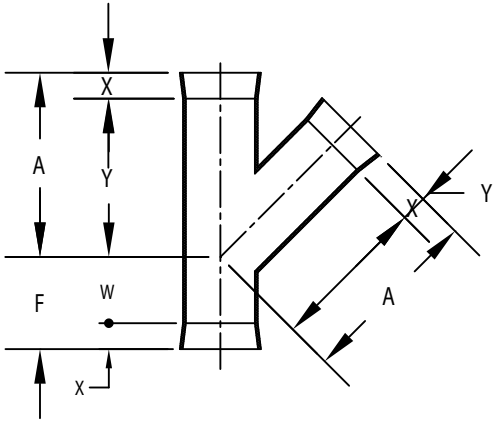
Molded reducing branches do not have gussets.

Stub-in branches with gussets are recommended for instrument branches.

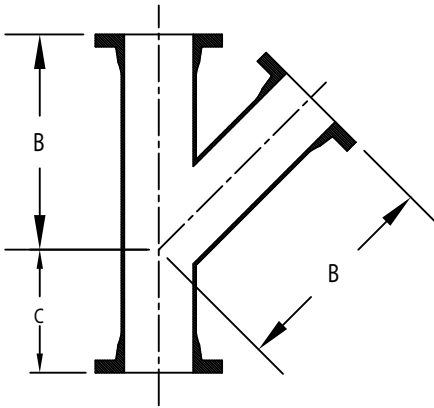
Stub Diameter	1"	1 1/2"	2"	3"	4"	5"	6"
Stub Length	6"	6"	6"	6 1/2"	7"	8 1/2"	8 1/2"

Fitting and Dimensions

BELLED LATERALS



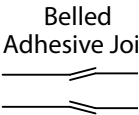
Lateral BxBxB



FxFxF

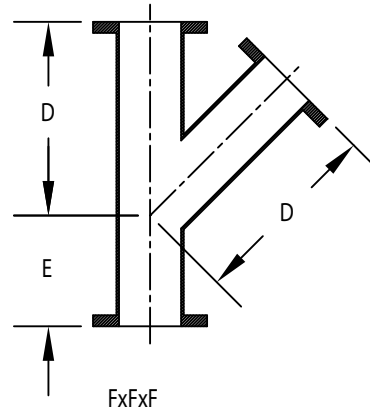
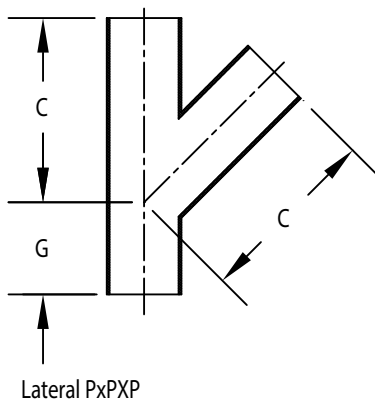
Pipe Dia	A	F	B	C	Y	W	X
1"	10"	6"	11 7/8"	7 7/8"	8 5/8"	4 5/8"	1 3/8"
1 1/2"	10"	6"	11 7/8"	7 7/8"	8 5/8"	4 5/8"	1 3/8"
2"	10"	6"	11 15/16"	7 15/16"	8 5/8"	4 5/8"	1 3/8"
3"	12"	6"	14 1/16"	8 1/16"	10 5/8"	4 5/8"	1 3/8"
4"	14"	6"	16 3/16"	8 3/16"	12 5/8"	4 5/8"	1 3/8"
5"	16"	8"	18 5/8"	10 5/8"	14 1/4"	6 1/4"	1 3/4"
6"	16"	8"	18 11/16"	10 11/16"	14 1/4"	6 1/4"	1 3/4"
8"	20"	10"	24 3/4"	14 3/4"	16 7/16"	6 7/16"	3 9/16"
10"	24"	10"	29 1/2"	15 1/2"	19 7/8"	5 7/8"	4 1/8"
12"	26"	12"	32 1/4"	18 1/4"	21 1/8"	7 1/8"	4 7/8"

Dimensions also apply to lap joint flanged laterals
 Combinations of belled ends & flanged ends available as required



Fitting and Dimensions

PLAIN END LATERALS



Pipe Dia	C	G	D	E
1"	10"	6"	10"	6"
1 1/2"	10"	6"	10"	6"
2"	10"	6"	10"	6"
3"	12"	6"	12"	6"
4"	14"	6"	14"	6"
5"	16"	8"	16"	8"
6"	16"	8"	16"	8"
8"	20"	10"	20"	10"
10"	24"	10"	24"	10"
12"	26"	12"	26"	12"
14"	30"	12"	30"	12"
16"	32"	14"	32"	14"
18"	36"	14"	36"	14"
20"	38"	16"	38"	16"
24"	42"	18"	42"	18"
30"	52"	20"	52"	20"
36"	62"	22"	62"	22"
42"	72"	24"	72"	24"
48"	82"	26"	82"	26"
54"	96"	30"	96"	30"
60"	114"	36"	114"	36"

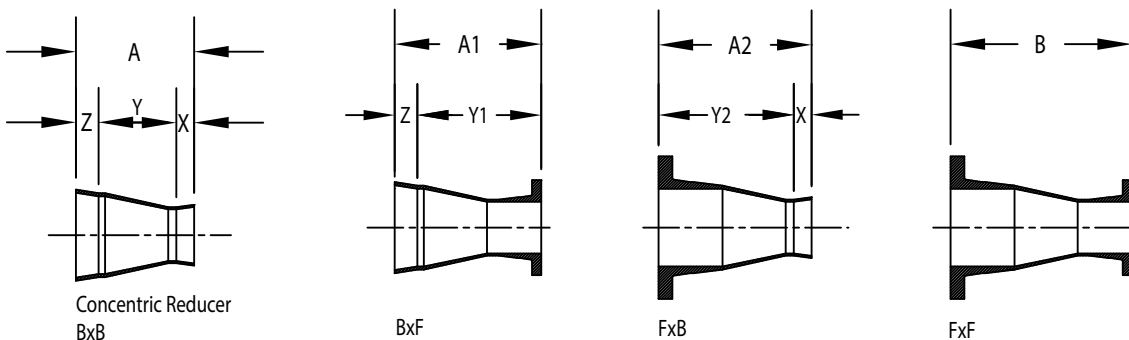
Dimensions also apply to lap joint flanged laterals
 Combinations of plain ends & flanged ends available as required

Butt Joint



Fitting and Dimensions

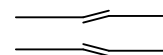
BELLED CONCENTRIC REDUCERS



Pipe Dia	A	A1	A2	B	Y	Y1	Y2	Z	X
1 1/2"x1"	4 3/4"	6 1/2"	6 5/8"	8 3/8"	2"	5 1/8"	5 1/4"	1 3/8"	1 3/8"
2"x1"	6"	7 3/4"	7 15/16"	9 11/16"	3 1/4"	6 3/8"	6 9/16"	1 3/8"	1 3/8"
2"x1 1/2"	5"	6 7/8"	6 15/16"	8 13/16"	2 1/4"	5 1/2"	5 9/16"	1 3/8"	1 3/8"
3"x1"	8 5/8"	10 3/8"	10 11/16"	12 7/16"	5 7/8"	9"	9 5/16"	1 3/8"	1 3/8"
3"x1 1/2"	7 1/2"	9 3/8"	9 9/16"	11 7/16"	4 3/4"	8"	8 3/16"	1 3/8"	1 3/8"
3"x2"	6 1/4"	8 3/16"	8 5/16"	10 1/4"	3 1/2"	6 13/16"	6 15/16"	1 3/8"	1 3/8"
4"x1"	11 1/4"	13"	13 7/16"	15 3/16"	8 1/2"	11 5/8"	12 1/16"	1 3/8"	1 3/8"
4"x1 1/2"	10"	11 7/8"	12 3/16"	14 1/16"	7 1/4"	10 1/2"	10 13/16"	1 3/8"	1 3/8"
4"x2"	8 3/4"	10 11/16"	10 15/16"	12 7/8"	6"	9 5/16"	9 9/16"	1 3/8"	1 3/8"
4"x3"	6 1/4"	8 5/16"	8 7/16"	10 1/2"	3 1/2"	6 15/16"	7 1/16"	1 3/8"	1 3/8"
5"x3"	9 1/8"	11 3/16"	11 3/4"	13 13/16"	6"	9 7/16"	10 3/8"	1 3/4"	1 3/8"
5"x4"	6 3/16"	8 3/8"	8 13/16"	11"	3 1/16"	6 5/8"	7 7/16"	1 3/4"	1 3/8"
6"x2"	14 1/8"	16 1/16"	16 13/16"	18 3/4"	11"	14 5/16"	15 7/16"	1 3/4"	1 3/8"
6"x3"	11 5/8"	13 11/16"	14 5/16"	16 3/8"	8 1/2"	11 15/16"	12 15/16"	1 3/4"	1 3/8"
6"x4"	9 1/8"	11 5/16"	11 13/16"	14"	6"	9 9/16"	10 7/16"	1 3/4"	1 3/8"
6"x5"	6 9/16"	9 3/16"	9 1/4"	11 7/8"	3 1/16"	7 7/16"	7 1/2"	1 3/4"	1 3/4"
8"x4"	17 1/2"	19 11/16"	22 1/4"	24 7/16"	12 9/16"	16 1/8"	20 7/8"	3 9/16"	1 3/8"
8"x5"	14 1/2"	17 1/8"	19 1/4"	21 7/8"	9 3/16"	13 9/16"	17 1/2"	3 9/16"	1 3/4"
8"x6"	12 7/8"	15 9/16"	17 5/8"	20 5/16"	7 9/16"	12"	15 7/8"	3 9/16"	1 3/4"
10"x6"	17 7/8"	20 9/16"	23 3/8"	26 1/16"	12"	16 7/16"	21 5/8"	4 1/8"	1 3/4"
10"x8"	15"	19 3/4"	20 1/2"	25 1/4"	7 5/16"	15 5/8"	16 15/16"	4 1/8"	3 9/16"
12"x8"	20"	24 3/4"	26 1/4"	31"	11 9/16"	19 7/8"	22 11/16"	4 7/8"	3 9/16"
12"x10"	15 1/2"	21"	21 3/4"	27 1/4"	6 1/2"	16 1/8"	17 5/8"	4 7/8"	4 1/8"

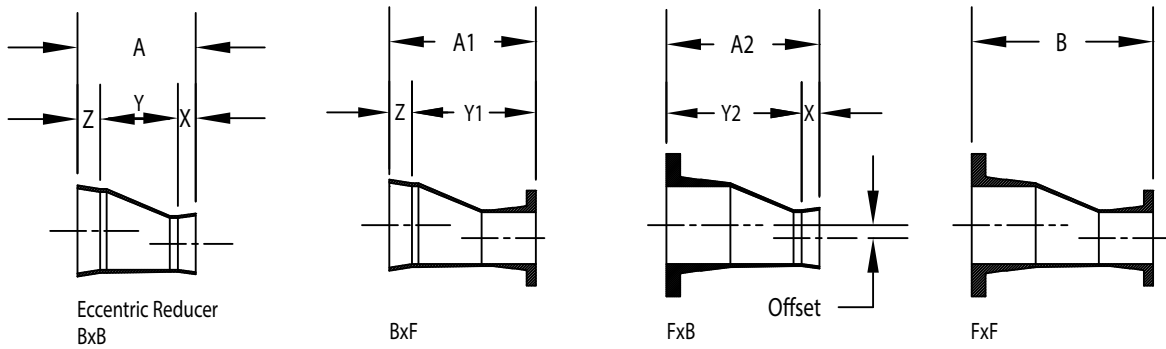
Reducing section length = 2.5 x (large dia - small dia)
 Dimensions also apply to lap joint flanged reducers
 Reducing angle = 11.3°

Belled
 Adhesive Joint



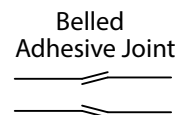
Fitting and Dimensions

BELLED ECCENTRIC REDUCERS



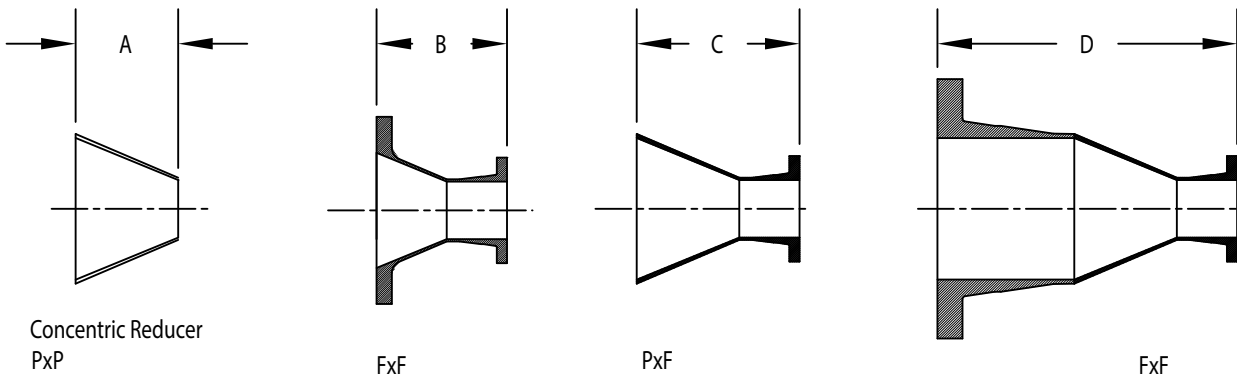
Pipe Dia	A	A1	A2	B	Y	Y1	Y2	Z	X	Offset
1 1/2"x1"	5"	6 3/4"	6 7/8"	8 5/8"	2 1/4"	5 3/8"	5 1/2"	1 3/8"	1 3/8"	1/4"
2"x1"	6"	7 3/4"	7 15/16"	9 11/16"	3 1/4"	6 3/8"	6 9/16"	1 3/8"	1 3/8"	1/2"
2"x1 1/2"	5"	6 7/8"	6 15/16"	8 13/16"	2 1/4"	5 1/2"	5 9/16"	1 3/8"	1 3/8"	1/4"
3"x1"	8 5/8"	10 3/8"	10 11/16"	12 7/16"	5 7/8"	9"	9 5/16"	1 3/8"	1 3/8"	1"
3"x1 1/2"	7 1/2"	9 3/8"	9 9/16"	11 7/16"	4 3/4"	8"	8 3/16"	1 3/8"	1 3/8"	3/4"
3"x2"	6 1/4"	8 3/16"	8 5/16"	10 1/4"	3 1/2"	6 13/16"	6 15/16"	1 3/8"	1 3/8"	1/2"
4"x1"	11 1/4"	13"	13 7/16"	15 3/16"	8 1/2"	11 5/8"	12 1/16"	1 3/8"	1 3/8"	1 1/2"
4"x1 1/2"	10"	11 7/8"	12 3/16"	14 1/16"	7 1/4"	10 1/2"	10 13/16"	1 3/8"	1 3/8"	1 1/4"
4"x2"	8 3/4"	10 11/16"	10 15/16"	12 7/8"	6"	9 5/16"	9 9/16"	1 3/8"	1 3/8"	1"
4"x3"	6 1/4"	8 5/16"	8 7/16"	10 1/2"	3 1/2"	6 15/16"	7 1/16"	1 3/8"	1 3/8"	1/2"
6"x2"	14 1/8"	16 1/16"	16 13/16"	18 3/4"	11"	14 5/16"	15 7/16"	1 3/4"	1 3/8"	2"
6"x3"	11 5/8"	13 11/16"	14 5/16"	16 3/8"	8 1/2"	11 15/16"	12 15/16"	1 3/4"	1 3/8"	1 1/2"
6"x4"	9 1/8"	11 5/16"	11 13/16"	14"	6"	9 9/16"	10 7/16"	1 3/4"	1 3/8"	1"
6"x5"	7"	9 5/8"	9 11/16"	12 5/16"	3 1/2"	7 7/8"	7 15/16"	1 3/4"	1 3/4"	1/2"
8"x4"	16 3/4"	18 15/16"	21 1/2"	23 11/16"	11 13/16"	15 3/8"	20 1/8"	3 9/16"	1 3/8"	2"
8"x5"	14 1/2"	17 1/8"	19 1/4"	21 7/8"	9 3/16"	13 9/16"	17 1/2"	3 9/16"	1 3/4"	1 1/2"
8"x6"	12"	14 11/16"	16 3/4"	19 7/16"	6 11/16"	11 1/8"	15"	3 9/16"	1 3/4"	1"
10"x6"	18"	20 11/16"	23 1/2"	26 3/16"	12 1/8"	16 9/16"	21 3/4"	4 1/8"	1 3/4"	2"
10"x8"	15 1/2"	20 1/4"	21"	25 3/4"	7 13/16"	16 1/8"	17 7/16"	4 1/8"	3 9/16"	1"
12"x8"	20 3/4"	25 1/2"	27"	31 3/4"	12 5/16"	20 5/8"	23 7/16"	4 7/8"	3 9/16"	2"
12"x10"	16 3/4"	22 1/4"	23"	28 1/2"	7 3/4"	17 3/8"	18 7/8"	4 7/8"	4 1/8"	1"

Reducing section length = 2.5 x (large dia - small dia)
 Dimensions also apply to lap joint flanged reducers
 Reducing angle = 21.8°



Fitting and Dimensions

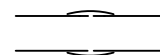
PLAIN END CONCENTRIC REDUCERS



Pipe Dia	A	B	C	D
1 1/2" x 1"	1 1/4"		7 1/4"	13 1/2"
2" x 1"	2 1/2"		9 1/2"	15 1/2"
2" x 1 1/2"	1 1/4"		7 1/4"	13 1/2"
3" x 1"	5"	11"	11"	17"
3" x 1 1/2"	3 3/4"	9 3/4"	9 3/4"	15 3/4"
3" x 2"	2 1/2"		8 1/2"	14 1/2"
4" x 1"	7 1/2"	13 1/2"	13 1/2"	19 1/2"
4" x 1 1/2"	6 1/4"	12 1/4"	12 1/4"	18 1/4"
4" x 2"	5"	11"	11"	17"
4" x 3"	2 1/2"		8 1/2"	14 1/2"
6" x 2"	10"	16"	16"	24"
6" x 3"	7 1/2"	13 1/2"	13 1/2"	21 1/2"
6" x 4"	5"	11"	11"	19"
6" x 5"	2 1/2"		10 1/2"	18 1/2"
8" x 4"	10"	16"	16"	24"
8" x 5"	7 1/2"	15 1/2"	15 1/2"	23 1/2"
8" x 6"	5"		13"	21"
10" x 6"	10"	18"	18"	25"
10" x 8"	5"		13"	23"
12" x 10"	5"		15"	25"

Pipe Dia	A	B	C	D
14"x10"	10"	20"	20"	32"
14"x12"	5"		15"	27"
16"x12"	10"	20"	20"	32"
16"x14"	5"		17"	29"
18"x14"	10"	22"	22"	36"
18"x16"	5"		17"	31"
20"x16"	10"	22"	22"	36"
20"x18"	5"		19"	33"
24"x18"	15"	29"	29"	45"
24"x20"	10"	24"	24"	40"
30"x20"	25"	39"	39"	59"
30"x24"	15"	31"	31"	51"
36"x24"	30"	46"	46"	68"
36"x30"	15"	35"	35"	57"

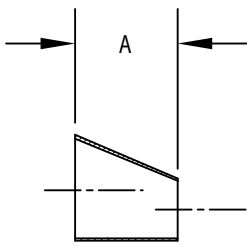
Butt Joint



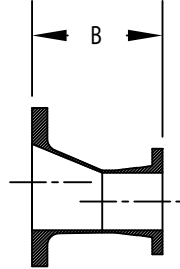
Reducing angle = 11.3°

Fitting and Dimensions

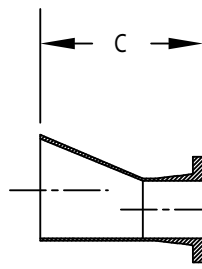
PLAIN END ECCENTRIC REDUCERS



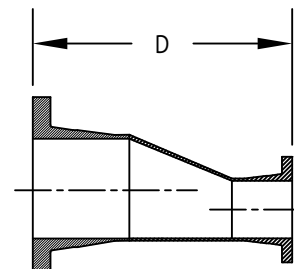
Eccentric Reducer
PxP



FxF



PxF



FxF

Pipe Dia	A	B	C	D
1 1/2" x 1"	1 1/4"		7 1/4"	13 1/2"
2" x 1"	2 1/2"		9 1/2"	15 1/2"
2" x 1 1/2"	1 1/4"		7 1/4"	13 1/2"
3" x 1"	5"	11"	11"	17"
3" x 1 1/2"	3 3/4"	9 3/4"	9 3/4"	15 3/4"
3" x 2"	2 1/2"		8 1/2"	14 1/2"
4" x 1"	7 1/2"	13 1/2"	13 1/2"	19 1/2"
4" x 1 1/2"	6 1/4"	12 1/4"	12 1/4"	18 1/4"
4" x 2"	5"	11"	11"	17"
4" x 3"	2 1/2"		8 1/2"	14 1/2"
6" x 2"	10"	16"	16"	24"
6" x 3"	7 1/2"	13 1/2"	13 1/2"	21 1/2"
6" x 4"	5"	11"	11"	19"
6" x 5"	2 1/2"		10 1/2"	18 1/2"
8" x 4"	10"	16"	16"	24"
8" x 5"	7 1/2"	15 1/2"	15 1/2"	23 1/2"
8" x 6"	5"		13"	21"
10" x 6"	10"	18"	18"	25"
10" x 8"	5"		13"	23"
12" x 10"	5"		15"	25"

Pipe Dia	A	B	C	D
14" x 10"	10"	20"	20"	32"
14" x 12"	5"		15"	27"
16" x 12"	10"	20"	20"	32"
16" x 14"	5"		17"	29"
18" x 14"	10"	22"	22"	36"
18" x 16"	5"		17"	31"
20" x 16"	10"	22"	22"	36"
20" x 18"	5"		19"	33"
24" x 18"	15"	29"	29"	45"
24" x 20"	10"	24"	24"	40"
30" x 20"	25"	39"	39"	59"
30" x 24"	15"	31"	31"	51"
36" x 24"	30"	46"	46"	68"
36" x 30"	15"	35"	35"	57"

Butt Joint

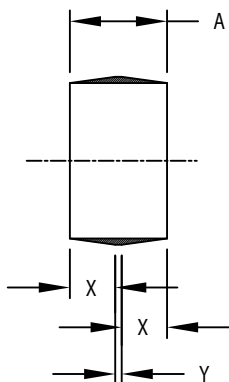


Reducing angle = 21.8°

Fitting and Dimensions

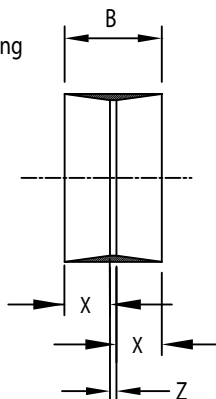
BELLED FITTINGS

Nipple



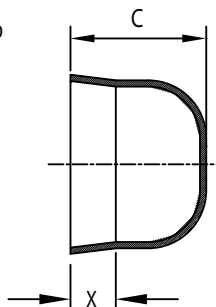
Pipe Dia	A	Y	X
1"	2 7/8"	1/8"	1 3/8"
1 1/2"	3"	1/4"	1 3/8"
2"	3"	1/4"	1 3/8"
3"	3"	1/4"	1 3/8"
4"	3"	1/4"	1 3/8"
5"	3 3/4"	1/4"	1 3/4"
6"	3 3/4"	1/4"	1 3/4"
8"	7 5/8"	1/2"	3 9/16"
10"	8 3/4"	1/2"	4 1/8"
12"	10 1/4"	1/2"	4 7/8"

Coupling



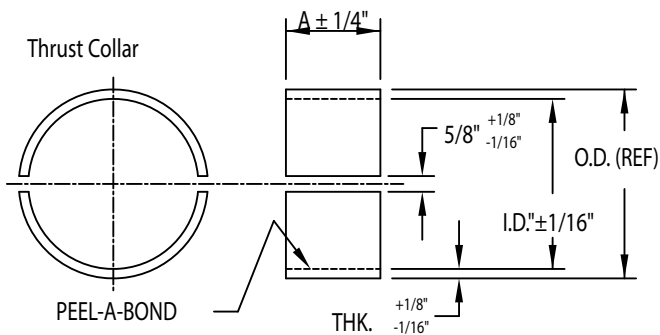
Pipe Dia	B	Z	X
1"	4"	1 1/4"	1 3/8"
1 1/2"	4"	1 1/4"	1 3/8"
2"	4"	1 1/4"	1 3/8"
3"	4"	1 1/4"	1 3/8"
4"	4"	1 1/4"	1 3/8"
5"	5"	1 1/2"	1 3/4"
6"	5"	1 1/2"	1 3/4"
8"	8 1/2"	1 3/8"	3 9/16"
10"	10"	1 3/4"	4 1/8"
12"	11"	1 1/4"	4 7/8"

End Cap



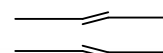
Pipe Dia	C	X
1"	2 1/16"	1 3/8"
1 1/2"	3"	1 3/8"
2"	4"	1 3/8"
3"	4"	1 3/8"
4"	4"	1 3/8"
5"	5"	1 3/4"
6"	5"	1 3/4"
8"	8"	3 9/16"
10"	10"	4 1/8"
12"	12"	4 7/8"

Thrust Collar



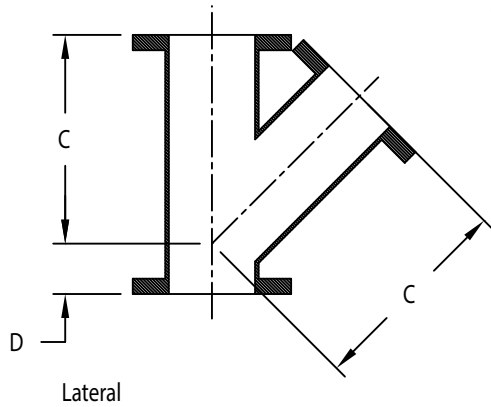
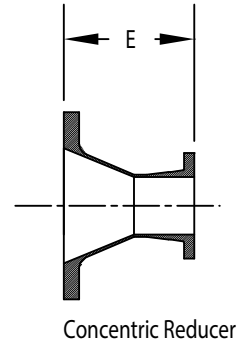
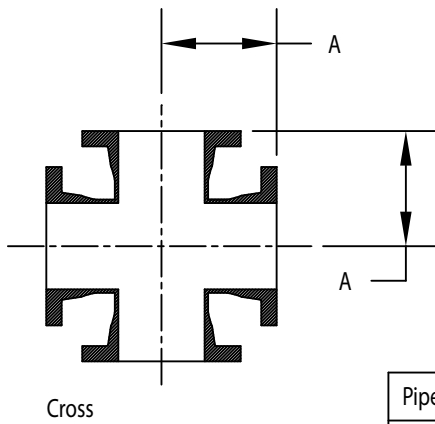
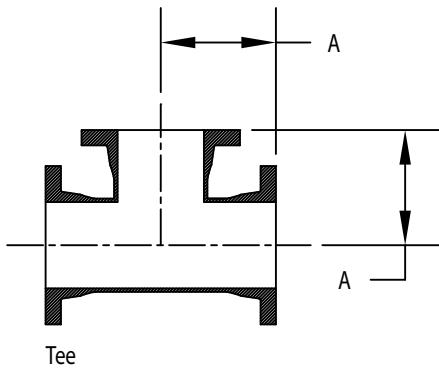
PIPE DIA.	DIM `A`	I.D.	O.D.(REF)	THK.
1"	3"	1 1/2"	2 1/8"	5/16"
1 1/2"	3"	2"	2 5/8"	5/16"
2"	3"	2 5/8"	3 1/4"	5/16"
3"	3"	3 5/8"	4 1/4"	5/16"
4"	3"	4 5/8"	5 1/4"	5/16"
5"	3 1/2"	5 11/16"	6 7/16"	3/8"
6"	3 1/2"	6 3/4"	7 1/2"	3/8"
8"	4"	8 13/16"	9 9/16"	3/8"
10"	5"	10 7/8"	11 3/4"	7/16"
12"	5 1/2"	13"	14"	1/2"

Belled Adhesive Joint



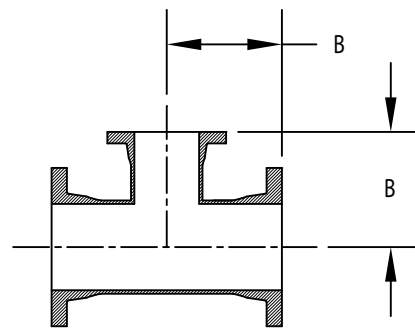
Fitting and Dimensions

ANSI TEE, REDUCING TEE, CROSS, LATERAL & CONCENTRIC REDUCERS



Pipe Dia	E	Pipe Dia	E
1 1/2" x 1"	5"	6" x 4"	9"
2" x 1 1/2"	5"	8" x 4"	11"
3" x 1 1/2"	6"	8" x 6"	11"
3" x 2"	6"	10" x 6"	12"
4" x 2"	7"	10" x 8"	12"
4" x 3"	7"	12" x 8"	14"
6" x 3"	9"	12" x 10"	14"

Pipe Dia	A	C	D
1"	3 1/2"	5 3/4"	1 3/4"
1 1/2"	4"	7"	2"
2"	4 1/2"	8"	2 1/2"
3"	5 1/2"	10"	3"
4"	6 1/2"	12"	3"
5"	7 1/2"	13 1/2"	3 1/2"
6"	8"	14 1/2"	3 1/2"
8"	9"	17 1/2"	4 1/2"
10"	11"	20 1/2"	5"
12"	12"	24 1/2"	5 1/2"



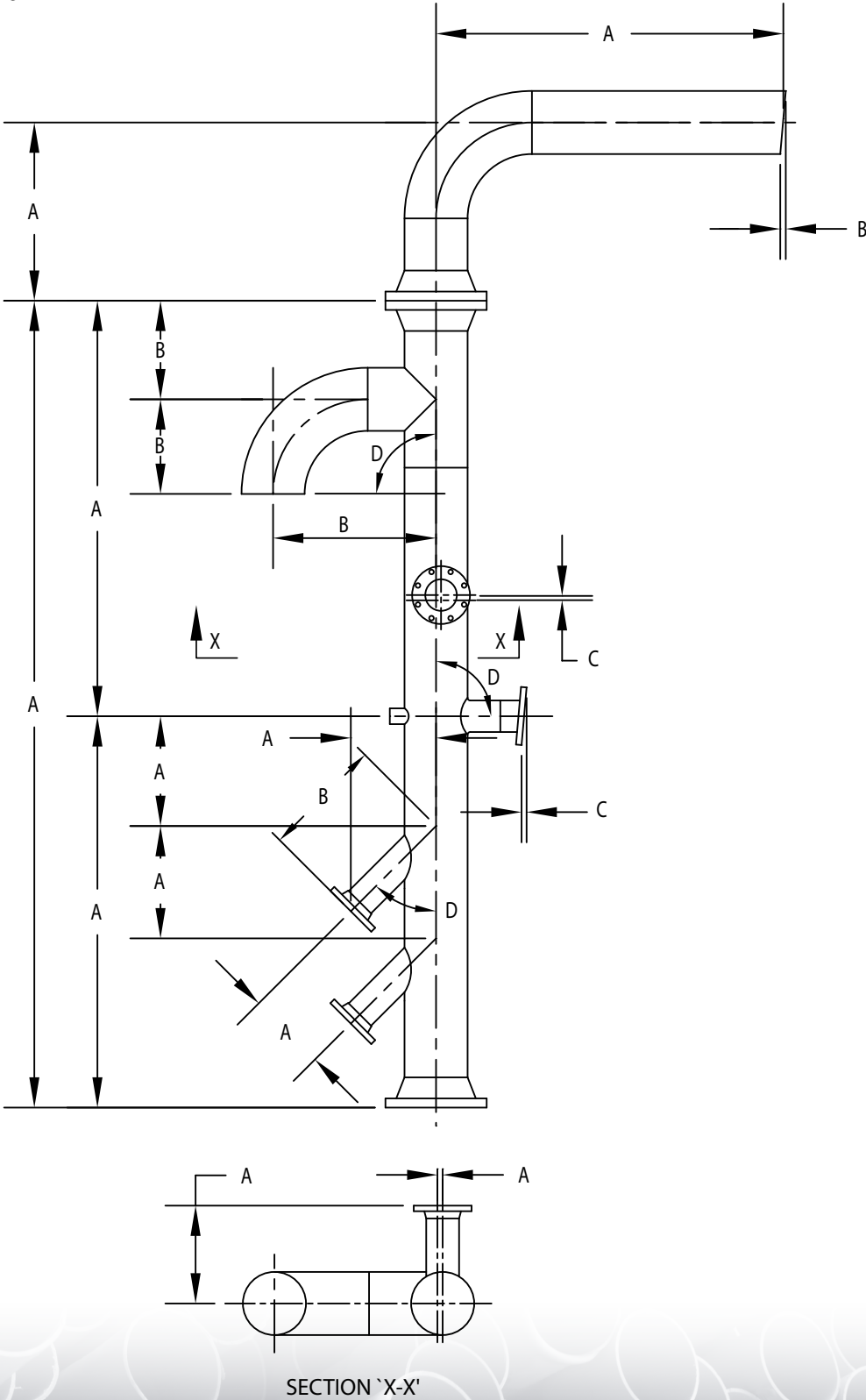
Pipe Dia	B
1 1/2" x 1 1/2" x 1"	4"
2" x 2" x 1 1/2"	4 1/2"
3" x 3" x 2"	5 1/2"
4" x 4" x 3"	6 1/2"
6" x 6" x 4"	8"
8" x 8" x 6"	9"
10" x 10" x 8"	11"
12" x 12" x 10"	12"

Lap joint flanges are not available for ANSI fittings
Fitting dimensions per ASME B16.5 Class 150

Fitting and Dimensions

APPLICATION OF PIPE FABRICATION TOLERANCES

Figure 1



FABRICATION TOLERANCES

Scope

This standard covers general pipe shop fabricating tolerances for prefabricated piping assemblies

A. Linear Tolerances

- A.1 The tolerances on linear dimensions (intermediate or overall) apply to the face to face, face to end, and end to end measurements of fabricated straight pipe and headers; center to end or center to face of nozzles or other attachments; or center to face of bends as illustrated on fig. 1. These tolerances are not cumulative.
- A.2 Linear tolerances on 'A' are $\pm 1/8''$ for sizes 10'' and under and $\pm 3/16''$ for sizes 12'' thru 36''.
- A.3 Linear tolerances on 'A' for sizes over 36'' are subject to tolerances of $\pm 1/4''$, increasing by $\pm 1/16''$ for each 12'' in diameter over 36''.
- A.4 Due to the cumulative effects of tolerances on fittings or flanges, when joined without intervening pipe segment, deviations in excess of those specified in paragraphs A.2 and A.3 may occur

B. Center Line Tolerances

For fittings that must conform to face-to-centerline dimensions, the allowable tolerance is:

$\pm 1/8''$ up to and including 12'' \emptyset

$\pm 3/16''$ for 14'' \emptyset and larger

C. Flange Tolerances

- C.1 The flange face shall be perpendicular to the axis of the fitting within $1/2^\circ$ and shall be flat to within $1/32''$ up to and including 24'' \emptyset . For diameters greater than 24'' \emptyset , the flange face shall be perpendicular to the axis of the fitting within $1/4^\circ$, and shall be flat with $1/16''$.
- C.2 Rotation of flanges from the indicated position measured as shown in fig. 1, $1/16''$ maximum.

D. Angles

$\pm 1/2^\circ$ up to and including 24'' \emptyset

$\pm 1/4^\circ$ for larger than 24'' \emptyset

Fitting and Dimensions

MANUFACTURING TOLERANCES

Component	Item	Diameter	Tolerance
Pipe	Inside Diameter:	1" to 12" Greater than ½"	+0.060" / -0.060" +0.120" / -0.120" or 1%, whichever is greater
	Wall Thickness: Liner	All Sizes	+0.030" / -0.000"
	Total Thickness	1" to 6" Greater Than 6"	+0.30" / -0.010" +0.030" + 5% F/W Thickness -(0.010" + 5% F/W Thickness)
	Length:	1" to 12" 14" to 36" Greater than 36"	+0.125" / -0.125" +0.188" / -0.188" +0.250" / -0.250"
	Straightness:	All Sizes	Deviation of straightness of I.D. of pipe shall not exceed 0.3% of effective length or 0.75", whichever is smaller
	Winding Angle:	All Sizes	+2° / -2°
Fittings	Inside Diameter	1" to 12" Greater than 12"	+0.120" / -0.060" +0.120" / -0.120" or 1%, whichever is greater
	Wall Thickness	Minimum thickness, except for pre-tapered ends: same as pipe. No maximum thickness can be stated, as reinforcement required to give the necessary strength varies substantially over the surface of the fittings (reference individual manufacturing specifications for part thickness).	
	Ends:	1" to 24" Greater than 24" 1" to 12" Greater than 12"	+1° / -1° +0.5° / -0.5° +0.120" / -0.120" or 1%, whichever is greater +0.250" / -0.250" or 1%, whichever is greater
	Nipples:	1" to 6"	+0.188" / -0.000"

Fitting and Dimensions

MANUFACTURING TOLERANCES

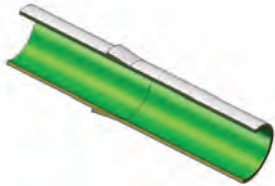
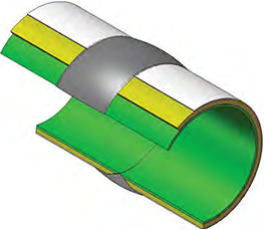

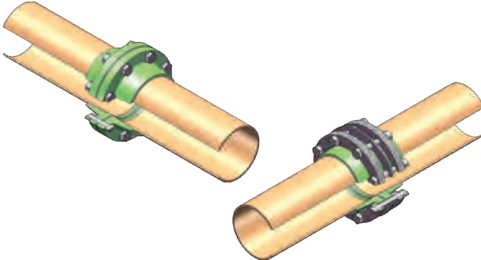
Component	Item	Diameter	Tolerance
Flanges	Inside Diameter	1" to 12"	+0.060" / -0.060"
		12" or greater	+0.120" / -0.120" or 0.5%, whichever is greater
	Thickness	All Sizes	+0.120" / -0.000"
	Flatness	1" to 18 ¼"	+0.030" / -0.030"
		Greater than 24"	+0.060" / -0.060"
Perpendicularity (to Axis)	1" to 24"	+0.5° / -0.5°	
	Greater than 24"	+0.25° / -0.25°	
	Bolt Hole Diameter	All Sizes	±5% of hole diameter, or ±0.125", whichever is smaller
Adhesive Joints	Spigot Edge Thickness	1" to 12"	+0.030" / -0.015"
	Insertion Depth	1" to 12"	+0.120" / -0.060"
	Angular Misalignment	1" to 12"	±0.5°
Butt Joints	Axial Gaps	1" to 12"	+0.125"
		14" to 24"	+0.188"
		Greater than 24"	+0.250"
	Radial Offset	1" to 12"	+0.125" / -0.125"
		14" to 24"	+0.188" / -0.188"
Greater than 24"		+0.250" / -0.250"	
	Angularity	All Sizes	±0.5°
Assembly		Per Pipe Fabrication Institute Standard ES-3. (Ref. Page 52). Note: Dimensions with 2" or more trim allowance at field joint locations shall have a tolerance of +1 / -0.5" unless otherwise noted.	

RPS Composites Inc.

740 Main Street
P.O. Box 299
Mahone Bay, Nova Scotia
Canada B0J 2E0
Tel: (902) 624.8383 | (800) 343.9355
Fax: (902) 624.6395
www.rpscomposites.com

RPS Composites designs and fabricates piping systems for a wide range of fluid handling applications. These pipe systems are available with a number of different joining systems. The choice of the most appropriate joint for any application depends on a number of factors including chemical media, pressure, pipe diameter, liner thickness, and skill level of installation labor. Following are descriptions and typical

applications of the most commonly utilized joints for RPS piping systems. Detailed joining instructions are available in RPS Composites' Installation Manual. For specific recommendations, contact the RPS representative in your area or RPS sales department directly.

Tapered Adhesive Joints	Butt & Wrap Joint	Bell & Spigot O-Ring Joint	Flanges
			
<p>Available with:</p> <ul style="list-style-type: none"> • 100 mil lined 150 psi pipe systems 1" - 12" <p>Fittings are supplied with integral belled ends and pipe is supplied belled by plain end. Components are permanently bonded in the shop or field using RPS adhesive, formulated from the same resin used in fabrication of the pipe systems liner.</p> <p>Adhesive bonded joints are the lowest cost joining method for shop and field assembly of FRP pipe systems.</p>	<p>Available with:</p> <ul style="list-style-type: none"> • All diameters, and combinations of pressure and liner thickness <p>Butt & Wrap joints are very dependable joints for both shop and field assembly of RPS piping components.</p> <p>Pipe and fitting ends are sanded to prepare a good bonding surface. Components are aligned, "butted" together, and sealed with a resin putty. A "wrap" is applied to permanently bond the components. The "wrap" is made up of layers of glass reinforcement saturated with resin.</p> <p>Butt joints are custom designed to match the performance requirements of each piping system.</p> <p>A variety of butt joint designs are available depending on the service conditions. These include straight, tapered, and edge capped.</p>	<p>Available in:</p> <ul style="list-style-type: none"> • Sizes 8" dia. and larger for buried applications <p>RPS' Bell & Spigot O-Ring joints are primarily designed for pipe in buried applications. Above ground designs are available where individual pipe sections are restrained.</p> <p>Pipe is supplied with an integral bell on one end and a machined spigot with O-Ring grooves on the other. Elastomeric O-Rings, installed in the spigot end, are compressed on a molded flat seating area when the spigot is inserted in the bell. The Bell & Spigot O-Ring joint is the most economical method of joining large diameter pipe.</p> <p>The compacted soil around the pipe acts as an anchor for each pipe section, and thermal expansion is taken up in the joint area.</p>	<p>Available in:</p> <ul style="list-style-type: none"> • Full Face or Lap Joint Style in ALL sizes and pressures to 150 psi. <p>Full Face flanges are suitable for mating to flanges with full face contact.</p> <p>Lap joint style flanges are specified for connections to raised face flanges and wafer style valves. Flange drilling available as ANSI, DIN, or custom.</p> <p>Standard RPS FRP flanges are supplied with sealing rings on flange faces. Flanges without sealing rings are also available.</p> <p>RPS flanges are joined to pipe and fittings by either Tapered Adhesive or Butt & Wrap joints.</p>

Detailed Joining Instructions are available in RPS' Installation Manual

Estimated Joining Times (Minutes)

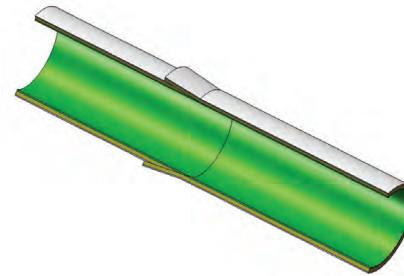


Tapered Adhesive & Butt Joints

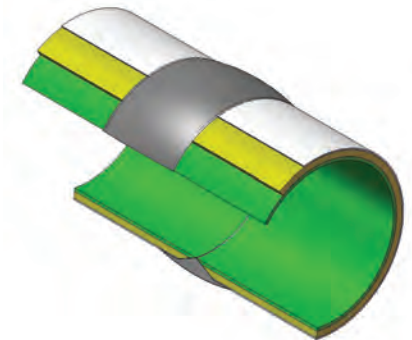
Dia. (inches)	Cut		End Prep		Assemble		Bond/Lay-up		Total Joint Time		Cure	
	TA	B&W	TA	B&W	TA	B&W	TA	B&W	TA	B&W	TA	B&W
1	2	2	1	5	3	7	5	15	11	29	50	180
1 1/2	2	2	1	5	3	7	5	20	11	34	50	180
2	2	2	1	7	5	10	10	30	18	49	50	180
3	2	2	1	10	5	10	10	30	18	52	50	180
4	2	2	3	10	7	10	10	30	22	52	50	180
6	3	3	4	15	10	15	10	35	27	68	50	180
8	5	5	7	30	15	25	15	40	42	100	70	180
10	10	10	10	30	15	25	15	40	50	105	70	180
12	10	10	10	30	20	30	20	80	60	150	70	220
14	-	10	-	45	-	30	-	140	-	225	-	220
16	-	15	-	60	-	40	-	180	-	295	-	240
18	-	15	-	80	-	40	-	200	-	335	-	240
20	-	20	-	100	-	45	-	240	-	405	-	280
24	-	20	-	120	-	45	-	300	-	485	-	280

NOTES:

1. Cure times for RPS' Tapered Adhesive joints require a heating collar (blanket).
2. Cure time for Butt & Wrap joints is the total cure time, and includes intermediate cures during lay-up sequences.
3. For Tapered Adhesive joints, the bonding time includes mixing, applying adhesive, seating the joint, securing the joint, and applying the heating collar.
4. For the Butt & Wrap joints, the lay-up time includes mixing of pastes and resin, as well as, wet out and applying of glass reinforcement. Final resin coat is also included.
5. Times listed are for joining only and do not cover handling, measuring, jiggging, travel, break-time, downtime, supports, etc.
6. Times are estimates and should be used only as a guide.



TA = Tapered Adhesive Joining



B&W - Straight Butt & Wrap Joining

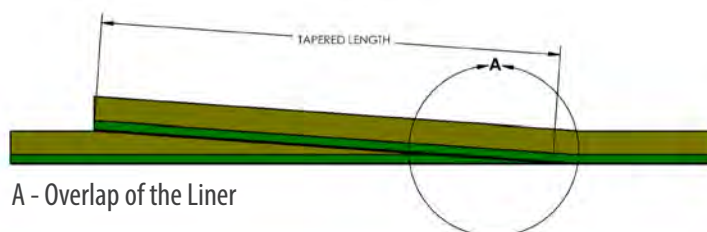
RPS Tapered Adhesive Joints



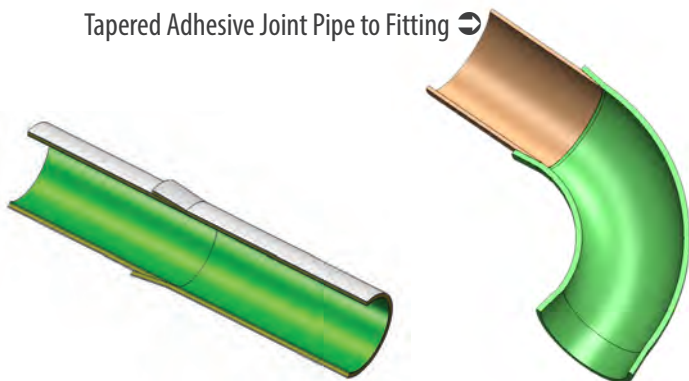
Benefits and Savings of Tapered Adhesive Joints

RPS Composites Tapered Adhesive Joint (TAJ) system is the lowest cost joining method for shop and field assembly of RPS Composites corrosion resistant pipe systems. Available with our P, H, and A series pipe systems in sizes 1" (25mm) through 12" (300mm), the tapered adhesive joint incorporates a matched fit between integral bell ends of pipe and fittings and machined tapers on the end of the adjoining pipe. This matched fit helps the joint to align during insertion and ensures a very thin adhesive line in the finished joint. All tapered adhesive joints are post cured with a heating collar to ensure full cure of the adhesive and to speed up installation time.

Pipe components are permanently bonded together using RPS corrosion resistant P-1500 or H-1500 adhesive formulated from the same resin as is used in the pipe corrosion barrier. The resulting joint has an overlap of corrosion barriers of the adjoining components.



Tapered Adhesive Joint Pipe to Fitting ↻



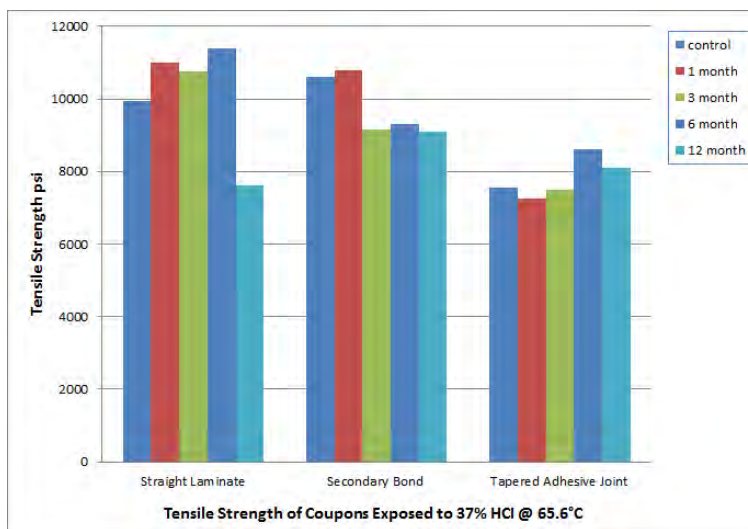
Tapered Adhesive Joint Pipe to Pipe ↻

RPS Composites tapered adhesive joint offers advantages over laminated butt joints without compromising corrosion resistance.

After 12 months of exposure to 37% HCl at 150°F. (65.6°C.), the tapered adhesive joint coupons retained all tensile strength, while the straight laminate and butt & wrap joint coupons lost 23% and 16% respectively, as seen on the graph below.

Advantages include lower cost joining materials and installation.

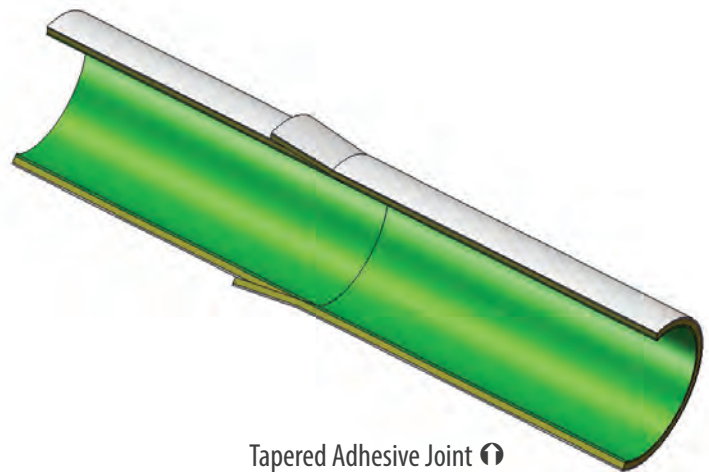
Heating Collar ↻



Joint Material Cost Comparison

Tapered Adhesive Joints vs. Butt Joints

Diameter	Tapered Adhesive	Butt Joints
	P-series	P-series
1"	\$1.75	\$23.20
1½"	\$1.75	\$23.40
2"	\$1.75	\$26.20
3"	\$2.10	\$29.60
4"	\$2.60	\$36.50
6"	\$5.20	\$51.10
8"	\$10.20	\$75.10
10"	\$10.20	\$114.30
12"	\$10.20	\$146.20



Estimated Joining Times (in minutes)

Tapered Adhesive Joint and Butt Joints

Dia. (inches)	Cut		End Prep		Assemble		Bond/Lay-up		Total Joint Time		Cure	
	TAJ	B&W	TAJ	B&W	TAJ	B&W	TAJ	B&W	TAJ	B&W	TAJ	B&W
1	2	2	1	5	3	7	5	15	11	29	50	180
1 1/2	2	2	1	5	3	7	5	20	11	34	50	180
2	2	2	1	7	5	10	10	30	18	49	50	180
3	2	2	1	10	5	10	10	30	18	52	50	180
4	2	2	3	10	7	10	10	30	22	52	50	180
6	3	3	4	15	10	15	10	35	27	68	50	180
8	5	5	7	30	15	25	15	40	42	100	70	180
10	10	10	10	30	15	25	15	40	50	105	70	180
12	10	10	10	30	20	30	20	80	60	150	70	220
14	-	10	-	45	-	30	-	140	-	225	-	220
16	-	15	-	60	-	40	-	180	-	295	-	240
18	-	15	-	80	-	40	-	200	-	335	-	240
20	-	20	-	100	-	45	-	240	-	405	-	280
24	-	20	-	120	-	45	-	300	-	485	-	280

Features and Benefits

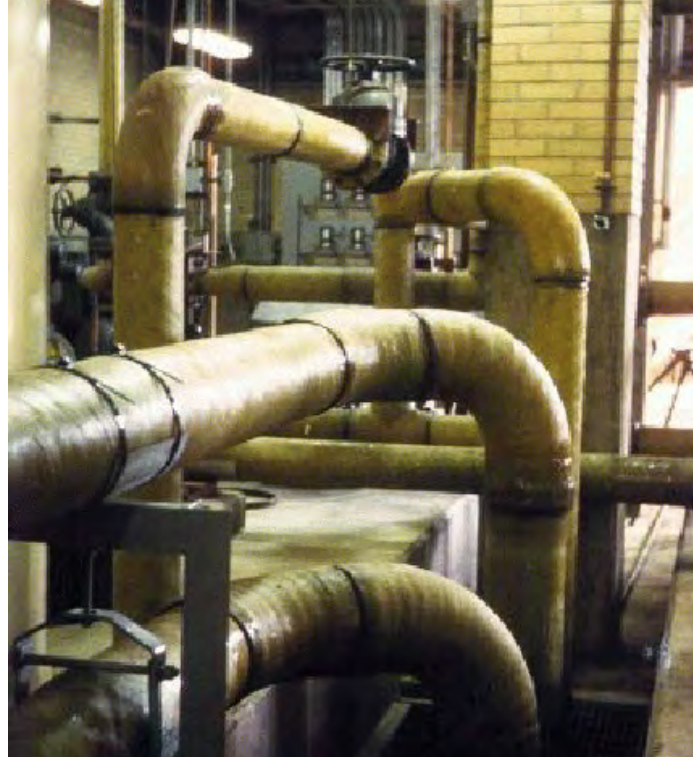
Features	Benefits
Matched Bell and Spigot	Self Aligning
Thin Adhesive Line	High Joint Strength
Two Part Premeasured Adhesive & Catalyst	Lower Joint Material Cost
Adhesive Bonded Joint	Lower Installed Costs

RPS offers piping systems with both Butt & Wrap and Tapered Adhesive Joints. Both systems have advantages and benefits. Below is a comparison of some of the major differences:

	Butt & Wrap Joints	Tapered Adhesive Joints
Advantages	<ul style="list-style-type: none"> A variety of corrosion barriers available Accommodates any liner thickness Hydro burst pressures of 500 to 1200 psi All resin types available 	<ul style="list-style-type: none"> Excellent corrosion resistance Continuous corrosion liner throughout pipe, fittings & joints Hydro burst pressures 1500+ psi A variety of resin choices Tapering Tool: <ul style="list-style-type: none"> - Vacuum dust control - Fast accurate field tapers (3" taper in 15 seconds) Pre-measured kits, no measuring Heat Cured Joints <ul style="list-style-type: none"> - Can be immediately placed in service - Complete cure of adhesive with post-cured pipe & fittings for maximum chemical resistance
Disadvantages	<ul style="list-style-type: none"> 2 – 3 times more expensive than tapered adhesive Highly trained/skilled work force required Dust generated during sanding Increased levels of hazardous materials at the job Requires accurate measuring of catalysts, etc. under field conditions Increased potential for inside diameter mismatch/gaps in corrosion barrier 	<ul style="list-style-type: none"> Tapering Tool required in field Limited to 1" to 12" sizes

Benefits and Savings of Tapered Adhesive Joints

FRP piping systems with Tapered Adhesive Joints by RPS Composites



Detailed joining instructions are available in RPS Composites' Installation Manual.

RPS Composites Inc.

740 Main Street

P.O. Box 299

Mahone Bay, Nova Scotia

Canada B0J 2E0

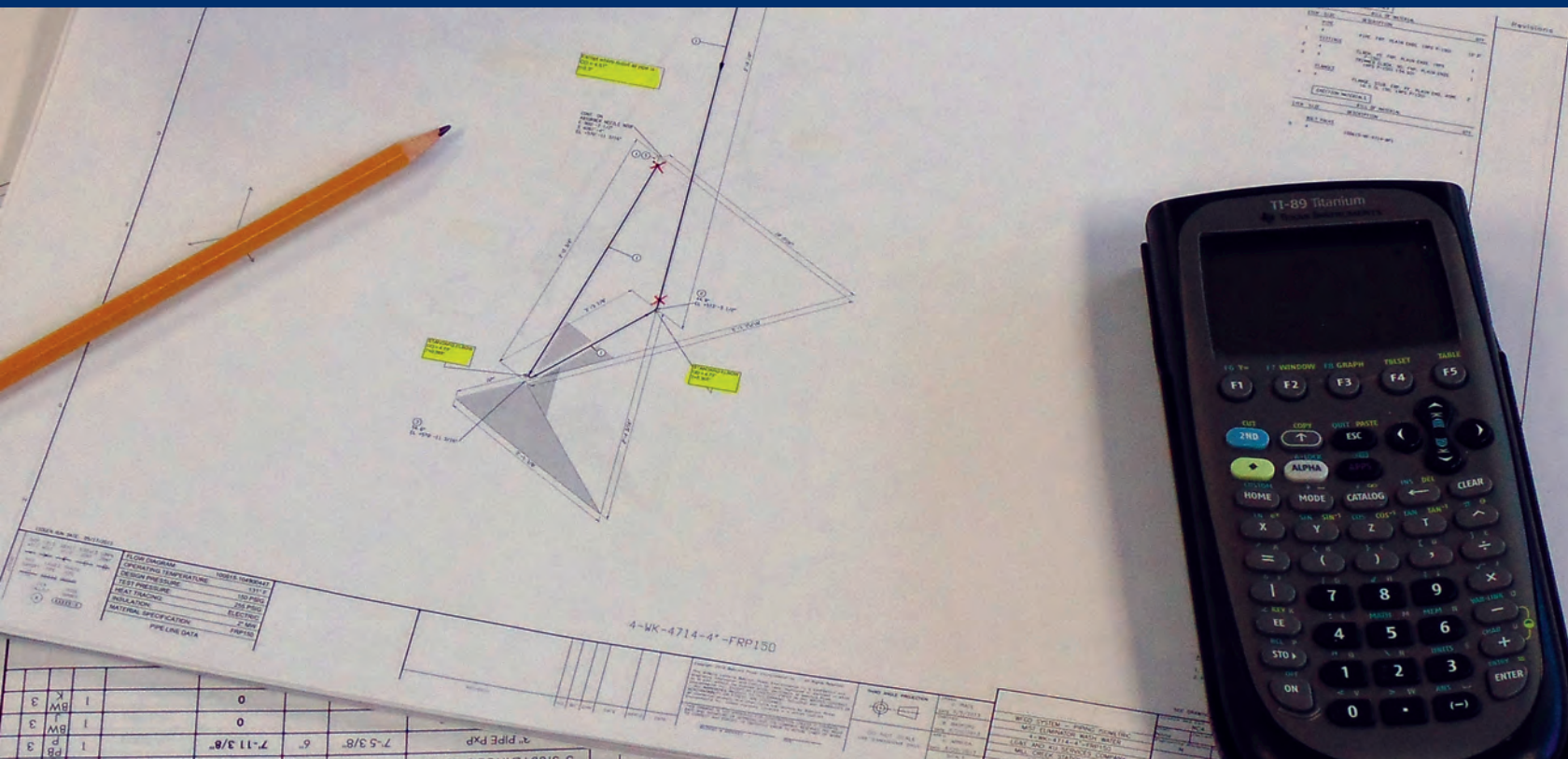
Tel: (902) 624.8383 | (800) 343.9355

Fax: (902) 624.6395

www.rpscomposites.com



RPS Design Manual



Engineered Composite Solutions



TABLE OF CONTENTS

INTRODUCTION	3	ABOVE GROUND PIPE & FITTING DESIGN	10
DESCRIPTION OF FRP MATERIALS	3	Filament Wound Pipe Design	10
Glass Reinforcements	3	Contact Molded Pipe & Fitting Design.....	11
Resins.....	4	Pressure Stress Multipliers and Fitting Design	11
Additives	4	Design for Vacuum.....	12
MANUFACTURING	5	ABOVE GROUND PIPING SYSTEM DESIGN	13
Filament Winding	5	Differences between FRP and Steel & General	
Custom Contact Molding.....	5	Recommendations.....	13
PIPE PROPERTIES	7	Recommended Hanger Spacing for 150 psi	
General Physical Properties.....	7	Rated Piping.....	14
Mechanical Properties of Filament Wound Pipe.....	7	Pipe Supports	15
Mechanical Properties of Hand Lay-up Pipe and Fittings .7		Design for Thermal Expansion	15
Mechanical Properties of Corrosion Barrier.....	7	Pipe Stress Analysis and Allowable Stress.....	19
Composite Properties	7	BURIED PIPE DESIGN & INSTALLATION	21
HYDRAULICS	8	JOINING SYSTEMS	25
Friction Loss Calculations	8	QUALITY ASSURANCE and RESEARCH & DEVELOPMENT	28
Head Loss in Fittings	9	REFERENCES	28
Transient Pressures	9		

INTRODUCTION

RPS COMPOSITES (RPS) produces fiberglass reinforced plastic (FRP) pipe and fittings intended for use in a wide variety of applications. The intent of this manual is to provide designers and users with the tools necessary to confidently design or specify above-ground or buried piping systems utilizing RPS components.

DESCRIPTION OF FRP MATERIALS

- Fiberglass reinforced plastics are composite products consisting of glass reinforcement embedded in thermosetting resin. The usage of FRP has grown steadily over the past three decades due to the advantages that FRP offers over traditional materials. Some of the advantages of FRP are:
 - Excellent Corrosion Resistance
 - High strength to weight ratio
 - Light weight compared to most metals
 - Non-conductive to electricity
 - Dimensionally stable
 - Low maintenance costs
 - Unlimited shape/size configurations
 - Orthotropic in nature (different properties in different directions)
 - FRP consists of three main components:
 - Glass Reinforcements
 - Resin
 - Additives

A description of these components, and how they are used at RPS is summarized below:

Glass Reinforcements

The mechanical strength of FRP depends on the type, amount, and orientation of the glass reinforcement within the part. The strength of an FRP laminate will increase as more layers of glass reinforcement are used and as the ratio of glass to resin is increased. (i.e more glass per unit volume). Several types of glass reinforcements are utilized at RPS and can be summarized as follows:

- **CHOPPED STRAND MAT** – This type of reinforcement utilizes short glass fibres (typically ½" to 2" long), randomly oriented and held together with a resinous binder. Chopped strand mat provides good chemical resistance due to the high resin, low glass ratio achieved in the application of the material. Since the



glass fibres are not continuous, it is difficult for chemicals to penetrate the laminate by following along the fibre. Thus, the chopped strand mat in the corrosion barrier is often referred to as the “anti-wicking” barrier. Chopped strand mat is available in a variety of weights with 1-1/2 oz. per square foot the most commonly utilized.

- **WOVEN ROVING** – Also commonly used, this type of reinforcement utilizes glass fibres orientated in the 0°/90° directions. Unlike chopped strand mat, the fibres are continuous and no binder is used to hold the arrangement together. Woven roving lacks the chemical resistance of chopped strand mat due to the continuity of the glass fibres and high glass content; however, it does offer increased strength. Typically, laminates over ¼" thick should incorporate woven roving, where possible, to improve strength properties. Woven roving layers should always be preceded and followed by chopped strand mat layers to maximize adhesion. Woven Roving is commonly used with a glass weight of 24 oz. per square yard (2.67 oz. per square foot).
- **CONTINUOUS ROVING** – This type of reinforcement is used in the structural layers of filament wound piping and in the structural layers of some fittings, such as on the exterior of larger diameter elbows. The high glass content (low resin content) created by applying the continuous rovings provides high strength in the direction of the fibre. Continuous rovings should not be exposed to chemical environments as they could allow “wicking” of chemicals into the laminate.
- **SURFACING VEIL** – As the name implies, surfacing veils are generally only used on the surface of laminates. The veil layer provides a high resin to reinforcement ratio (typically 90:10), which creates excellent chemical resistance at the part’s surface, where it is most needed. All corrosion barriers in RPS products

are started with one layer of surfacing veil. For increased chemical resistance, two layers of veil can be used; however, beyond this, the corrosion barrier may be susceptible to cracking due to the high resin content created with the surfacing veil. Nexus surfacing veil is a polyester product, which provides good chemical resistance, appearance and workability. "C" glass veil is a corrosion resistant glass veil which also provides good characteristics. The choice to use C glass veil versus Nexus is usually a matter of preference concerning workability, with most manufacturers using one or the other. It should be noted, however, that C glass veil is not generally recommended in services containing fluorides.

- OTHER REINFORCEMENTS – A wide variety of reinforcements exist which can be used to meet specific needs (e.g. Carbon veil for electrical conductivity). RPS is experienced in the design of products utilizing various reinforcements and can provide assistance in choosing the right reinforcements for the job.

Resins



The second major component of FRP piping is the resin system. FRP is fabricated using thermosetting resins. These types of resins are cured using chemical additives; and once cured, are essentially infusible (unlike thermoplastic resins, which can be re-melted). In an FRP laminate, the resin acts to hold the reinforcement in place and the resin system is

chosen for its chemical, mechanical and thermal properties as well as its processing ability.

RPS uses a wide variety of resins as summarized below:

- BIS-A VINYL ESTER – The most commonly used resin at RPS, vinyl esters provide excellent chemical resistance, excellent resilience and good workability.
- EPOXY NOVOLAC VINYL ESTER – Used in RPS "H" series piping, Epoxy Novolacs offer increased chemical resistance to strong acids and higher temperature capability compared to BIS-A type vinyl esters.
- ISOPHTHALIC POLYESTER – Used in RPS "I" series piping,

Isophthalic's or "Iso's" offer good chemical resistance at lower cost compared to vinyl esters. In mild to moderate corrosive applications, isophthalic's can be an economical alternative.

- FIRE RETARDENT RESINS – All of the resin types mentioned above are available in fire retardant versions. These fire retardant derivatives generally incorporate bromine and antimony compounds to improve fire resistance and create a laminate, which is self-extinguishing when the flame source is removed. Most fire retardant resins will provide a Class 1 flame spread rating when tested in accordance to ASTM E-84.
- OTHER RESINS – RPS also has experience in the use of many other resins including:
 - o Chlorendic Polyesters
 - o Bisphenol Fumarates
 - o Phenolics
 - o Terephthalic
 - o And others

Additives

- A number of additives are used in FRP laminates. Some of the most common additives are briefly described below:
- Catalyst/Promoters – Thermosetting resins require both catalysts and promoters to cure. Again, a wide variety of options exist such as MEKP (methyl ethyl ketone peroxide), BPO (benzoyl peroxide), CHP (cumene hydrogen peroxide), DMA (dimethyl aniline), CoNap (cobalt naphthenate) and others. Resin suppliers provide recommendations regarding correct levels of catalysts and promoters, and these should be strictly adhered to. The choice of which catalyst/promoter system to use is usually a matter of fabricator preference, however, in some applications, superior performance can be achieved with one over the other (eg. BPO/DMA for Sodium Hypochlorite service).
- Thixotropes – These are generally silica based products which add thixotropy to minimize drain-out of resin.
- Gel Time Retarders – Chemicals such as 2,4-Pentanedione slow the cure process. They are generally used in large parts fabrication.

- Pigments – Pigments can be added to laminates and exterior coatings to impart unlimited colour options and to provide resistance to UV degradation.
- Antimony Compounds – These compounds increase fire resistance when used with a fire retardant resin.
- Paraffin – Used in top coats of laminates to seal the surface and allow for proper cure at the surface.
- Abrasion Resistant Fillers – RPS “A” and “AA” series pipe and fittings include abrasion resistant fillers added to the corrosion barrier for use in services where abrasion is a concern.
- Others – Other additives such as antifoaming agents, carbon black, and milled fibres, are used to impart specific properties.

MANUFACTURING

RPS manufactures FRP piping systems, duct, tanks and stacks from 1” (25mm) to 18’ (5.5m) diameter. A variety of techniques using varying degrees of automation are used to fabricate the various components.



Each technique produces a product with unique characteristics. These techniques are summarized below:

Filament Winding

The majority of pipe and ducting produced at RPS is manufactured by the filament winding process. Filament winding involves pulling glass fibres, under controlled tension, through a catalyzed resin bath. The resin bath travels back and forth past a rotating mandrel, with the angle of fibre placement determined by the translational speed of the resin bath relative to the rotational speed of the mandrel. Through this motion, a pattern is established and repeated until



the desired thickness is achieved. RPS utilizes both mechanical and computerized electromechanical filament winding machines to produce high quality, consistent parts. The tension of the glass fibres produces a laminate with high glass content, typically 70% by weight, creating a strong structural cage, highly orthotropic in nature. Prior to filament winding, a corrosion barrier, generally consisting of surfacing veil and chopped strand glass reinforcement, is applied to the mandrel by contact molding.

Custom Contact Molding

In contrast to piping, the majority of fittings at RPS are manufactured using the custom contact molding technique. Using this approach, resin and glass are applied by spray gun, or by hand to stationary or



rotating molds. The resin/reinforcement combination is “rolled out” to remove entrapped air, compact the layers, and ensure complete wet-out of the glass fibres. The number of layers that can be continuously applied to the mold is limited since heat generated by the resin cure may create blistering in the part. To prevent this, laminates are laid-up in stages, which are allowed to cure and cool before the next stage of reinforcement is applied. Each sequence of reinforcement

must begin and end with a layer of chopped strand glass to provide proper adhesion.

The contact molding technique provides for an unlimited number of plies and orientation of reinforcement, allowing the designer to place the material where it is most needed. This creates parts which



range from quasi-isotropic to highly orthotropic. The manual nature of the technique means a high skill level is required to produce a high quality, consistent part. Materials such as chopped strand glass, woven roving, Nexus veil, C-veil, and unidirectional reinforcement are all applied using this technique. Traditionally, most corrosion barriers are applied by contact molding.

As mentioned above, the contact molding technique is generally broken down into two sub-methods; namely, hand lay-up and spray-up. As the name implies, hand lay-up involves saturating glass reinforcement and applying this material by hand to the mold.



Alternatively, a chopper gun can be used to mechanically apply the glass reinforcement. With this technique, one or more strands of glass fibre are fed into a gun which cuts or “chops” the glass to a set length (typically 1” to 1¼” long). The chopped glass is then propelled into a stream of catalyzed resin. Glass

content is controlled by adjusting the flow of resin relative to the speed of the chop. The amount of time the chopper gun is held in one spot determines how thick or how much material is applied. The chopper gun can be used alone to produce an “all chop” component, which would be similar to a laminate made of “all chopped strand mat”. Alternatively, the chopper gun can be used in conjunction with hand lay-up material, such as woven roving, to produce a laminate with higher glass content and strength. The resin spraying ability of the chopper gun can also be used alone to “wet-out” hand lay-up laminates, which can reduce labour costs on larger parts.

PIPE AND FITTING PROPERTIES

FRP is a composite material and can have different properties in different directions. Some general physical properties are essentially the same for all FRP products produced at RPS. However, most mechanical properties are significantly different in the Axial (Longitudinal) versus Hoop (Circumferential) directions. It should be noted that the corrosion/abrasion layer included in all RPS products is generally not considered in structural design of pipe; however, it is often necessary to know the properties of the corrosion liner and the composite properties of the laminate (refer to the section Pipe Stress Analysis for more information on this subject).

General Physical Properties of RPS FRP Pipe & Fittings*

Coefficient of Thermal Expansion	1.2 to 1.5 x 10 ⁻⁵ in./in./deg. F.	2.2 to 2.7 x 10 ⁻⁵ mm./mm./deg. C.
Thermal Conductivity	1.3 BTU in./ft. ² /deg.F/hr.	188 (W-mm.)/(m ² deg. C)
Density	0.058 lb./in. ³	1.61 g/cm. ³
Hazen Williams's Flow Coefficient	150	
Manning's Flow Coefficient	0.009	

*These are approximate values, if exact values are required consult RPS Engineering

Mechanical Properties of A-150 & P-150 Filament Wound Structural Layers

Ultimate Tensile & Compressive Strength		
Hoop	40,000 psi	(276 Mpa)
Axial (due to pressure)	20,000 psi	(138 Mpa)
Axial (due to bending)	12,000 psi	(83 Mpa)
Tensile & Compressive Modulus of Elasticity		
Hoop	2.3 x 10 ⁶ psi	(15,860 Mpa)
Axial	1.4 x 10 ⁶ psi	(9,655 Mpa)
Poisson's Ratio		
Change in axial strain caused by hoop stress		0.7
Change in hoop strain caused by axial stress		0.4

Mechanical Properties of A-150 & P-150 Hand Lay-Up Structural Layers

Ultimate Tensile & Compressive Strength		
Hoop/Axial (laminates < 1/4" thick*)	14,000 psi	(96 Mpa)
Hoop/Axial (laminates ≥ 1/4" thick**)	20,000 psi	(138 Mpa)
Tensile & Compressive Modulus of Elasticity		
Hoop/Axial (laminates < 1/4" thick*)	1.2 x 10 ⁶ psi	(8,276 Mpa)
Hoop/Axial (laminates ≥ 1/4" thick**)	1.7 x 10 ⁶ psi	(11,724 Mpa)
Poisson's Ratio, hoop/axial & axial/hoop . . . 0.34*, 0.255**		

*Indicates "all mat" construction

**Indicates mat and woven roving construction

Mechanical Properties A-150 & P-150 Corrosion Barrier

Ultimate Tensile & Compressive Strength		
Hoop/Axial	10,000 psi	(69 Mpa)
Tensile & Compressive Modulus of Elasticity		
Hoop/Axial	1.0 x 10 ⁶ psi	(6,897 Mpa)
Poisson's Ratio, hoop/axial & axial/hoop . . . 0.34		

Composite Properties

The composite properties of an FRP laminate can be estimated by simply proportioning structure and liner properties with thickness. This is demonstrated below.

Example: 12" diameter Filament Wound Pipe

t liner = 0.11"
t winding = 0.26"
total thickness = 0.37"

$$\begin{aligned} \text{Composite Tensile Modulus (hoop)} &= \frac{\text{Modulus of Liner} \times \text{Liner thickness}}{\text{Total thickness}} + \frac{\text{Modulus of Structure} \times \text{Structure thickness}}{\text{Total Thickness}} \\ &= \frac{1.0 \text{ e } 6 \times 0.11}{0.37} + \frac{2.3 \text{ e } 6 \times 0.26}{0.37} = 1.91 \text{ e } 6 \text{ psi} \end{aligned}$$

This technique can also be used to estimate other composite properties such as Poisson's ratio.

HYDRAULICS



RPS fibreglass piping offers significant advantages over steel piping in terms of flow characteristics. The smooth interior of FRP piping minimizes friction loss. Furthermore, it is not necessary to degrade friction factors as the surface remains smooth over time for most applications. The inside diameter of RPS FRP is also larger than most schedule steel piping providing increased capacity.

Friction Loss Calculations

Friction loss, or head loss, is generally calculated using one of three methods. Namely, Hazens-Williams, Manning's, or Darcy-Weisbach. Each of the methods has its relative merits, disadvantages, and limitations; and the designer should be aware of which formula to use for the given application. The equations and parameters, which relate to RPS FRP piping, are summarized below:

Hazen-Williams Equation – This equation is valid for turbulent flows for piping under full flow, and generally provides a conservative solution for head loss in FRP pipe.

$$hf = 0.2083 (100 \cdot Q / C)^{1.85} / d^{4.87}$$

where,

hf = Friction loss, ft H₂O/100 ft of piping
 C = Hazen William's coefficient = 150 for RPS pipe
 Q = Flow rate, gpm (U.S.)
 d = Inside diameter, inches

Manning's Equation – This equation is generally used to determine the head loss in sewers and drains since it is valid for partial flow under the influence of elevation head only.

$$Q_m = (1.486 / n) (S)^{0.5} \cdot A \cdot R^{0.667}$$

where,

Q_m = Flow rate, cfs
 n = Manning's coefficient = 0.009 for RPS pipe
 S = Hydraulic gradient of slope
 A = Cross sectional area of pipe, ft²
 R = Hydraulic radius = Area / wetted perimeter, ft.

Darcy-Weisbach Equation – This equation applies to all fluids and full pipe flows. The primary advantage of the equation is that it is valid for laminar and turbulent flow. However, the friction factor used in the equation is variable.

$$HF = f \cdot L (V^2) / (2 \cdot ID \cdot g)$$

where,

HF = Head loss, ft
 f = Friction factor (see below)
 L = Total length of pipe, ft
 V = Fluid velocity, fps
 ID = Inside diameter, ft
 g = Gravitational constant = 32.2 ft/sec²

The friction factor depends on the flow regime.

$$\text{For laminar flow, } f = 64/Re$$

Where,

$$Re = \text{Reynold's number} = ID \cdot V / \mu$$

and,

$$\mu = \text{Fluid kinematic viscosity, ft}^2/\text{sec}$$

For turbulent flow (i.e Re>3000) the friction factor can be determined using the Moody diagram. RPS FRP piping has a surface roughness parameter (e) equal to 1.7 x 10⁻⁵ ft. The roughness parameter divided by the diameter (ft.) is known as the relative roughness. By using the relative roughness and Reynold's number, the designer can look-up the appropriate friction factor using the smooth pipe segment of the Moody Diagram.

Head Loss in Fittings

The above equations can be used to calculate the head loss for a given length of piping. However, when fittings are introduced into the system, the head loss can be significantly increased. A common method for dealing with head loss in fittings is to calculate an “equivalent pipe length” which is added to the straight run of pipe. An alternative and more accurate method for determining head loss in fittings is to determine the appropriate loss coefficients or “K”

Type of Fitting	K Factor
90° smooth radius elbow	0.5
90° single-mitered elbow	1.4
90° double-mitered elbow	0.8
90° triple-mitered elbow	0.6
Tee, straight flow	0.4
Tee, flow to branch	1.4
Tee, flow from branch	1.7
Reducer, single size reduction	0.7
Reducer, double size reduction	3.3

factors. The K factors depend only on the fitting type and do not involve diameter. All the factors are simply summed together and incorporated into the loss equation. This is demonstrated below using the Darcy Weisbach formula.

$$H_f = \left\{ \sum K's + f_t (L/ID) \right\} (V^2/2g)$$

Following Typical “K” factors for FRP fittings are summarized:

Transient Pressures

Transient pressures such as “Water Hammer” can occur when fluid velocity inside piping is rapidly changed. The change in velocity can be caused by pump start-ups or valve closings. Under certain conditions, the magnitude of the transient can be sufficient to seriously damage or rupture the piping. The magnitude of water hammer is related to the fluid type, pipe thickness, pipe diameter, pipe elastic modulus, and the change in fluid velocity. The pressure surge, which is in addition to the operating pressure in the system, can be calculated as follows:

$$P_s = (a/g) \cdot (SG/2.3) \cdot (\Delta V)$$

Where,

$$a = \text{Wave velocity (ft/s)} = 12 / [(\rho/g)(1/k + d/(E \cdot t))]^{0.5}$$

$$\rho = \text{Fluid density (lb/ft}^3\text{)}$$

$$g = \text{Gravitational constant (32.2 ft/s}^2\text{)}$$

$$k = \text{Bulk modulus of fluid (300,000 psi for water)}$$

$$d = \text{Pipe ID (in.)}$$

$$t = \text{Pipe wall thickness (in.)}$$

$$E = \text{Modulus of elasticity of pipe (psi)}$$

$$SG = \text{Specific gravity (dimensionless)}$$

$$\Delta V = \text{Change in velocity of fluid (ft./sec.)}$$

The inherent flexibility of FRP piping minimizes the magnitude of water hammer; however, care must be taken when starting-up systems and opening and closing valves. In general, steps should be taken to minimize or eliminate water hammer in FRP piping systems.

Gas Flows

Fiberglass piping is generally recommended for above ground gas lines only when the operating pressure is very low. The table below lists the recommended maximum allowable pressure for gas flows versus diameter. For pressures above those listed in the table, external protection is recommended per ASME/ANSI B31.8 “Gas Transmissions and Distribution Piping Systems.”

Gas Line Pressure	
Diameter (in.)	Maximum Recommended Pressure (psi)
<6"	25
8"	14
10"	9
12"	6
14"	5
16"	4

References

For more information on hydraulics refer to:

Pipe Fabricators Institute / SPI - “Fiberglass Pipe Handbook”

American Water Works Association - “Fiberglass Pipe Design – AWWA M45”

ABOVE GROUND PIPE & FITTING DESIGN

As mentioned earlier, FRP piping utilizes glass fibres to reinforce a resin matrix. The fibres can be orientated in any direction to provide optimum properties. This feature highlights the advantage and complexity of FRP design. The methods used to design pipe and fittings are briefly summarized below:

Filament Wound Pipe Design

RPS A150 and P150 piping have internal pressure ratings based on ASTM D2992. This standard provides two methods for determining the "Hydrostatic Design Basis" or "HDB", which is the hoop stress (or strain) that provides an estimated life of 100,000 hours (per the static test method) or 150 million cycles (per the cyclic test method). The static test method involves subjecting numerous samples of piping to various levels of stress such that failures occur in both the short term and long term (10,000 hours maximum). The data is then plotted on a logarithmic scale, and extrapolated to 11.4 years and 50 years to determine the HDB. Similarly, the cyclic method tests samples for up to 15 million cycles, and the data is extrapolated to 150 million cycles to determine the HDB. A service factor equal to 1.0 or less for the cyclic method and 0.5 or less for the static method is then applied to the HDB to determine the corresponding pressure rating or hydrostatic design strength (HDS).

With the hydrostatic design strength, the required wall thickness can be calculated using the ISO formula, as follows:

$$\text{Structural Thickness} = \frac{\text{Pressure} \times \text{Diameter}}{2 \times \text{HDB} \times \text{Service Factor}}$$

or

$$\text{Structural Thickness} = \frac{\text{Pressure} \times \text{Diameter}}{2 \times \text{HDS}}$$

For piping which does not have an HDB rating, the structural wall thickness is based on the short term burst strength (determined in accordance with ASTM D1599).

This provides a conservative estimate of the required wall thickness, calculated as follows:

$$\text{Structural Thickness} = \frac{\text{Pressure} \times \text{Diameter} \times \text{FOS}}{2 \times \text{hoop strength}}$$

where,

Pressure = Design pressure of the system

Diameter = Inside pipe diameter

FOS = Required factor of safety (typically 6 to 10)

Hoop strength = Short term hoop strength (typically 40,000 psi for pipe wound at 55°)

Corrosion Barrier Addition: The corrosion barrier (liner) is generally added to the thickness calculated above, as follows:

$$t_{\text{total}} = t_{\text{liner}} + t_{\text{structure}}$$

However, in less aggressive environments, the designer may choose to include the corrosion barrier (or some portion thereof) in the structural calculations.

In some cases, the structural thickness may be increased to accommodate other factors such as vacuum or stiffness requirements. Small diameter adhesively bonded piping may also have increased thickness to provide adequate bond length in the joint.

Design Manual

Filament Wound Pipe Wall Thickness‡ (in.)					
Diameter**	Butt Joint System			Adhesive Joint System	
	150 psi	100 psi	50 psi	150 psi	100/50 psi
	Total Thickness	Total Thickness	Total Thickness	Total Thickness	Total Thickness
1	0.19	0.19	0.19	0.19	0.19
1.5	0.19	0.19	0.19	0.19	0.19
2	0.19	0.19	0.19	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19
4	0.19	0.19	0.19	0.20	0.20
6	0.22	0.19	0.19	0.24	0.24
8	0.26	0.21	0.19	0.28	0.24
10	0.30	0.24	0.19	0.32	0.27
12	0.34	0.26	0.19	0.37	0.31
14	0.37	0.29	0.20	N/A	N/A
16	0.41	0.31	0.21	N/A	N/A
18	0.45	0.34	0.22	N/A	N/A
20	0.49	0.36	0.24	N/A	N/A
24	0.56	0.41	0.26	N/A	N/A
30	0.67	0.49	0.30	N/A	N/A
36	0.79	0.56	0.34	N/A	N/A.

* Includes 0.11" non-structural Corrosion Barrier

** See Dimensional Catalogue for exact ID's. Contact RPS for pipe and fitting OD's. Fitting OD's will be considerably greater than pipe OD's.

Contact Molded Pipe and Fitting Design

The design of contact molded pipe and fittings is based on the short term ultimate strength properties of the liner and structural layers. The design method involves calculating the total number and type of reinforcing layers required rather than an overall thickness. Based on in-house testing and industry standards, the short-term unit strength of the various types of reinforcement used at RPS has been determined. This is compared with the overall strength required per the ISO formula. Factors of Safety (FOS), typically in the range of 6 to 10, are applied to the stress calculation.

Example: 6"Ø 150 psi, contact molded pipe with 10:1 FOS

$$\begin{aligned} \text{Unit Hoop Stress} &= \text{Pressure} \times \text{diameter} \times \text{FOS} / 2 \\ &= 150 \times 6 \times 10 / 2 = 4500 \text{ lb/in.} \end{aligned}$$

$$\begin{aligned} \text{Unit Axial Stress} &= \text{Pressure} \times \text{diameter} \times \text{FOS} / 4 \\ &= 150 \times 6 \times 10 / 4 = 2250 \text{ lb/in.} \end{aligned}$$

A variety of possible reinforcements could be used to meet these requirements. However, a trial and error approach is generally required. For example, if this pipe were to be constructed from 1.5 oz/ft² chopped strand and 24 oz/yd² woven roving, the following combination could be used:

4 layers of chopped strand @ 600 lb/in. = 2400 lb/in.

2 layers of woven roving @ 1250 lb/in. = 2500 lb/in.

Total Strength = (2400 + 2500) = 4900 lb/in.

This would satisfy both the hoop and axial strength requirements.

Pressure Stress Multipliers and Fitting Design

Many fittings are subject to higher pressure stress than the ISO formula would indicate due to their geometric configuration. For example, size on size tees typically have a pressure stress of approximately 2 times that of the same diameter pipe. To compensate for this, the designer should include "pressure stress multipliers" (PSM) in the ISO equation.

$$\text{Unit Hoop Stress} = \text{Pressure} \times \text{Diameter} \times \text{FOS} \times \text{PSM} / 2$$

By not including a pressure stress multiplier (PSM) in the stress calculation, the true factor of safety is reduced. Therefore, the appropriate multiplier should be calculated and included in the fitting design. It should be noted that the above mentioned increased stress may only be localized, and thus, the reinforcement required to compensate for the effect may also only need to be localized. This needs to be examined on a case by case basis and may require hydrostatic testing and/or finite element analysis for verification.

The nature of fitting construction and the effect of the pressure stress multiplier results in fittings which may be considerably thicker than the adjoining pipe, particularly in the case of tees. This needs to be considered with respect to clearances with structural steel and other pipe lines or equipment.

Design for Vacuum



Very often, thin-walled piping, and particularly ducting, must be designed to handle vacuum loads. The resistance to vacuum is related to the stiffness of the pipe or duct, which is related to the thickness and modulus of elasticity. Generally, the design for vacuum service follows two approaches.

Low to Moderate Vacuum Rating / Small Diameters:

- Increase wall thickness to provide required collapse pressure.

High Vacuum Requirements / Large Diameters:

- Use Stiffening Ribs to provide required collapse pressure

The decision to use stiffening ribs is generally a question of economics. That is, stiffening ribs are used at the point when the cost associated with the required increase in pipe wall thickness exceeds the cost of applying the ribs.

For pressure piping, vacuum resistance is generally achieved through increased wall thickness as the application of ribs could create high local stresses when the pipe operates under pressure.

The collapse pressure of pipe or ducting is calculated based on the "Structural Plastic Design Manual" equations.

For Pipe/Duct without ribs

(assumed to be an infinitely long cylinder)

$$P_{cr} = \frac{E_h t^3}{4 \cdot (1 - \nu_{T/L} \cdot \nu_{L/T}) \cdot R^3}$$

Where,

E_h = Hoop flexural modulus of pipe/duct

t = Wall thickness of pipe/duct

$\nu_{T/L}$ = Poisson's ratio for hoop stress causing axial strain

$\nu_{L/T}$ = Poisson's ratio for axial stress causing hoop strain

R = Pipe/Duct outside radius

For Pipe/Duct with ribs

$$P_{cr} = \frac{5.5 \cdot k_n \cdot Ax^{1/4} D_o \cdot ^{3/4}}{L \cdot R \cdot \sqrt{R}}$$

Where,

k_n = "knockdown factor" = 0.9

$Ax = E_a \cdot t$

$$D_o = \frac{E_h \cdot t^3}{12 \cdot (1 - \nu_{T/L} \cdot \nu_{L/T})}$$

E_a = Axial tensile modulus of pipe/duct (psi)

L = Length between ribs (in.)

R = Pipe/Duct outside radius

Corrosion Barrier Addition: The corrosion barrier (liner) is generally added to the thickness calculated above, as follows:

$$t_{total} = t_{liner} + t_{structure}$$

In less aggressive environments, the designer may choose to include the corrosion barrier (or some portion thereof) in the structural calculations. However, the composite properties (i.e. Hoop Modulus of total wall, Poisson Ratio's of total wall, etc.) must be determined and used in the calculations. This is particularly important in vacuum design since the collapse pressure is related to the thickness cubed ($P_{critical} \propto t^3$)

ABOVE GROUND PIPING SYSTEM DESIGN



The design of piping systems using RPS piping, or most other FRP piping, differs from steel piping system design. The differences in design are related to the differences in mechanical and physical properties between FRP and steel. Following are some important points to consider:

Differences between FRP and Steel

FRP has greater flexibility than steel. ($E_{FRP} \approx 1/20th E_{steel}$)

- o Requires closer support spacing
- o Larger oscillations occur more easily
- o Earlier column failure possible
- o Loads on supports are lower for a given amount of expansion

FRP has a lower longitudinal strength than steel

- o Requires closer support spacing
- o Requires support of heavy valves
- o Requires prevention of severe water hammer
- o Longitudinal loads are relatively more important

FRP does not yield (no plastic deformation)

- o Stress concentrations and point loads must be avoided

Cold Temperature Design

- o Most properties including impact resistance remain unchanged for temperatures down to -50 deg. F

FRP has a greater coefficient of thermal expansion (about 2.5 times steel)

- o Requires greater allowance for movement

Strength and rigidity drop rapidly above 200 deg. F.

- o Careful design needed at high temperatures.
- o Hot spots must be avoided

Creep

- o FRP will creep under long term steady load, however, this will vary greatly with fiber orientation. The high safety factors used in FRP design (typically 6 to 10) generally account for this.

Note:

FRP fittings may be significantly thicker than the adjoining FRP pipe. Give careful consideration to clearances in tight areas.

General Recommendations and Comments on FRP Piping Systems Design

- Give early consideration to supports since FRP piping generally requires closer support spacing than steel piping.
- FRP piping is flexible and undesirable longitudinal oscillations can occur at pump start-up etc.. To prevent this, anchor each straight leg once, and only once.
- Control side-ways oscillations by replacing every fourth hanger with a guide
- All clamps, hangers and anchors should have an 1/8" rubber lining to prevent chafing of the FRP and provide a uniform contact surface
- Expansion joints should be used sparingly (see pg. 19 for more detail)
- Do not rely on friction for support of risers and anchors, use FRP thrust collars
- Friction clamps should only be relied on to support or resist very small longitudinal loads, when in doubt use FRP thrust collars.
- Include guides as required to prevent column-type buckling failure (see ahead for more detail)
- Heavy valves must be supported independently
- Water-hammer must be minimized
- Incorporate field joints generally at each change of direction. Keep in mind that FRP flanges should not be "drawn" into place and should freely line-up.
- Avoid bolting full face FRP flanges to raised face flanges. Use FRP Vanstone style flanges or spacers as required.
- For other than flange supports, avoid locating supports at or adjacent to fittings. Allow enough room between the support and the fitting for the joint overlay.

Recommended Hanger Spacing

Note: Refer also to information on guide spacing to prevent column-type buckling (page 19).

Support Spacing (ft.) @ 150 deg. F* for RPS P150 & A150 piping.				
Diameter	Single Span		Continuous Span	
	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	7.0	7.0	9.0	9.0
1-1/2	7.3	7.1	9.3	8.7
2	8.0	7.5	9.8	9.2
3	8.4	7.7	10.3	9.5
4	8.7	8.0	10.7	9.8
6	10.9	10.0	13.3	12.2
8	10.9	10.0	13.1	12.0
10	13.0	11.6	15.6	13.9
12	13.7	13.0	16.4	15.6
14	13.7	13.0	16.4	15.6
16	15.2	14.0	18.2	16.8
18	16.7	15.0	20.0	18.0
20	17.4	15.5	20.9	18.6
24	19.1	17.0	22.9	20.4
30	20.5	18.3	24.6	22.0
36	22.1	19.7	26.5	23.6

Criteria: Strength Ratio (SR) in structures > 1.6; Deflection < 0.5"
*For 180 deg. F service, derate span by 0.90

For information on support spacing for pressure ratings, specific gravities, or diameters other than those listed above, please contact RPS directly

Pipe Supports

Supports for RPS FRP piping should be designed with the principles mentioned in the previous sections borne in mind. For example, the supports should ensure point loading of the pipe does not occur, and they should ensure there is no chafing or abrasion between the pipe and the support. A complete line of standard supports suitable for RPS piping is included in the RPS Pipe Support Catalog. The type of support to use for a specific application will depend upon a number of factors, the most important of which are the intended function of the support and the configuration of the available structural steel. The basic types of supports are weight supports, guides, and anchors. Various configurations of each of these types of supports are shown in the RPS Pipe Support Catalog. The choice of which type of weight support to use for example, would depend on whether the pipe will be supported from underneath the pipe, or from above the pipe. In the first case, a Slide Shield, a Flange Slide, or a Base Slide would all be suitable support types. In the latter case, a Clamp or Clevis Hanger would be appropriate choices.

The supports shown in the RPS Pipe Support Catalog are standard types of supports only. Custom-designed supports are also available as required to suit particular project requirements. Please contact RPS for further information.



Thermal Expansion Design

FRP piping will expand when heated. The amount of expansion that occurs depends on:

- The difference between the maximum operating and installed temperatures
- The coefficient of thermal expansion (which typically equals 1.4×10^{-5} in/in/deg.F for RPS piping)
- The length of pipe that is free to expand

To deal with thermal expansion, the designer generally follows one of two approaches:

- Create a semi-rigid support system
- Create a rigid (anchored) support system

These two types of approaches are explained in more detail below.

Semi-Rigid Piping System

As mentioned above, FRP will want to expand when heated. If the piping is totally free to expand, it will do so, and no stress will be introduced into the piping system as a result of the temperature change. However, this is not normally the case as changes in direction and pipe supports generally provide some resistance to expansion. This creates stress in the piping and introduces forces on the supports. By controlling the length of straight runs of piping and the length of off-set legs, the designer can most generally control the thermal expansion. The two basic principals that must be satisfied are:

- Provide sufficient support to carry the self weight of the pipe and other loads such as wind and snow.
- Provide enough flexibility to absorb thermal expansion

These two principals are often in conflict with one another, which can make the design process a trial and error procedure. The recommended hanger spacings, listed at the start of this section, provide sufficient support for self weight. The most common method of providing the required flexibility in the system is with changes in direction or offset legs. It should be noted, however, that the change in direction should generally be at an elbow, not at branch connections such as tees or saddles.

Design Manual

The required length of an offset leg can be calculated as follows:

$$L_{leg} = 1/12 \cdot \{ 3 \cdot E \cdot I \cdot \Delta L / M \}^{0.5} \text{ (ft.)}$$

Where,

E = Axial Modulus of elasticity

I = Moment of Inertia of total wall

$$= \pi / 64 (OD^4 - ID^4)$$

ΔL = Change in length = $C_e \cdot L_f \cdot \Delta T$

and

C_e = Coefficient of thermal expansion

L_f = Length from anchor

ΔT = Difference between max. operating and installed temperatures

M = Allowable Bending Moment = $S_b \cdot Z_s$

and

S_b = Allowable bending stress

Z_s = Section Modulus of structure

$$= 2 \cdot I_s / OD$$

I_s = Moment of Inertia of structure

$$= \pi / 64 (OD^4 - (ID + 2 \cdot t)^4)$$

Example: What is the required offset length for the given piping arrangement and parameters?

OD = 8.52 in.

T = 0.26 in. $T_s = 0.15$ in.

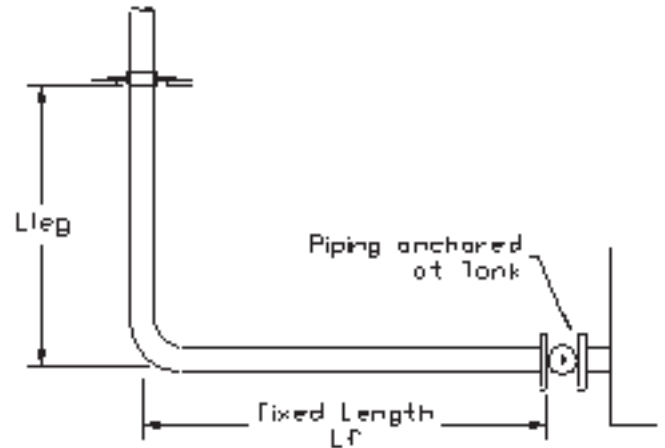
$S_b = 650$ psi

E = 1.29e6 psi

$L_f = 24$ ft. = 288 in.

$\Delta T = 100$ deg. F

$C_e = 1.4 \times 10^{-5}$ in/in/deg.F



Laterally Free Length Required at Elbow*

ID	Expansion (in.)						
	0.2	0.4	0.6	0.8	1	2	4
1	1.9	2.7	3.3	3.8	4.2	5.9	8.4
1.5	2.3	3.3	4.0	4.6	5.2	7.3	10.3
2	2.8	4.0	4.9	5.7	6.4	9.0	12.7
3	4.0	5.7	6.9	8.0	8.9	12.6	17.9
4	5.3	7.4	9.1	10.5	11.8	16.6	23.5
6	5.9	8.3	10.2	11.7	13.1	18.6	26.3
8	7.7	10.9	13.4	15.5	17.3	24.4	34.6
10	8.4	11.9	14.6	16.9	18.8	26.7	37.7
12	9.1	12.8	15.7	18.1	20.3	28.7	40.6
14	9.7	13.7	16.7	19.3	21.6	30.6	43.2
16	10.3	14.6	17.8	20.6	23.0	32.6	46.0
18	10.8	15.3	18.7	21.6	24.2	34.2	48.4
20	11.3	16.0	19.6	22.7	25.3	35.8	50.6
24	12.2	17.3	21.1	24.4	27.3	38.6	54.6
30	13.4	19.0	23.2	26.8	30.0	42.4	60.0
36	14.6	20.6	25.2	29.1	32.6	46.1	65.2

* When the offset leg terminates at a flange or tee, the free length should be increased by 20%

Solution:

$$I_{total} = \pi/64 \cdot (8.52^4 - 8.0^4) = 57.6 \text{ in}^4$$

$$\Delta L = 1.4 \times 10^{-5} \cdot 288 \cdot 100 = 0.40 \text{ in.}$$

$$I_{struct} = \pi/64 \cdot (8.52^4 - (8.0 + 0.11 \times 2)^4) = 34.5 \text{ in}^4$$

$$Z_{struct} = 2 \cdot I_s / OD = 2 \cdot 34.5 / 8.52 = 8.1 \text{ in}^3$$

$$M_{allow} = S_b \cdot Z_s = 650 \times 8.1 = 5265.0 \text{ in-lb}$$

Therefore,

$$L_{leg} = 1/12 \cdot \{ 3 \cdot 1.29E6 \cdot 57.6 \cdot 0.40 / 5265.0 \}^{0.5} = 10.85 \text{ ft.}$$

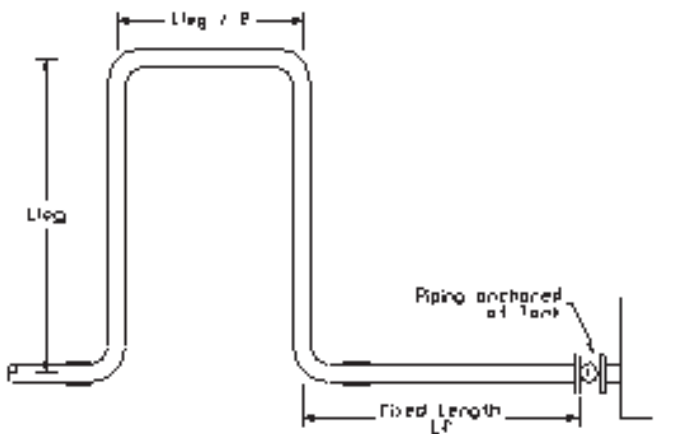
This is the minimum offset that should be used to ensure the bending stress in the piping is maintained at an acceptable level.

Corrosion Barrier Addition: When calculating thermal forces and stresses, it is very important to consider the **effect of the corrosion barrier**. This is summarized below:

- The thermal force should be calculated based on the total wall area (i.e include the corrosion barrier in this calculation).
- The composite modulus should be used to calculate the thermal load. However, since the structural modulus is generally slightly higher, the structural modulus can be used to provide a slightly more conservative result.
- The structural wall area should be used to determine the pipe stress resulting from the thermal force. In some less aggressive environments, the designer may choose to consider the contribution of the corrosion barrier (or some part thereof) for the stress calculation.

Expansion Loops

When changes in direction are not possible or practical, the designer may want to consider creating an **expansion loop** in the system to



absorb the thermal growth and force. The length of the loop will be the same as the free leg length calculated in the above example. The axial portion of the loop is normally taken as ½ of the leg length. Guides should be included immediately upstream and downstream of the expansion loop.

Rigid Piping System

An alternative to the semi-rigid piping system is the rigidly restrained piping system. With this system, thermal expansion is prevented by anchoring the pipe in various locations. The corresponding forces are transferred into the support structure and the piping itself. This system is possible due to the low elastic modulus of FRP in comparison to steel. As demonstrated in the example calculation, the low elastic modulus creates forces which are often easily handled by the support structure.

$$\text{Force} = E \cdot A \cdot C_e \cdot \Delta T$$

Where:

E = Axial modulus of elasticity

A = Cross sectional Area of piping

C_e = Coefficient of thermal expansion

ΔT = Difference between operating and installed temperature

Example Part A: What is the thermal force at anchor #1 for the given piping arrangement?

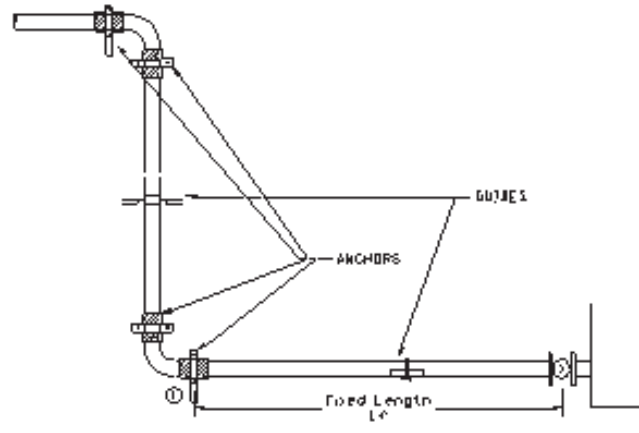
$$OD = 6.48 \text{ in.}$$

$$ID = 6.00 \text{ in.}$$

$$C_e = 1.4 \times 10^{-5} \text{ in/in/deg.F}$$

$$E = 1.5e6 \text{ psi}$$

$$\Delta T = 50 \text{ deg. F}$$



Solution:

$$\text{Area} = \pi \cdot (6.48^2 - 6.00^2) / 4 = 4.70 \text{ sq.in.}$$

$$\begin{aligned} \text{Force} &= 1.5 \times 10^6 \cdot 4.70 \cdot 1.4 \times 10^{-5} \cdot 50 \\ &= 4,940 \text{ lbs} \end{aligned}$$

Note: this is the actual force and does not include a design factor (or factor of safety).

Example Part B: What is the stress on the piping given the above anchoring force.

Solution:

$$\text{Stress} = \text{Force} / \text{Structural Area}$$

Where,

$$\begin{aligned} \text{Structural Area} &= \pi \cdot (6.48^2 - 6.22^2) / 4 \\ &= 2.59 \text{ sq.in.} \end{aligned}$$

$$\begin{aligned} \text{Stress} &= 4940 \text{ lbs} / 2.59 \text{ sq.in.} \\ &= 1905 \text{ psi}^* \end{aligned}$$

*Note: This is the stress on the structural wall assuming a 0.11" thick corrosion liner.

Guide Spacing and Column-type Buckling

In the general recommendations for supporting FRP piping is pointed out that **every 4th hanger should be replaced by a guide to prevent unwanted oscillations**. However, guides are also required to prevent column-type buckling in a rigid system. This is demonstrated in the example below:

Example: Determine the required hanger and guide spacing for the rack piping shown below. As shown in the sketch, the piping is rigidly restrained at the valve and at the change in direction.

$$\text{OD} = 6.48 \text{ in.}$$



$$\text{ID} = 6.0 \text{ in.}$$

$$\text{Ce} = 1.4 \times 10^{-5} \text{ in/in/deg.F}$$

$$E = 1.5 \text{e}6 \text{ psi}$$

$$\Delta T = 50 \text{ deg. F}$$

$$\text{Lf} = 100 \text{ ft.}$$

Solution: The support spacing must first be determined. For RPS 6"Ø, 150psi rated piping, the maximum support spacing would be 10.9' (see "Recommended Hanger Spacing Table")

$$\text{Support Spacing} < 10.9 \text{ feet}^*$$

* This could be increased to 13.3' after three (3) simple supports since the arrangement would be considered a continuous support.

The thermal force on the anchor would be:

$$\text{Force} = E \cdot A \cdot \text{Ce} \cdot \Delta T$$

$$\text{where, Area} = \pi \cdot (6.48^2 - 6.00^2) / 4 = 4.70 \text{ sq.in.}$$

$$\text{Force} = 1.5 \times 10^6 \cdot 4.70 \cdot 1.4 \times 10^{-5} \cdot 50 = 4,940 \text{ lbs}$$

The guide spacing depends on the critical buckling load of the piping arrangement calculated as follows:

$$P_{\text{critical}} = \pi^2 \cdot E \cdot I / L^2$$

The equation can be re-arranged to solve to L (the critical buckling length)

$$L_{\text{critical}} = (\pi^2 \cdot E \cdot I / P_{\text{applied}})^{1/2}$$

Where,

$$E = \text{Axial modulus of pipe} = 1.5 \text{ e}6 \text{ psi}$$

$$I = \text{Moment of inertia of cross section}$$

$$= \pi/64 \cdot (\text{OD}^4 - \text{ID}^4)$$

$$= \pi/64 \cdot (6.48^4 - 6.0^4) = 22.93 \text{ in}^4$$

$$P_{\text{applied}} = \text{Applied compressive force} = 4940 \text{ lbs.}$$

$$\begin{aligned} L_{\text{critical}} &= (\pi^2 \cdot 1.5 \text{e}6 \cdot 22.93 / 4940)^{1/2} \\ &= 262 \text{ in} = 21.8 \text{ feet} \end{aligned}$$

Therefore, for this example, every second support (which were required at approximately 10' intervals) should be replaced by a guide to prevent column-type buckling.

Expansion Joint Use and Design

In some situations, it is not possible or practical to deal with expansion using changes in direction or expansion loops and/or the forces associated with a rigid system are too high for the piping or supports. In these situations, expansion joints can be used to absorb thermal growth. Some general comments regarding expansion joints and FRP piping are summarized below:



- Expansion joints are not normally required on small bore FRP piping systems as they are generally inherently flexible.
- Expansion joints may be required to absorb large differential expansion between, for example, steel tanks and FRP piping.
- Expansion joints may be used to isolate the FRP piping system from vibrating equipment such as large pumps or fans.
- When choosing expansion joints, the designer needs to consider that the required activation force needs to be smaller than would normally be suitable on similar diameter steel piping.
- The use of tie-rods or limiting rods should be avoided if possible as these act to concentrate forces on the FRP flange and could result in damage to the FRP flange. If tie-rods are necessary, the FRP flange may require a steel backing ring to better distribute the pressure load.

Pipe Stress Analysis and Allowable Stresses

An ever increasing number of companies are choosing to design and analyze their piping systems using computerized pipe stress analysis programs. These programs can quickly provide the user with information on deflections, stresses and forces. Below are some general tips for analyzing RPS FRP piping using computerized analysis programs.

- An easy, yet accurate and conservative way to analyze FRP piping is to input a **total wall thickness and a corrosion allowance**. This will allow the program to calculate forces and weights based on the total wall but determine stress based on the structural or corroded wall. The inputs should be based on composite wall properties, keeping in mind the following:

- o Different modulus values are required for each diameter or diameter range.
- o Different coefficients of thermal expansion are required for each diameter or diameter range.
- o Different Poisson's ratios are required for each diameter or diameter range.
- o The same allowable stress can be used for all sizes, since the analysis is based on the structural wall only.

TIP – Consider setting-up a computer spreadsheet to quickly calculate the composite pipe properties for the required diameters!

- Consider entering the “maximum operating pressure” rather than the “rated pressure”. Very often companies purchase, for example, 150 psi rated piping, and use the piping for low pressure or even gravity feed. By using the maximum operating pressure in the pipe stress analysis, the user may be able to solve many stress problems.
- Stress analysis without a corrosion allowance (i.e. including some contribution of the corrosion barrier in the stress calculations) requires different allowable stresses for different diameter ranges, since the corrosion barrier will contribute less and less structurally as the diameter increases. This makes the analysis more complex and the designer should contact RPS directly for more information on this approach.

Allowable Stresses

RPS piping is filament wound and highly orthotropic in nature. In particular, the piping has different strength values related to pressure and bending.

For stress analysis based on the structural wall only (i.e. total thickness less the corrosion allowance). The following allowable stresses apply:

Allowable Stress	1"	– 2500 psi
@ 150 psi	1.5"	– 2300 psi
	2"	– 2400 psi
	3"	– 2550 psi
	≥ 4"	– 2600 psi

Design Manual

Allowable Stress 1" – 2500 psi
 @ 0 psi > 1" – 2000 psi

(Use linear interpolation for all pressures in between 0 and 150 psi)

Example: What is the allowable stress of 4" Ø RPS 150 psi rated piping operating at 80 psi?

$$\begin{aligned} \text{Allowable stress at 80 psi} &= 80 \cdot (2600-2000) + 2000 \\ &\quad (150-0) \\ &= 2320 \text{ psi} \end{aligned}$$

The above mentioned allowable stresses provide a *combined factor of safety of 6 to 1*

Note:

1. Many codes require the use of a "hot" and "cold" allowable stress; however the allowable stress for FRP piping applies to both the "hot" and "cold" allowable.
2. The analysis of thermal loads as separate from other loads such as pressure and weight is not appropriate for FRP piping. The stresses resulting from the combined loads, including thermal loads, must comply with the allowable stresses.
3. Allowable stresses for elbows are typically different than for filament wound pipe. The following values can be used:

Allowable Stress 1" – 3" – 1500 psi
 @ 150 psi 4" – 6" – 1800 psi
 > 6" – 2600 psi

Allowable Stress 1" – 3" – 1500 psi
 @ 0 psi 4" – 6" – 1800 psi
 >6" – 2900 psi

Stress Intensification Factors (SIFs)

Proper pipe stress analysis requires an understanding of stress intensification factors (SIFs). These factors are required to account for the increased bending stresses that occur in fittings as compared to straight pipe. Exact determination of SIF requires testing and/or finite element analysis. Typical SIFs are listed below. Please contact RPS for additional information.

Elbows (150 psi Rated)	
ID	SIF
1	1.5
2	1.5
3	2.0
4	2.0
6	2.0
8	3.0
10	3.0
12	3.0
14	3.4
16	3.5
18	3.7
20	3.7
24	3.8
30	4.0
36	4.1

Reducing Branches (150 psi Rated)

d/D*	SIF
≥ 0.5	2.3
< 0.2	1.5

*Use linear interpolation between these values

Tee's & Laterals (150 psi Rated)

ID	SIF
< 12"	2.3
> 12"	2.5

General Comments on SIF's

- SIF's will generally be higher than those listed for fittings with a lower pressure rating.
- The flexibility factor (k) for FRP fittings is often assumed to be 1.0. For larger diameter piping (eg. > 12" diameter), and for thin-walled piping, it may be helpful to take advantage of the inherent flexibility of elbows. More accurate values for the flexibility factor of these elbows can be calculated from:

$$K = 0.6 / h$$

where,

$$h = \frac{\text{Elbow thickness} \cdot \text{Bend radius}}{(\text{Diameter} / 2)^2}$$

BURIED PIPE DESIGN & INSTALLATION



FRP piping is considered to be flexible pipe and the design relies on the passive support of the soil around the pipe to resist loads from above. Therefore the designer needs to appreciate that the proper installation of buried FRP piping is at least as important as a proper design.

Buried Pipe Design

The design of buried FRP piping generally follows the guidelines of the American Water Works Association document AWWA M45. This manual supersedes the design information previously presented in AWWA C950. Buried pipe deflection is predicted using the Spangler equation which combines material properties with soil properties and live loads to predict an overall deflection.

$$\frac{\Delta y}{D} = \frac{(D_1 \cdot W_c + W_L) \cdot K_x}{0.149 \cdot PS + 0.061 \cdot E'} \quad (\text{deflection})$$

where,

D_1 = Deflection Lag factor (typically 1.5)

W_c = Vertical soil load = $\gamma_s \cdot H / 144$, psi

and

γ_s = Unit weight of overburden, lb/ft³

H = Burial depth to top of pipe, ft

$$W_L = \text{Live load on pipe} = P \cdot I_f / (144 \cdot L_1 \cdot L_2), \text{ psi}$$

and

$$P = \text{wheel load} = 16,000 \text{ lbs for HS-20}$$

$$\begin{aligned} I_f &= \text{Impact factor} \\ &= 1.1 \text{ for } 2' < H < 3' \\ &= 1.0 \text{ for } H > 3' \end{aligned}$$

$$\begin{aligned} L_1 &= \text{load width parallel to direction of travel} \\ &= 0.83 + 1.75 H \end{aligned}$$

$$\begin{aligned} L_2 &= \text{load width in direction perpendicular to travel} \\ &= 1.67 + 1.75H \text{ for } 2' < H < 2.48' \\ &= (43.67 + 1.75H)/8 \text{ for } H > 2.48' \end{aligned}$$

$$K_x = \text{Bedding coefficient} = 0.083 \text{ to } 0.1$$

$$PS = \text{Pipe stiffness} = EI / \{0.149 (r + \Delta y/2)^3\}$$

$$\begin{aligned} E' &= \text{Modulus of soil reaction, psi} \\ &(\text{depends on soil type and compaction}) \end{aligned}$$

The designer can examine the effects of the deflection in terms of stress or strain by using an empirical equation, which has been shown to provide a good correlation between field measurements and experimental results.

$$\begin{aligned} \sigma_b &= D_f \cdot E \cdot \left[\frac{\Delta y}{D} \right] \left[\frac{t_t}{D} \right] \quad (\text{stress due to deflection}) \\ \epsilon_b &= D_f \cdot \left[\frac{\Delta y_a}{D} \right] \left[\frac{t_t}{D} \right] \quad (\text{strain due to deflection}) \end{aligned}$$

where,

D_f = Shape factor based on soil and pipe stiffness

E = Ring flexural modulus, psi

Δy_a = Maximum allowable long term deflection, in.

t_t = Pipe total wall thickness, in.

D = Mean pipe diameter, in.

Design Manual

These values are compared with the long term ring bending strain divided by a design factor.

$$\sigma_b \leq \frac{S_b \cdot E}{FS}$$

or

$$\epsilon_b \leq \frac{S_b}{FS}$$

where,

S_b = Long term ring bending strain

FS = Design factor = 1.5

The effects of pressure also need to be examined and the pressure class of the piping determined based on the HDB.

for stress basis,

$$P_c < \{HDB/FS\} \cdot \{2 \cdot t/D\}$$

for strain basis,

$$P_c < \{HDB/FS\} \cdot \{2 \cdot E_h \cdot t / D\}$$

where,

P_c = Pressure class, psi

HDB = Hydrostatic design basis (psi for stress basis and in./in for strain basis)

FS = Minimum design factor = 1.8

t = Thickness of pipe reinforced wall, in.

D = Mean diameter of pipe, in.

E_h = Hoop tensile modulus, psi

The working pressure must be less than the pressure class denoted as:

$$P_w \leq P_c$$

The surge pressure should be less than:

$$P_s \leq 1.4 \cdot P_c - P_w$$

The effects of combined loading of pressure and bending are also examined and evaluated as follows:

for stress basis,

$$\frac{\sigma_{pr}}{HDB} \leq \frac{1 - \{(\sigma_b \cdot rc) / (S_b \cdot E)\}}{FS_{pr}}$$

and

$$\frac{\sigma_b \cdot rc}{S_b \cdot E} \leq \frac{1 - \{\sigma_{pr} / HDB\}}{FS_b}$$

for strain basis,

$$\frac{\epsilon_{pr}}{HDB} \leq \frac{1 - \{(\epsilon_b \cdot rc) / S_b\}}{FS_{pr}}$$

and

$$\frac{\epsilon_b \cdot rc}{S_b} \leq \frac{1 - \{\epsilon_{pr} / HDB\}}{FS_b}$$

where,

FS_{pr} = Pressure design factor = 1.8

FS_b = Bending design factor = 1.5

σ_{pr} = Working stress due to pressure, psi
= $P_w \cdot D / 2 \cdot t$

σ_b = Bending stress due to max. deflection, psi
= $D_r \cdot E \cdot (\delta d/D)(t_r/D)$

rc = Rerounding coefficient due to internal pressure

ϵ_{pr} = Working strain due to internal pressure
= $P_w \cdot D / (2 \cdot t \cdot E_h)$

ϵ_b = Working strain due to max. deflection
= $D_r \cdot (\delta d/D)(t_r/D)$

δd = Maximum permitted long term installed deflection, in.

The possibility of buckling also needs to be examined with the allowable buckling pressure calculated as follows:

$$q_a = (1/FS) \{32 \cdot R_w \cdot B' \cdot E' \cdot EI / D^3\}^{1/2}$$

where,

FS = Design factor = 2.5

R_w = Water buoyancy factor
= $1 - 0.33 (hw/h) \geq 0$

and

hw = Height of water above pipe, ft.

B' = Empirical coefficient of elastic support
 $= 1 / (1 + 4e^{-0.065H})$

$h \approx H$ = Height of soil above pipe, ft.

E' = Modulus of soil reaction, psi

This equation is valid for:

$2' \leq H \leq 80'$ without vacuum

$4' \leq H \leq 80'$ with vacuum

The allowable buckling pressure is compared with the applied buckling loads as follows:

$$\gamma_w \cdot hw + R_w \cdot W_c + P_v \leq q_a$$

where,

γ_w = Specific weight of water = 0.0361 lb/in³

P_v = Internal vacuum pressure, psi

When live loads are present, this should be examined separately. The simultaneous effect of live load and internal vacuum need not typically be considered.

$$\gamma_w \cdot hw + R_w \cdot W_c + WL \leq q_a$$

Buried Pipe Installation

As mentioned at the start of this section, the installation of buried pipe is at least as important as the proper design of the piping. Below is a summary of some of the important points to consider when installing buried FRP piping.

- The initial excavation should encompass the pipe diameter plus 6" to 12" below the pipe and at least 12" on either side. The side walls should be adequately sloped or safely supported.

The bedding should consist of at least 6" of well graded, granular material (ex. sand or gravel) which will allow for drainage of ground and surface water under the piping. This material should be slightly shaped to accept the contour of the pipe and well compacted to at least 98% Proctor Density. All large rocks should be removed and any soft spots in the native soil should be excavated and re-filled.

- The "haunches" of the pipe need to be well supported with the above mentioned fill and the fill must be well compacted

(typically >98% Proctor) using hand equipment and small machinery.

- The remainder of the fill in the pipe-zone should be placed in reasonable lifts (typically 6" at a time) and must be well graded to allow for proper drainage and well compacted (typically > 98% Proctor) to provide support for the pipe side walls. Care must be taken, however, to ensure the piping does not go out of round during backfilling & compacting.
- In-situ or native soil can generally be applied in 12" lifts to fill outside of the pipe zone. The top layer of the material should be stabilized to prevent erosion.
- Do not pass spreading equipment directly over the pipe until 4' of fill has been placed over the crown.
- Groundwater should be redirected away from the buried pipe using culverts or swales.
- FRP piping is lightweight and, when empty, will float-out of its bedding if surface and ground water are not properly redirected. Once the piping has "floated" it must be reinstalled.
- For severe traffic loads such as at railway crossings, the FRP piping should be concrete encased.
- Use a flexible gasket to protect the outside of the buried pipe where it passes through a concrete wall.
- Watch for differential soil movement where buried pipe passes through walls.
- If O-ring joints are used, concrete thrust blocks are required at significant changes in direction.
- For O-ring joints, remove material under the spigot to lessen the chance of foreign material entering the bell during insertion.
- If butt and wrap joints are used, the area under the joint must be sufficiently excavated to allow the worker to apply and roll-out the reinforcing material.

RPS is also experienced in the design of partially buried piping. This design and installation method can provide reduced wall thickness compared to fully buried piping due to the reduction of soil loading. It is critical, however, that well compacted soil be placed around the piping sufficient to hold the piping in place and maintain roundness.

References

For more information on buried piping design and installation refer to:

RPS Pipe & Fittings Installation Manual

American Water Works Association - "Fiberglass Pipe Design – AWWA M45"

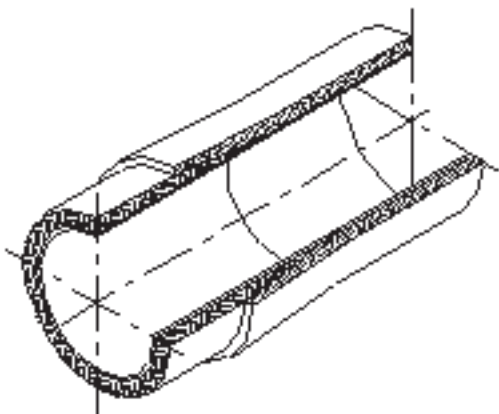
"Standard Practice for Underground Installation of Fiberglass Pipe – ASTM D 3839" – ASTM Standard

JOINING SYSTEMS



RPS utilizes four (4) major types of joining systems on our products. The designer needs to carefully examine each system to determine which best suits the particular application. A description of each joining system from a design standpoint is provided below:

RPS Tapered Adhesive Joint



The RPS Tapered Adhesive joint utilizes a matching bell and spigot system combined with a specially formulated adhesive to provide quick and easy assembly of numerous combinations of pipe and fittings.

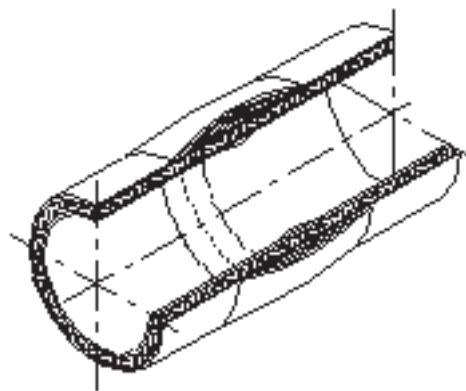
- Available in 1"Ø to 12"Ø
- Quick to assemble (about 3 times faster than butt and wrap joint)
- Self-aligning due to tapered fit
- Provides excellent chemical resistance due to continuity of the corrosion barrier and thin adhesive line.

- Adhesive formulated using the same resin as the pipe (bis-A vinyl ester or epoxy novolac vinyl ester)
- Some limitations on fittings available (see RPS Dimensional Catalogue for more information)
- Requires minimal training
- Requires specialized tool for field tapering (available to rent or purchase).
- Pipe wall thickness and/or liner thickness may be limited; however various options do exist (consult RPS directly for more information)

Butt & Wrap Joint

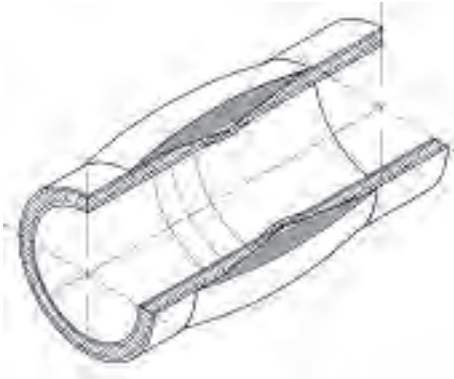
The Butt and Wrap joint is an industry standard providing simple assembly of an unlimited number of components. RPS offers both a "straight" and "tapered" butt joint with the details summarized below.

Straight Butt & Wrap Joint



- Available in all sizes / laminate combinations
- Simple assembly procedure
- Provides good corrosion resistance
- Ends can be "capped" (ex. 2 layers of Veil) to increase corrosion resistance
- Inside lay-up recommended on larger diameters (> 20") to improve chemical resistance.
- Provides same axial strength as pipe
- Has generally lowest burst strength of all bonded joint types
- Has high bending strength

Tapered Butt & Wrap Joint

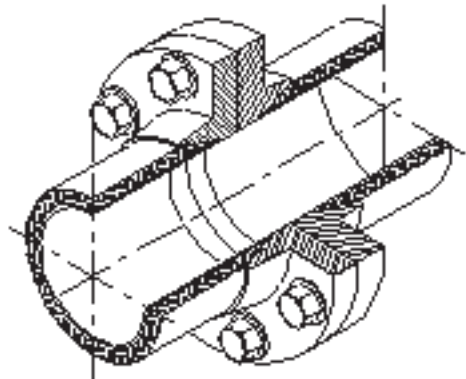


- Available in all sizes / laminate combinations
- Offers improved chemical resistance over straight butt joint by providing continuous corrosion liner. Comparable to tapered adhesive joint.
- Offers increased pressure strength over straight butt joint
- More time consuming to install than a straight butt joint.
- More costly than straight butt joint due to increased labour component
- Requires more sanding in the field compared to straight butt joint.
- Inside lay-up recommended on larger diameters (> 20") to improve chemical resistance.

Flanged Joint

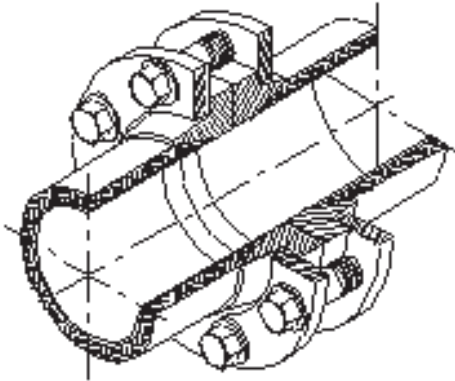
Flanged joints may be used to connect pipe and fittings, and to connect to equipment. RPS offers full face style flanges and Lap Joint style flanges as summarized below. Standard drilling for flanges conforms to ANSI B16.5 Cl.150 for $\leq 24"$ \emptyset and ANSI B16.47 Series A Cl.150 for $> 24"$ \emptyset . Other drilling patterns are available (eg. DIN 2501 PN10)

Full Face Flange



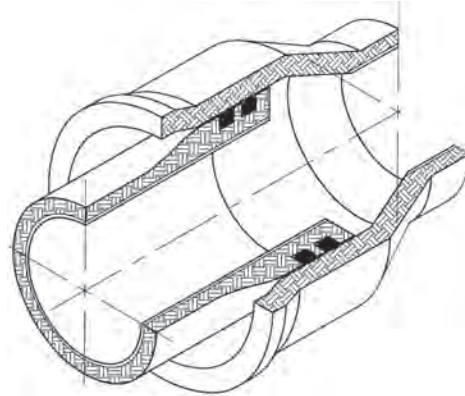
- Available in all sizes
- Allow for dismantling of components
- Quick to assemble in field
- Most costly of all joint types
- Experience has shown flanges offer the greatest potential for leaks
- Requires bolting compatible with the process
- Requires gaskets compatible with the process although soft (60-70 durometer) EPDM are most common
- Cannot use "ring" gaskets
- Can be damaged by over-torquing
- FRP flanges must be properly aligned to avoid overstressing during installation, cannot be forced into place.
- Sealing rings on full face flanges provide sealing at lower bolt torques

Lap Joint Style Flange



- Available in all sizes
- Allows some rotation adjustment
- Seals at lower torque compared to full face flange
- Similar cost to full face in large diameters, more costly in small diameters
- Also requires proper alignment to prevent overstressing at installation
- Loose ring (generally mild steel). Coating should be compatible with the service conditions
- Bolts and rings must be compatible to avoid corrosion
- Sealing rings on lap joint flanges provide sealing at lower bolt torques

O-Ring Joint



Generally used with large diameter buried pipe to provide quick installation.

- Available in most sizes
- Allows for quick installation
- Available in high pressure ratings
- Does not provide axial restraint, therefore thrust blocks required at significant changes in direction.
- Provides approximately 1° of angular adjustment
- Has good chemical resistance, but for more severe applications, o-ring material must be chosen to suit service conditions.
- A “double o-ring” allows for testing prior to service
- Not recommended for slurry applications

General Comments on Joining Systems

Whenever possible, RPS recommends the use of our *Tapered Adhesive* joining system to provide high chemical resistance and a low installed cost. For sizes 14"Ø and larger, choose the *Straight Butt & Wrap* system, if possible, to minimize sanding in the field and improve installation time. For severe corrosion environments ($\geq 14''\text{Ø}$), choose the *Tapered Butt & Wrap* system, or choose edge-capping and the straight butt and wrap system. Avoid flanged joints to minimize cost and reduce the risk of leaks. Where flanged joints are necessary, consider Lap Joint flanges on larger diameters ($\geq 14''$) to offer adjustment and provide superior sealing capability.

QUALITY ASSURANCE and RESEARCH & DEVELOPMENT

RPS Composites' quality assurance program is based on the ISO 9001:2015 Standard and includes written procedures and work instructions covering all aspects of the Company's operation, including design and document & data control. All calculations and drawings affecting the fit, form or function of our products are reviewed by our engineers to ensure compliance to the required specifications and standards. In addition, our R&D department is continuously testing our existing product line as well as exploring new possibilities to improve existing products or create new products.

REFERENCES

The following is a list of references that contain useful information relating to the design of FRP piping and fittings. The references are categorized by various subjects; however, some of the references may contain information beyond the main subject.

General Information on FRP Design

"Fiberglass Pipe Handbook" – The Composites Institute of the Society of Plastics Industry

"Corrosion Resistant Plastic Composites in Chemical Plant Design" – John H. Mallinson

"Custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment PS 15-69" – National Bureau of Standards

"Structural Plastics Design Manual" – American Society of Civil Engineers

"Fiberglass Pipe Design – AWWA M45" – American Water Works Association

"Reinforced plastic pipes, fittings and joints for process plants – BS 6464" – British Standards Institute

"Design and construction of glass reinforced plastics (GRP) piping systems for individual plants or sites – BS 7159" – British Standards Institute

Seismic & Wind Design

"Minimum Design Loads for Buildings and Other Structures (ASCE 7)" – American Society of Civil Engineers

Stress Intensification Factors (SIF's)

"Design and construction of glass reinforced plastics (GRP) piping systems for individual plants or sites – BS 7159" – British Standards Institute

Regulatory Codes Applicable to FRP Piping

"Process Piping – ASME B31.3" – American Society of Mechanical Engineers

"Power Piping – ASME B31.1" – American Society of Mechanical Engineers

Pipe Support and Pipe Stress Analysis

"Piping and Pipe Support Systems" – Paul R. Smith / Thomas J. Van Laan

Testing and Research

"Standard Test Method for Tensile Properties of Plastics – ASTM D 638" – ASTM Standard

"Standard Test Method for Flexural Properties – ASTM D 790" – ASTM Standard

"Standard Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings – ASTM D 1599" – ASTM Standard

"Standard Test Method for Longitudinal Tensile Properties of Fiberglass Pipe and Tube – ASTM D 2105" – ASTM Standard

"Standard Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor – ASTM D 2583" – ASTM Standard

"Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass Pipe and Fittings – ASTM D 2992" – ASTM Standard

"Standard Specification for Filament Wound Fiberglass Pipe – ASTM D 2996" – ASTM Standard

"Standard Specification for Machine Made Fiberglass Flanges – ASTM D 4024" – ASTM Standard

"Standard Specification for Contact Molded Fiberglass Flanges – ASTM D 5421" – ASTM Standard

Design Manual

RPS Composites Inc.

740 Main Street
P.O. Box 299
Mahone Bay, Nova Scotia
Canada B0J 2E0
Tel: (902) 624.8383 | (800) 343.9355
Fax: (902) 624.6395
www.rpscomposites.com

RPS Design Manual - Dec 2016



RPS Installation Manual



Engineered Composite Solutions



TABLE OF CONTENTS

Purpose and Intended Use.....	3
Materials.....	4
Safety.....	6
Installation.....	12
Testing.....	18
Bonding Procedure Specification for RPS 150 psi Tapered Adhesive Joint	20
Type 'B' Taper Tool Instructions for 1" - 12" (25-200mm) Dia.	30
Bonding Procedure Specification for RPS 150 psi Butt & Wrap Joints.....	31
PEEL-A-BOND™	
Purpose, Handling, and Removal.....	53
Flange Joining.....	54
O-Ring Joining	57
Bonder Qualification Procedure (P-150/A-150/H-150)	59
'A' Liner Repair Paste Kit.....	61
Saddles	
Purpose and Installation	64

PURPOSE & INTENDED USE

This manual has been prepared by RPS and is supplied for the purchaser's assistance. It should be read carefully by all those using RPS products because of the nature of the information contained. Unless the purchaser has prescribed particular installation procedures, compliance with the procedures outlined herein is essential for proper performance of RPS products.

The manual covers certain aspects of handling, storage, safety, inspection, joining, assembly, and installation of RPS pipe, fittings, and related products.

The information contained in this manual is based on RPS' experience with installation criteria as a manufacturer and supplier of RPS products. However, it is the purchaser's primary responsibility to ensure proper use of RPS products.

By its written warranty, RPS has warranted that its products are free from defects in materials and workmanship when installed in accordance with this manual and when exposed to the purchaser's represented operating conditions. RPS is not responsible for actual product installation, system design, or system performance. The owner, engineer, or contractor (or their agents) are responsible for specifying system design and all procedures for installation, inspection, and satisfactory system performance; and are responsible for ensuring:

- a) this manual and all other procedures, developed for installation, inspection, and system performance, are supplied to any person or legal entity using in any way RPS products; and
- b) the proper procedures for installation, inspection, and system performance are followed by any person or legal entity using in any way RPS products.

RPS' liability is limited to the price of the products supplied, as set out in the warranty. Reference should be made to the RPS Warranty for particulars.

If the purchaser has any questions about RPS products installation, inquiries should be directed to RPS prior to design, if possible, and if not, prior to installation. RPS will endeavour to assist customers with the installation of its product, but in all situations, it is the purchaser's primary responsibility to ensure proper use of RPS products.

RPS continually endeavours to improve its products. These changes may necessitate changes in this manual. The purchaser should ensure it uses a current version of the Pipe and Fittings Installation Manual.

Pipe & Fittings Installation

MATERIALS

Receiving Material

- 1) On arrival inspect load for:
 - shifting of load
 - dislocation of supports
 - damaged cartons or crates
 - damaged goods
- 2) Immediately report any problems to the carrier and to RPS

Unloading and Handling

- 1) Handle FRP products with care to prevent damage
- 2) Piping shipped "uncrated" should only be unloaded by:
 - hand (small light sizes only)
 - slings or ropes attached in 2 places, lifted by hoist or forklift (all sizes)
 - forklift (for 12" dia. and smaller only - not stacked)
- 3) Pipe, fittings, or headers shipped "crated" should only be unloaded by:
 - hand (small crates only)
 - slings or ropes using hoists
 - forklift
- 4) Do not lift pipe by inserting forks into ends of pipe.
- 5) Do not drop or throw FRP products, chemicals, or taper tools from the truck to the ground. Do not rest pipe on rocks or unlevel ground.
- 6) Pipe "ends" are fragile; HANDLE WITH CARE.
- 7) DO NOT USE CHAINS OR CABLES.
- 8) NO SMOKING when handling resin, paste, adhesives, or chemicals
- 9) Do not roll FRP pipe unless over a smooth surface.

Transporting

- 1) Avoid "point loading" to prevent damage. If necessary, cover supports with carpet or wood saddles to disperse loads when transporting large pipes or headers.

- 2) Cover forklift "forks" with wood or carpeting to protect pipe when transporting uncrated FRP products.
- 3) Use metal or nylon strapping to tie down load and isolate strapping with carpet, wood, or masonite if transporting by truck. NEVER USE CHAIN BINDERS.
- 4) Supports for pipe and headers to be located at about ¼ length from each end of the pipe if transporting by truck.

Unpacking

- 1) Check that all items listed on shipping papers are included or are listed as back ordered.
- 2) Prior to storing, check that all spool pieces, headers, manifold, pre-assembled pipe, etc. are marked or identified per customer drawings for easy future identification.
- 3) Prevent items from receiving any damage such as deep scratches or impact damage from handling. In particular, check tapered ends of pipe for large cracks or break-outs. Ensure that loose protective covers are replaced or adequate substitutes are found.
- 4) Ensure that mixing instructions, catalysts, etc. are not discarded or lost. It is a good policy to retain all shipping cartons or crates of joining material and to store these materials in the same manner as received for safety, as well as, security measures.

Storing

- 1) ENSURE THAT CATALYSTS & PROMOTERS ARE NEVER PLACED TOGETHER, AS FIRE OR EXPLOSION HAZARD WOULD THEN BE CREATED.
- 2) Avoid careless stacking of pipes or headers.
- 3) Store pipe on level supports or sand. Do not point load. Be sure there are no stones, etc. against FRP products. Do not store on snow if point loading may occur when snow melts.
- 4) Prevent "point loading" from supports; if necessary, cover supports with carpet or masonite, or use saddles. Where saddles have been used for supporting the pipe during transportation, these should be used to support the pipe after unloading.
- 5) STORE JOINING MATERIALS INSIDE IN COOL, DRY AREAS, 5°C. to 25°C. (40°F. to 75°F.). HIGHER TEMPERATURES WILL DECREASE SHELF LIFE OF CHEMICALS. TAPERING TOOLS SHOULD BE KEPT IN A DRY AREA.

Pipe & Fittings Installation

- 6) RPS pipe, fittings, and headers are coated for ultraviolet protection and may be stored in the open sun. HOWEVER, covering must be supplied if the bonding (joining) surfaces are unprotected and the storage area is exposed to dust, grease, tar, soot, or other contaminants that could affect the “bonding” or joining surfaces.
- 7) HEADERS, MANIFOLDS, OR OTHER STRUCTURES OF CRITICAL CONFIGUR-ATION SHOULD BE FLAT ON MOUNTING SURFACES, IF APPLICABLE, AND PROTECTED FROM OPEN SUN TO PREVENT WARPAGE. Note that warpage is usually temporary, but this cannot be guaranteed.
- 8) Heating Blanket Storage
 - Blankets should be stored flat, or wrapped on a paper or pipe core having a minimum outside diameter of 4”.
 - Blanket storage should be such that blankets do not receive damage from tools or other matter being thrown on top of them.
- 9) Do not remove protective coverings until items are ready for installation, including:
 - plastic end caps from tapered ends of pipe
 - protective cover from flanges
 - plastic covers from joining kits
 - crates or covers from cans or containers of resin or chemicals
- 10) CAUTION: NEVER STORE RESINS, ADHESIVES, PASTES, PROMOTERS, CATALYSTS, OR CLEANING MATERIALS (SOLVENTS, ACETONE) IN AREAS HAVING OPEN FLAME, SPARKS, HOT SURFACES, OR OPEN SUN.

Shelf Life

- 1) All adhesives, paste, and resins are shipped from the factory with labeled expiry dates. THESE MATERIALS SHALL NOT BE USED AFTER THE LABELED EXPIRY DATE.
- 2) Store materials in a cool, dry area at 5°C. to 25°C. (40°F. to 75°F.) or shelf life will be reduced and material may suffer permanent damage.
- 3) To assist field contractor scheduling, the following table shows maximum material shelf life from time of factory packaging to time of final usage.

Field Polyester Resins & Paste	See Note Below
P1500 & H1500 Adhesive	6 Months Max.
BPO Catalyst (pouch)	12 Months Max.
Field Epoxy Resins & Paste	12 Months Max.
E1500 Adhesive	12 Months Max.
'A' Liner Repair Paste	12 Months Max.

NOTE: Shelf life of Polyester Resins & Paste vary depending on the resin formulation. Contact RPS for the specific shelf life for your project.

Pipe & Fittings Installation

SAFETY

Safety Equipment

Application Equipment

Safety Glasses or Chemical

Goggles:

Source

Hardware Store

Gloves (rubber, leather, or

leather palm):

Hardware Store

3) Dust Masks:

Ind. Supplier

4) Hard Hat and Safety Shoes:

Ind. Supplier

5) Ear Plugs:

Ind. Supplier

6) Water Buckets & Soap:

Hardware Store

7) Fire Extinguisher - CO₂:

Ind. Supplier

- dry chemical:

Ind. Supplier

8) Eye Wash Kit:

Ind. Supplier

9) First Aid Kit:

Ind. Supplier

All local safety regulations must be followed.

USE YOUR SAFETY EQUIPMENT AT ALL TIMES WHEN MIXING OR USING RESINS, ACETONE, CATALYSTS, ETC.

Ventilation

- 1) Work in well ventilated area when using resins and all associated catalysts, acetone, etc.
- 2) Never work in small confined spaces without the buddy system, and without the guidance of an authorized, qualified instructor or supervisor. Use air-purifying respirators if ventilation is inadequate.

Flammable Materials

- 1) Fire - Use CO₂, dry chemical, or foam to fight fire. Use water to cool resins and catalysts if stored near the fire. Use water fog to fight large fires.
- 2) If resins are over catalyzed, they will generate excessive heat and combustion may occur. REMOVE SMOKING OR BUBBLING MATERIALS IMMEDIATELY TO AN OUTSIDE, OPEN AREA AND FILL CONTAINERS WITH WATER.
- 3) Discard all materials if exposed to water or other fire fighting chemicals.
- 4) NEVER torch-cut or weld empty cans/drums of resins, acetone, or other chemicals.

- 5) Positively NO SMOKING, WELDING, OR OPEN FLAME IS TO BE ALLOWED where adhesives, pastes, resins, acetone, or catalysts are being used.
- 6) Never store resins, adhesives, pastes, promoters, catalysts, or acetone in areas having open flame, sparks, or hot surfaces.
- 7) Explosion proof electric motors or air motors must be used for mixing in areas of concentrated resin, promoter, catalyst, or acetone vapors.

Material Hazards

The INFORMATION GIVEN BELOW IS A SUMMARY ONLY. For further information, SEE MATERIAL SAFETY DATA SHEETS.

1) Vinyl Ester and Polyester Resin, Paste, & Adhesive (P1500 / H1500)

Possible Hazards

Flammable: Fumes may be explosive. Do Not store or expose near open flame, hot spots, or in contact with strong oxidizing agents. For fire use water fog, foam, dry chemical, or CO₂.

Mildly Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

2) MEKP Catalyst

- 40% Methyl Ethyl Ketone Peroxide in Dimethyl Phthalate
- A strong oxidizing material; an organic peroxide.
- Use only with Polyester/Vinyl ester Resins per formula

Possible Hazards

Flammable & Explosive: Do Not store or expose near cobalt naphthenate/octoate, DMA/DEA (dimethylaniline), open flame, sparks, or hot spots. Do Not store in contact with copper, brass, rubber, or mild steel. Storage temp. is 18°C. to 30°C. (65°F. to 85°F.). For fire use dry chemical, foam, or CO₂; and water spray for large fires.

Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

IMPORTANT, NEVER MIX DIRECTLY WITH ACCELERATORS SUCH AS DMA OR COBALT NAPHTHENATE, AS A FIRE OR EXPLOSION MAY OCCUR. MIX WITH RESIN FIRST.

Pipe & Fittings Installation

3) **BPO** - 40% Benzoyl Peroxide (Catalyst)

Possible Hazards

Flammable & Explosive: Do Not store, expose near, or allow direct contact with cobalt naphthenate, DMA (dimethylaniline) / DEA (diethylaniline) or other aniline or amine products, open flame, sparks, hot spots, or open sun. Storage temp. is 5°C. to 25°C. (40°F. to 75°F.). High temp. will cause to decompose to toxic flammable/explosive material. Store only in original containers. DO NOT ALLOW CONTACT WITH OXIDIZING MATERIALS OR ACCELERATORS. For fire use dry chemical, foam, or CO₂; and water spray for large fires.

Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

IMPORTANT, NEVER MIX DIRECTLY WITH ACCELERATORS SUCH AS DMA OR COBALT NAPHTHENATE, AS A FIRE OR EXPLOSION MAY OCCUR. MIX WITH RESIN FIRST.

4) **DMA** - Dimethylaniline (Promoter)

DEA - Diethylaniline (Promoter)

Possible Hazards

Flammable & Explosive: Do Not store or expose near BPO, MEKP, open flame, sparks, or hot spots. For fire use dry chemical, foam, or CO₂. Do Not use sharp stream of water.

Ground equipment/containers to avoid electrical discharge.

Extremely Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

IMPORTANT, NEVER MIX DIRECTLY WITH BPO OR MEKP, AS A FIRE OR EXPLOSION MAY OCCUR. Do Not dispose material in drains or sewer system.

5) **Air Dry Solution**

- 10% Paraffin Wax/90% Styrene

Possible Hazards

Flammable & Explosive: Vapours are explosive. Do Not store or expose near open flame, sparks, hot spots, or other chemicals. Supply good ventilation. For fire use dry chemical, foam, or CO₂. Water is not usually effective.

Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

6) **Acetone Cleaner** - 2 propanone

Possible Hazards

Flammable & Explosive - Very volatile. Vapour forms explosive mixture with air. Do Not store or expose near open flame or hot spots. Storage temp. is 5°C. to 25°C. (40°F. to 75°F.). Supply good ventilation. For fire use dry chemical, foam, or CO₂.

Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

7) **Epoxy Resin, Paste, & Adhesive (E1500)**

Possible Hazards

Flammable: Do Not store or expose near open flame, sparks, or hot spots. Avoid contact with strong oxidizing agents or mineral acids. For fire use foam, CO₂, or dry chemical.

Moderately Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

8) **Epoxy Hardener (Polyamide Resin)**

Possible Hazards

Do Not store near epoxy resins.

Flammable: Do Not store or expose near open flame, sparks, or hot spots. For fire use foam, CO₂, or dry chemical.

Moderately Toxic: Practice good care and caution to avoid skin and eye contact, and to avoid breathing vapors. For more information, see Material Safety Data Sheets.

9) **Glass Fiber**

- from glass mat and woven roving in butt & wrap kits

Possible Hazards

Non-Flammable: Use self-contained breathing apparatus in a sustained fire due to trace amounts of fiber binder & sizing.

Health Hazard: May cause temporary mechanical irritation of skin, eyes, and upper respiratory tract.

Pipe & Fittings Installation

Use local exhaust ventilation to keep particulate levels below established limits.

If established limits are exceeded, follow local regulations and use NIOSH 42 CFR Part 84 respiratory protection (or equivalent in other national jurisdictions). N95 is usually acceptable unless higher concentrations or other contaminants warrant.

10) **Fiberglass Reinforced Plastic (FRP) Dust**

- from cutting/grinding/sanding of FRP laminates

Possible Hazards

Flammable: Combustible dust; potentially explosive in high concentrations. Avoid sources of ignition.

Use self-contained breathing apparatus in sustained fire. Fight with water, foam, CO₂, or dry chemicals.

Health Hazard: Dust is composed of cured vinyl ester or polyester resin, and glass fibers.

This may cause temporary mechanical irritation of skin, eyes, and upper respiratory tract.

Use local exhaust ventilation to keep particulate levels below established limits. Use a vacuum unit to capture dust close to source. Isolate with a protective shelter to keep dust away from fellow workers or equipment.

If established limits are exceeded, follow local regulations and use NIOSH 42 CFR Part 84 respiratory protection (or equivalent in other national jurisdictions). N95 is usually acceptable unless higher concentrations or other contaminants warrant.

Remove from skin using cold water with as little rubbing as possible to prevent irritation.

Pressure Testing

See the Testing section of this manual.

Pipe & Fittings Installation

Safety Data Sheet

Date: March 1, 2016

Version 1.0

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product Identifier: **Fibreglass Laminates** (RPS Finished Products - Pipe, Fittings, etc.) RPS P-150, A-150, AA-150, P-series XXX, A-Series-XXX

Details of the supplier of the safety data sheet	Emergency telephone number
RPS Composites Inc. 740 Main St. P.O. Box 299 Mahone Bay, NS B0J 2E0 Canada	Canutech: 613-996-6666 Product Information: 1-800-343-9355

SECTION 2. HAZARDS INFORMATION

Emergency Overview

Appearance: Solid

WARNING: GRINDING, DRILLING, SANDING, CUTTING OR OTHER MECHANICAL WORKING OF THIS PRODUCT MAY GENERATE DUSTS THAT COULD FORM COMBUSTIBLE (EXPLOSIVE) DUST-AIR MIXTURES.

Hazard classification: If combustible dust is generated during processing of this product, the dust is classified as a "flammable solid" and "explosive". Class I – Kst 177 bar M/sec

Potential Health Effects

Exposure Routes

Nuisance Dust inhalation, Skin contact, Eye contact, Ingestion

Eye Contact

Nuisance dust can cause eye irritation from eye contact.

Skin Contact

Nuisance dust can cause skin irritation. Symptoms may include redness, minor rash.

Ingestion

Swallowing small amounts of nuisance dust during drilling, cutting, grinding or machining is not likely to cause harmful effects. Swallowing large amounts may be harmful.

Inhalation

Breathing small amounts of nuisance dust generated during normal drilling, cutting grinding or other mechanical processing of this product is not likely to cause harmful effects. Breathing large amounts of nuisance dust may be harmful. Symptoms are not expected at air concentrations below the recommended exposure limits, if applicable (see Section 8).

Aggravated Medical Condition

Preexisting disorders of the following organs (or organ systems) may be

aggravated by significant and prolonged exposure to nuisance dust: respiratory tract, eyes, and skin (for example, asthma-like conditions or skin conditions).

Symptoms

Signs of overexposure to dust through breathing or swallowing may include: irritation of nose, throat, and airways, persistent coughing or shortness of breath.

Target Organs

Nose, throat, and respiratory tract.

Carcinogenicity

No data available

Reproductive Hazard

No data available

Hazard Statements

Flammable solid and dust

May form combustible dust concentrations in air

Causes skin irritation

Dust causes serious eye irritation

Dust causes respiratory irritation

Precautionary Statements: Prevention

Keep away from heat/sparks/open flames – No Smoking

Use explosion-proof electrical/ventilating/lighting equipment

Do not breathe dust

Wash skin thoroughly after handling

Do not eat/drink/smoke when using this product

Wear protective gloves/eye/face protection

Use dust collection methods to minimize dust concentrations in air

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Drilling, cutting machining, grinding or sanding this product may produce a combustible nuisance dust.

SECTION 4. FIRST AID MEASURES

General Advice: Move out of dangerous area

Contact a POISON CENTRE or doctor/physician if you feel unwell.

Show this safety data sheet to the doctor in attendance.

Do not leave the victim unattended.

If Inhaled: Move person to fresh air. Seek medical attention if irritation persists.

Eye Contact: Flush eyes with running water for at least 15 minutes. Seek medical attention if irritation persists.

Skin Contact: Wash with mild soap and running water. Use a washcloth to

Pipe & Fittings Installation

Safety Data Sheet

Date: March 1, 2016

Version 1.0

help remove fibres. To avoid further irritation, DO NOT rub or scratch irritated area. Rubbing or scratching may force fibres into skin. Seek medical attention if irritation persists.

Ingestion: Ingestion of this material is unlikely. If it does occur, observe individual for several days to insure that intestinal blockage does not occur. Treat symptomatically.

Notes to physician: No hazards which require special first aid measures.

SECTION 5. FIRE FIGHTING MEASURES

Suitable Extinguishing media: Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Water Spray
Foam
Alcohol-resistant foam
Carbon Dioxide (CO₂)
Dry Chemical

Specific Hazards during firefighting: Cutting, abrading, drilling, or otherwise mechanically altering this product can generate combustible dust which can present a fire or a potential explosion hazard. Extremely high airborne dust concentrations in combination with high energy dust are required to produce an explosion.

Special protective equipment for firefighters: Use self-contained breathing apparatus (SCBA) in firefighters a sustained fire.

Hazardous Combustion Products: Primary combustion products are carbon monoxide, carbon dioxide, and organic acids. Other undetermined compounds could be released in small quantities.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Land Spill: Scoop up or vacuum material and put into suitable container for disposal as a non-hazardous waste.

Water Spill: This material will sink and disperse along the bottom of waterways and ponds.

Air Release: This material will settle out in the air. It can then be scooped up or vacuumed for disposal as a non-hazardous waste.

Other Information: Comply with all applicable federal, state, provincial and local regulations. If dust is generated during processing of the product, do not allow dust deposits to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentrations. Avoid dispersion of dust into the air (i.e., cleaning surfaces with compressed air). Non-sparking tools should be used for cleaning dust.

SECTION 7. HANDLING AND STORAGE

Advice on safe handling: Cutting, abrading, drilling, or otherwise mechanically altering this product can generate combustible dust which can present a fire or a potential explosion hazard. It is prudent to implement standard safety precautions for handling and controlling finely divided organic particulate. This

includes eliminating ignition sources and build-up of static discharge. Maintain good housekeeping. Provide adequate ventilation. Properly maintain and operate dust control devices. All equipment should be bonded and grounded. For further guidance on prevention of dust explosions, refer to National Fire Protection Association (NFPA) 654: "Standard for the Prevention of Fire and Dust Explosions, from the Manufacturing, Processing and Handling of Combustible Particulate Solids".

SECTION 8. EXPOSURE CONTROL AND PERSONAL PROTECTION

Nuisance Dust

ACGIH TLV	Total Dust (8 hour TWA)	10 mg/m ³
OSHA PEL	TOTAL DUST (8 HOUR TWA)	15 mg/m ³
OSHA PEL	RESPIRABLE DUST (8 HOUR TWA)	5 mg/m ³

General Advice

These recommendations provide general guidance when grinding, drilling, cutting or sanding this product. Personal protective equipment should be selected for individual applications and should consider factors that affect exposure potential, such as handling practices and ventilation. It is the responsibility of the employer to follow regulatory guidelines established by federal, state and local authorities.

Exposure Controls

Provide sufficient ventilation (general or local exhaust) to maintain exposure levels below the TLV(s).

Engineering Measures: General dilution ventilation and/or local exhaust ventilation should be provided as necessary to maintain exposures below regulatory limits. Dust collection systems should be used in operations involving cutting, abrading, or drilling and may be required in operations using power tools. Exposures to dust from mechanical alteration of the product should be maintained below the OSHA PELs. All equipment should be bonded and grounded.

Respiratory Protection: Use an N95 or better respirator under the following conditions:

- 1) in any poorly ventilated space.
- 2) fabrication involving power tools.
- 3) any assemble or fabrication operation, which creates a dusty environment.

Use respiratory protection in accordance with your company's respiratory protection program, local regulations, or OSHA regulations under 42 CFR Part 84.

Skin Protection: Loose fitting, long sleeved shirt; long pants; and gloves.

Eye Protection: Safety glasses, goggles, or face shield.

Avoid Irritation: Be careful not to rub or scratch irritated areas, as they may force fibres into skin and intensify the irritation. The fibres should be washed off. Use

Pipe & Fittings Installation

Safety Data Sheet

Date: March 1, 2016

Version 1.0

of barrier creams can, in some instances, be helpful.

Hygienic Practices: Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposures to dusts and fibres by using good local exhaust ventilation, removal of all material from the skin and eyes after exposure, removal of material from clothing. (Use vacuum equipment to remove fibres and dusts from clothing. Compressed air should never be used. Always wash contaminated work clothes separately from other laundry and wipe out washer/sink to prevent loose glass fibres from getting on other articles), keep the work area clean of dusts and fibres generated during fabrication (Use vacuum equipment to clean up dusts and fibres. Avoid sweeping or using compressed air as techniques re-suspend dusts and fibres into the air), and have access to safety showers and eye wash stations.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Odour:	Pungent
Odour Threshold:	No data available
pH:	No data available
Melting point/Freezing point:	No data available
Boiling point/boiling range:	No data available
Flash point	No data available
Evaporation rate:	No data available
Flammability:	No data available
Upper explosion limit:	No data available
Lower explosion limit:	No data available
Vapour pressure:	No data available
Relative vapour density:	No data available
Density:	No data available
<u>Solubility(ies)</u>	
Water solubility:	Insoluble
Solubility in other solvents:	Insoluble
Partition coefficient: n-octanol/water	No data available
Thermal decomposition:	No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity: Product is stable

Chemical stability: Product is stable

Possibility of hazardous reaction: Fine dust dispersed in air from handling, cutting, sanding or grinding and in the presence of an ignition source is a potential dust explosion hazard.

Conditions to avoid: Heat, flame and sparks.

Hazardous decomposition products: Primary combustion products are carbon monoxide, carbon dioxide, and organic acids. Other undetermined compounds could be released in small quantities.

Hazardous polymerization: Will not occur

SECTION 11. TOXICOLOGICAL INFORMATION

Not Available

SECTION 12. ECOLOGICAL INFORMATION

Biodegradability

Biodegradability – Product: no data available

Bioaccumulation – Product: no data available

Ecotoxicity Effects

Toxicity to fish – Product: no data available

Toxicity to Daphnia and Other Aquatic Invertebrates

Toxicity to daphnia and other aquatic invertebrates - Product: no data available

Toxicity to Algae

Toxicity to algae – Product: no data available

SECTION 13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods

Dispose of in accordance with all applicable local, state and federal regulations. For guidance contact your state or local solid waste management authority.

SECTION 14. TRANSPORT INFORMATION

Shipping Information

Not DOT regulated.

SECTION 15. REGULATORY INFORMATION

Not available

SECTION 16. OTHER INFORMATION

The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by RPS Composites' Environmental Health and Safety Department (1-800-343-9355)

Pipe & Fittings Installation

INSTALLATION

General

This section provides general instructions for properly installing both aboveground piping and buried piping.

For aboveground piping, suitable methods of determining cut lengths for both adhesive jointed pipe and butt jointed pipe are included. Recommendations regarding proper support of the piping are also included. Details of the various jointing procedures can be found in the Tapered Adhesive Joining section of this manual.

For buried piping, selection and placement of pipe support and backfill materials are discussed. Jointing of pipe using O-ring joints is addressed in the O-Ring Joining section of this manual.

Determining Cut Dimensions

1) Pipe Installation using Tapered Adhesive Joints

Assumptions

- 1) 'D' dimensions are determined from drawings and then by actual measurement.
- 2) 'Y' dimensions are taken from RPS Dimensions Catalogue.
- 3) 'd' dimensions are 'D' minus 'Y'.

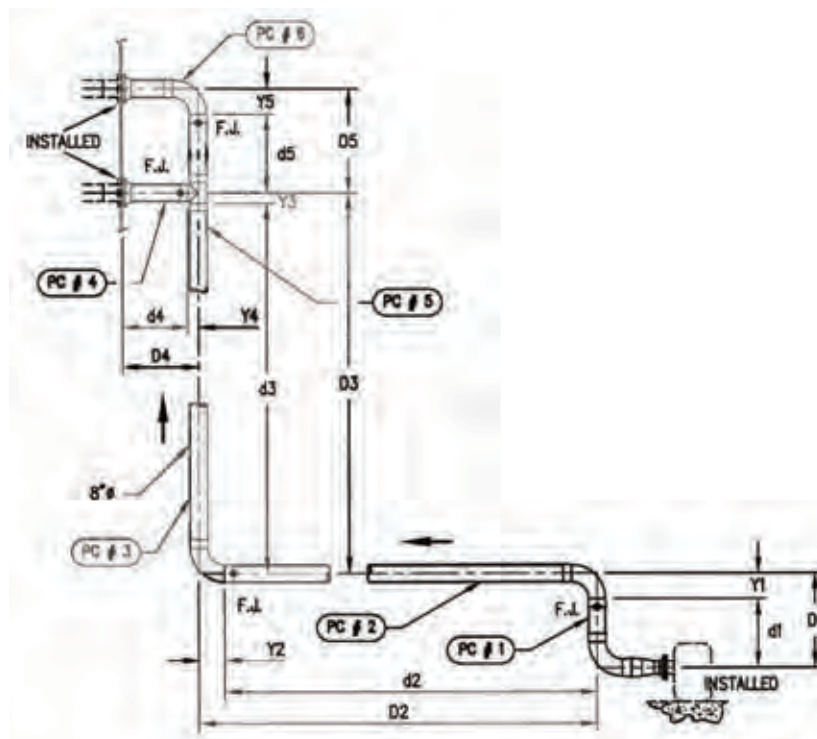
- 4) Usually, about 50% of joints can be factory joined (1 piece pipe and 1 fitting), leaving the remaining as field joints. Pipe for field joints would be precut with a trim allowance.
- 5) 'FJ' denotes Field Joints. Other joints are assumed to be prefabricated.

Installation

- 1) Determine dimension ' d_1 ', cut & taper PC #1 to this dimension. Bolt PC #1 to pump flange, bolt PC #6 to wall flange.
- 2) Determine dimension ' d_5 ' and ' d_4 ', cut & taper PC #4 & #5 to these dimensions. Install PC #4 & #5 using an ADHESIVE JOINT between #5 & #6 and #4 & #3.
- 3) Using the same procedure, install PC #2 & #3.

NOTE: Where space restricts movements, or where the pipe has been misaligned, it may be necessary to make the last two (2) joints using butt joints.

- 4) ENSURE FITS ARE SUCH THAT FLANGES ARE BOLTED (TORQUED) IN PLACE WITHOUT STRESS FROM MISALIGNMENT.



Pipe & Fittings Installation

2) Pipe Installation using Butt Joints

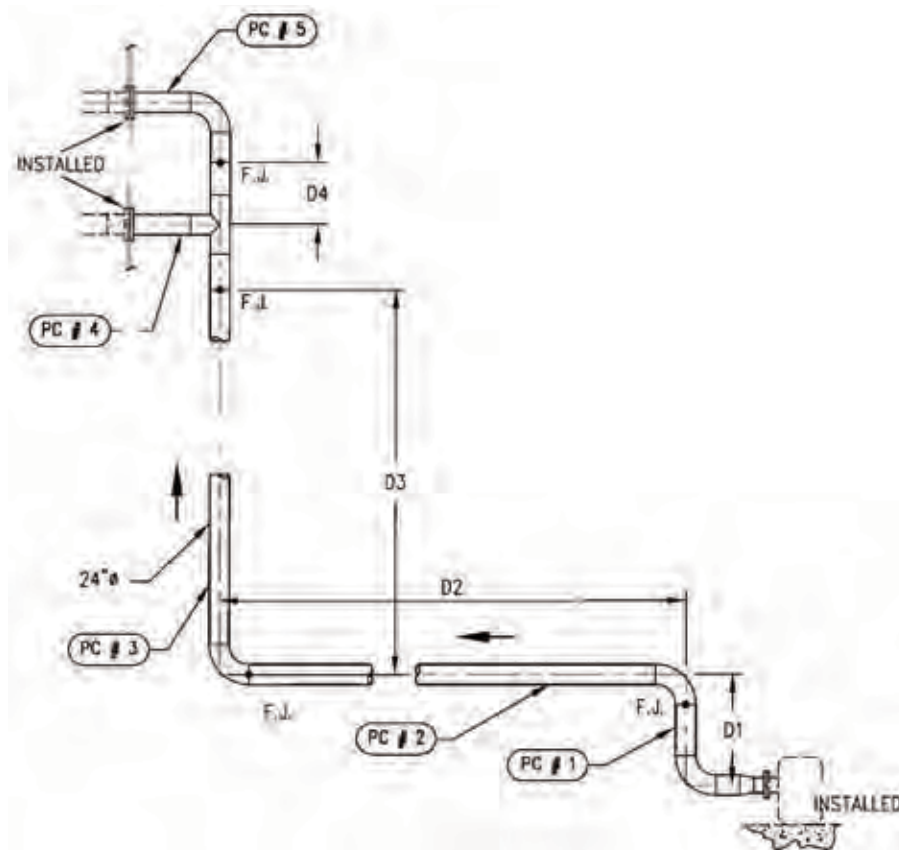
Assumptions

- 1) 'D' dimensions are determined from site drawings and then by actual measurement. Usually there will be a factory supplied trim allowance in each change in direction or between each pair of "fixed" flanges, etc.
- 2) 'FJ' denotes Field Joints. Other joints are assumed to be prefabricated.

Installation

- 1) Determine (measure) dimension 'D₁', then cut PC #1 to suit this dimension.
- 2) Install PC #1 & #5
- 3) Determine (measure) dimension 'D₄', then cut PC #4 to suit this dimension.
- 4) Install PC #4 using a Butt Joint between #4 & #5.

- 5) Determine (measure) dimension 'D₂', then cut PC #2 to suit this dimension.
- 6) Install PC #2 using a Butt Joint between #1 & #2.
- 7) Determine (measure) dimension 'D₃', then cut PC #3 to suit these dimensions.
- 8) Install PC #3 using two (2) butt joints.
- 9) ENSURE FITS ARE SUCH THAT FLANGES ARE BOLTED (TORQUED) IN PLACE WITHOUT STRESS FROM MISALIGNMENT.



Pipe & Fittings Installation

Hanging and Supporting RPS Pipe

Hanging and supporting of FRP piping systems differs from hanging and supporting of steel piping systems. The differences are related to the differences in mechanical and physical properties between FRP and steel. The most important differences, and the consequences of those differences, are summarized below:

FRP - DIFFERENCES FROM STEEL

- a) Greater Flexibility (about 1/20 of the rigidity of steel)
 - Consequences:
 - Requires closer support spacing
 - Large oscillations occur more easily
 - Earlier column failure
- b) Lower Longitudinal Strength
 - Consequences:
 - Requires closer support spacing
 - Requires support of heavy valves
 - Requires prevention of severe water hammer
 - Longitudinal loads are relatively more important
- c) FRP Does Not Yield (no plastic deformation). Fails After Ultimate Load Reached
 - Consequences:
 - Stress concentrations must be avoided
 - Avoid line contact and point loads
- d) Greater Coefficient of Thermal Expansion (about 2.5 times steel)
 - Consequences:
 - Requires greater allowance for movement
- e) Strength and Rigidity Drop Rapidly Above 90°C. (200°F.)
 - Consequences:
 - Careful design needed at high temperature
 - Hot spots must be avoided
- f) FRP is Flammable, although it can be made self-extinguishing
 - Consequences:
 - Choose self-extinguishing resins where required

Recommendations regarding proper hanging and supporting of RPS piping systems follows:

1) Hanger Spacings

Ensure that the following maximum hanger spacings are not exceeded unless approved by the consulting engineer or RPS.

Recommended Maximum Hanger Spacing

NOTE: Table I applies to both 'A' & 'P' series pipe. Spacings apply to uninsulated pipe containing liquids up to 66°C. (150°F.), operating at rated pressure, free to expand, fluid specific gravity (S.G. 1.0 & 1.3), & maximum 13mm (0.5") deflection. Reduce spacing if conditions are more severe (insulated pipe, ends restrained, wind, ice, etc.). Conversely, spacings may be increased if conditions are less severe (cold non-corrosive liquid, lower pressures) and approved by the consulting engineer or RPS.

RECOMMENDED HANGER SPACING				
Support Spacing (ft.) @ 150 deg. F.*				
For RPS P150 & A150 piping				
	Single Span		Continuous Span	
Dia.	SG = 1.0	SG = 1.3	SG = 1.0	SG = 1.3
1	7.0	7.0	9.0	9.0
1½	7.3	7.1	9.3	8.7
2	8.0	7.5	9.8	9.2
3	8.4	7.7	10.3	9.5
4	8.7	8.0	10.7	9.8
6	10.9	10.0	13.3	12.2
8	10.9	10.0	13.1	12.0
10	13.0	11.6	15.6	13.9
12	13.7	13.0	16.4	15.6
14	13.7	13.0	16.4	15.6
16	15.2	14.0	18.2	16.8
18	16.7	15.0	20.0	18.0
20	17.4	15.5	20.9	18.6
24	19.1	17.0	22.9	20.4
30	20.5	18.3	24.6	22.0
36	22.1	19.7	26.5	23.6

Table 1

Criteria: Strength Ratio (SR) in structure > 1.6 Deflection < 0.50"

* For 180 deg. F. service, derate span by 0.90

Pipe & Fittings Installation

2) Longitudinal Oscillations

- a) Prevent irregularities, surging or pulsing of flow rate, as this may cause undesirable longitudinal oscillations.
- b) Especially on long lines, prevent hi-velocity start-ups or abrupt shut offs (check valves, etc.) to prevent hydraulic shock or water hammer.
- c) If anchors have been installed, they should be located in each straight leg once, but not more than once. Often a single anchor, located at an elbow or tee, will hold two (2) adjacent legs.

3) Sideways Oscillations

Ensure that long straight runs, hung from single rod hangers, do not sway sideways. A guide (in lieu of a hanger) in every fourth place would prevent this condition.

4) Pipe Supports

A complete line of standard supports suitable for RPS piping is included in the RPS Pipe Support Catalogue. The supports shown are standard supports only. Custom-designed supports are also available to suit particular project requirements.

Supports for RPS pipe must be designed to achieve the intended function without causing damage to the pipe. Adhering to basic principles will minimize the chances of damaging the pipe. These principles include:

- a) Supports must be of sufficient width. Widths of saddles should typically be at least 1/3 of the pipe diameter.
- b) Elastometric gaskets (typically 1/16" thick for 4" and below, 1/8" thick 6" and above) should be inserted between the supports and the pipe due to the irregular outside surface of the pipe. The exterior surface of the pipe should never be in direct contact with steel or other building material.
- c) Pipe should never rest on narrow supports (such as steel angles). For small diameter piping, slide shields can be used. For larger diameter piping, saddles should be used.
- d) When riser clamps are used, ensure they are not too flexible. If the clamps are too flexible, they could deform and damage the pipe.
- e) Heavy equipment such as valves (and valve actuators)

should be supported independently.

- f) Pipe supports should be designed and installed to accurately fit the O.D. of the pipe.
- g) Pipe supports must be designed to be rigid enough not to deform excessively and become ineffective under load.

5) Summary

All of the foregoing subjects involve engineering consideration and must, therefore, be determined by the consulting engineer. The following conditions require careful consideration. Please contact RPS with specific questions about these or any other installation concerns:

- expansion joints and expansion joint tie bolts, O-ring joints, or bellow joints
- high longitudinal loads
- restraints using anchors, thrust blocks, thrust collars
- cast in concrete walls
- retaining sleeves
- column failure
- thin wall pipe buckling
- support of heavy valves or equipment
- water hammer
- vacuum
- insulation, pipe rating, and related hanger spacing
- hot spots
- transition from "buried condition to concrete"

Pipe & Fittings Installation

Buried Pipe & Fittings

1) Flexibility

RPS pipe is flexible and, as such, it forms a structural system with the surrounding soil. The support provided by the pipe bedding and pipe cover materials is the single most important parameter in the performance of this type of pipe. Reference: AWWA M45, ASTM D3839.

2) Materials

Bedding and Initial Backfill

- a) In native soils with good drainage, the pipe zone material (bedding and initial backfill) shall be free of silt and clay particles, and conform to the following gradation:

Max. Sieve Size	Percent Passing by Weight
1"	100
3/8"	70 - 100
No. 4	40 - 100
No. 10	15 - 65
No. 20	0 - 75
No. 36	0 - 10

- b) In native soils with poor drainage or water infiltration, the pipe zone material (bedding and initial backfill) shall be free of silt and clay particles and conform to the following gradation:

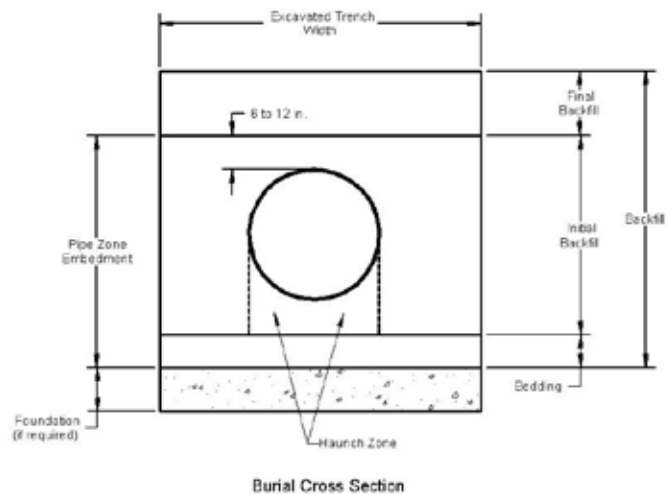
Max. Sieve Size	Percent Passing by Weight
1"	100
No. 4	0 - 10

Final Backfill

- a) Native site material excavated and approved by the Engineer. Material will be free of frozen lumps, roots and organic matter, and rocks and boulders of size greater than 4" (100mm) in any dimension. Excavated rock material of size greater than 4" (100mm) in any dimension is unacceptable.
- b) Imported material from a source approved by the Engineer.

3) Excavation

- a) Excavation will be conducted in such a manner as to minimize any disturbance to adjacent in-situ soils.



- b) Remove any unsuitable material from trench bottom and replace with approved granular material compacted to 95% Standard Proctor Density.
- c) Ensure that trench is excavated 6" to 12" below pipe position. Minimum trench width is 1.25 times diameter plus 12" (300mm). For 14"φ and larger, recommended minimum trench is 1.25 times pipe diameter plus 24" (600mm).

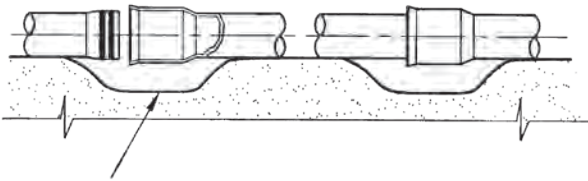
4) Installation

- a) Place pipe bedding material to required thickness (min. 4"), and shape bed true to line and grade, free from depressions and high points. Provide uniform bedding for the pipe and any protrusions such as joints.
- b) Compact full width of bed to 95% Standard Proctor Density.
- c) Shape bedding to a cylindrical surface conforming to the pipe radius.
- d) Ensure that the pipe is lifted into place using rope or web slings. Do not use chains or cables.
- e) Lay pipes on prepared bed, true to specified line and grade.

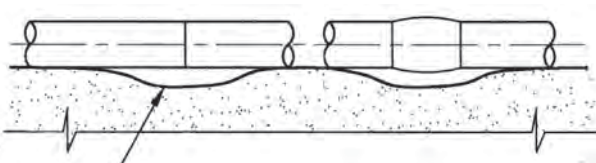
Pipe & Fittings Installation

f) Leave adequate clearance at each joint position to:

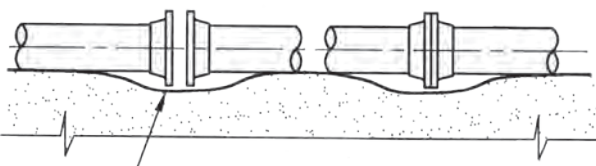
- prevent possibility of sand and gravel contaminating joining surface (especially O-ring joint surface).



- provide access to the joint to apply butt & strap materials.



- provide access to the joint to install bolts, etc.

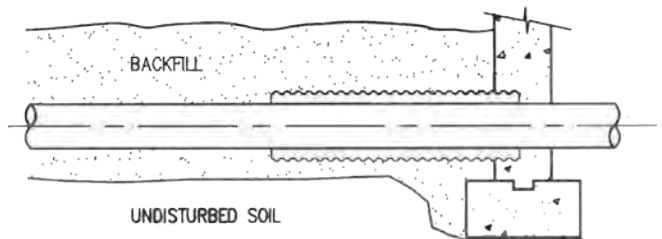
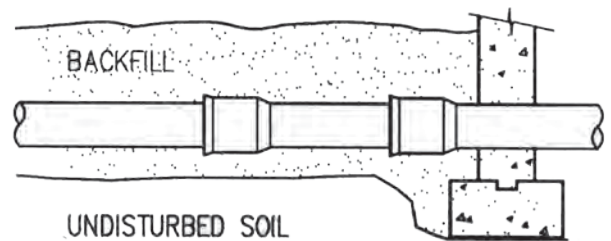


g) Place embedment materials by methods which will not disturb or damage the pipe. Work in and compact the haunching material in the area between the bedding and the underside of the pipe before placing and compacting the remainder of the pipe-zone embedment. Place embedment materials simultaneously on both sides of the pipe to the spring line. Do not permit compaction equipment to contact and damage the pipe. Hand tools are recommended to “tamp” the embedment materials adjacent to the pipe, especially in the haunch zone.

h) Place pipe-zone embedment material in uniform lifts not in excess of 6” (150mm). Compact material to 95% Standard Proctor Density. Minimum cover over top of the pipe is 6” (150mm).

5) Final Backfilling

- a) Internal pipe supports (“spiders”) should be installed in large diameter pipe to maintain pipe shape during backfilling.
- b) Place approved backfill in 12” (300mm) lifts to specified final heights. Compact backfill to 95% Standard Proctor Density.



6) Heavy Over-Loads

Do not pass equipment over the pipe until the backfill has reached a height of 4’ (1.5m) over the top of the pipe (unless pipe is encased in a culvert or concrete).

7) Transitions Through Concrete

Check that “fill supported” pipe does not pass through concrete walls unless supplied with:

- a) an expansion joint adjacent to the wall.
- b) protection by a long oversized sleeve of corrugated steel culvert.

Pipe & Fittings Installation

TESTING

Requirements

Whenever possible, RPS piping systems should be hydrostatically tested, prior to being put into service, to assure soundness of all joints and connections.

Liability

The following procedure is offered only as a guide to testing fiber-glass pipe. RPS can assume no responsibility or liability for the consequences of any testing practices.

Procedure

- 1) Test by Section - When assembling the piping system, it is recommended that small sections be joined at a time and tested for leaks before proceeding too far with the next section. This is particularly important at the beginning of the job when the techniques are new and the likelihood of leaks is greater.
- 2) Pipe Support - Ensure that pipe sections being tested are properly supported and restrained, otherwise a failure could damage the whole system.
- 3) Joint Curing - Before testing, the joint should be given the opportunity to fully cure. Without the application of extra heat, this will take at least 24 hours for butt joints at 70°F. or higher temperature. Taper joints, which must have been cured by the application of heat through heating blankets, can be tested after only a couple of hours. If butt joints have to be tested quickly, then application of extra heat, using heating blankets for about 1/2 hour, will make it possible to test the joint immediately after cooling down.
- 4) A 1" diameter or smaller threaded adapter can be bonded to the lowest point in the system to permit testing.
- 5) Water is introduced into this lowest point.
- 6) Bleed off the air through a partially open valve or loose flange at the highest point of the system. Be cautious of points where air could be entrapped.
- 7) After all the air is removed from the system, slowly close valve and carefully apply hydrostatic pressure. Test pressures should not exceed 1.5 times the piping system design pressure, and should not exceed the maximum allowable test pressure of the lowest-rated component in the system. Maintain test pressure for at least 10 minutes or as required for the project. Quick closing valves and booster pumps without suitable controls should not be used.

NOTE: It is recommended that the pressure be increased in several steps to minimize any problems should a leak occur.

Safety

- 1) The test operation should be well planned and carried out with all due precautions. There is no safe pressure; any pressure is potentially dangerous.
- 2) Pressurizing equipment should be operated by qualified and experienced personnel.
- 3) Care should be taken during testing to avoid sudden pressure surges or "water hammer", which can be a serious hazard.
- 4) Testing with air or gas is very dangerous. Only use hydrostatic test methods.
- 5) Pressurizing equipment should be suited to the size of the line and the pressure required.
- 6) Do not make any adjustment on pressurized fittings; relieve pressure first.
- 7) When testing long lines or large diameter pipe at elevated pressures, realize that a large amount of energy is stored in the pipe. This energy is many times greater than that stored in similar steel pipe because of the greater elasticity of FRP materials. If a joint separates at a high pressure, the sudden release of energy can cause violent movements of the pipe and may result in secondary damage away from the original break. This risk is reduced by testing well supported, restrained, short sections at one (1) time.

NOTES

Pipe & Fittings Installation

Bonding Procedure Specification for RPS 150psi Tapered Adhesive Joint

(Qualified by PQR SP-2720-011* rev A)

This Bonding Procedure Specification (BPS) is to provide fabrication details for making a tapered adhesive joint in RPS P-150/A-150/H-150 Reinforced Thermosetting



Plastic (RTR) pipe complying with B31.1 Power Piping Code or B31.3 Process Piping Code. All joints shall be made by bonders who have training in RTR piping and have satisfactorily passed the qualification tests of the appropriate code.

Joint Kits

- 1) RPS adhesive kits come in two sizes; single and double. Each kit includes adhesive, catalyst (ie: curing agent), towels, mixing sticks, and instruction sheets. The double kits provide two containers each of adhesive and catalyst (or hardener). The following is an estimated number of joints per kit, per size, that can be achieved if an adequate number of joints are prepared ahead of time.
- 2) The number of joints per kit is dependent on the "Working Time" of the mixed P1500 or H1500 adhesive. This "Working Time" varies with the temperature. At 18°C. (65°F.), you have less than 40 minutes; at 24°C. (75°F.), you have less than 20 minutes before the adhesive sets-up in the can. See chart below for approximate "Working Times".

Single Adhesive Kit

PIPE DIA.	BONDS PER KIT	
25mm	1"	6
40mm	1.5"	6
50mm	2"	6
80mm	3"	5
100mm	4"	4
150mm	6"	2
200mm	8"	1
250mm	10"	1
300mm	12"	1

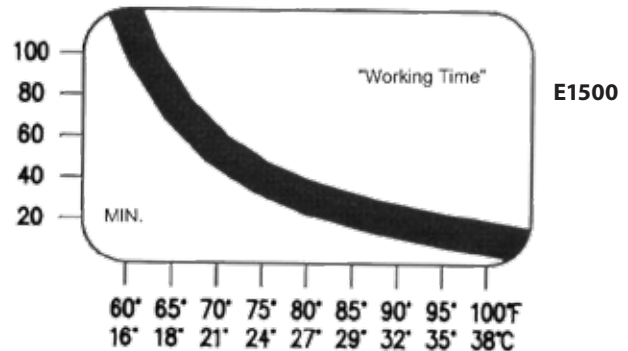
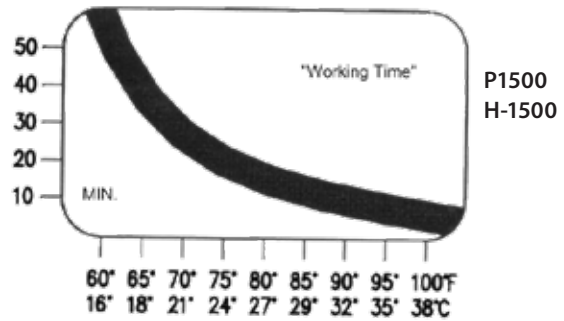


Double Adhesive Kit

PIPE DIA.	BONDS PER KIT	
25mm	1"	12
40mm	1.5"	12
50mm	2"	12
80mm	3"	10
100mm	4"	8
150mm	6"	4
200mm	8"	2
250mm	10"	2
300mm	12"	2



- 3) The number of joints per kit is dependent on the "Working Time" of the mixed E1500 adhesive. This "Working Time" varies with the temperature. At 18°C. (65°F.), you have less than 80 minutes; at 24°C. (75°F.), you have less than 40 minutes before the adhesive sets-up in the can. See chart below for approximate "Working Times".



*Does not apply to E-1500 Adhesive Joint

Pipe & Fittings Installation

Equipment

Application Equipment

- | | |
|---|---------------------------------|
| 1) Type 'B' Tapering Tool for tapered adhesive joints: | RPS |
| 2) Heating collar (110 volt): | RPS |
| 3) Pipe clamps, riser clamps, or friction clamps: | RPS, Crane Can., Grinnell, etc. |
| 4) Vacuum unit for 'B' Tool (industrial canister type): | Black & Decker #54840 or equiv. |
| 5) Hacksaw or circular saw with diamond coated or abrasive blade: | Ind. Tool Supplier |
| 6) Pipe strap wrench: | RPS, Ind. Tool Supp. |
| 7) Grease pencil: | Hardware Store |
| 8) Measuring tape: | Hardware Store |
| 9) Slotted head screwdriver: | Hardware Store |
| 10) Wrap-around or stiff paper: | Hardware Store |
| 11) 60 grit sandpaper: | Hardware Store |
| 12) Coarse file: | Hardware Store |
| 13) Wrenches to tighten clamps: | Hardware Store |
| 14) Level: | Hardware Store |
| 15) Knife or utility knife: | Hardware Store |
| 16) Soft wire or masking tape: | Hardware Store |

Safety Equipment

- | | |
|---------------------------------|----------------|
| 1) Leather/leather palm gloves: | Hardware Store |
| 2) Rubber gloves: | Hardware Store |
| 3) Safety glasses: | Hardware Store |
| 4) Ear plugs: | Hardware Store |
| 5) Bucket (filled with water): | Hardware Store |
| 6) Tyvek Suit | Hardware Store |

All local safety regulations must be followed.

Safety Instructions

- 1) **DO NOT SMOKE**, have **SPARKS**, or **OPEN FLAME** near work area.
- 2) Work in a well ventilated area or wear PPE as required by local regulations.
- 3) Wear leather gloves and safety glasses when handling and tapering pipe.



- 4) RPS P1500, H1500, E1500 adhesive and catalyst, (separately or combined) will cause skin irritation to some people. Avoid contact with skin and eyes. Wear rubber gloves and safety glasses. In case of contact, wash skin with soap and water. For eyes, flush with plenty of water for at least 15 minutes and get medical attention.
- 5) Leftover adhesive in can will become very hot (150°C. or 300°F. approx.) after going hard. It is advisable to put this hot can in a bucket of water to prevent injury. Do not allow catalyzed resin to get wet. This may stop the cure. Uncured resin is hazardous waste, cured resin is not.
- 6) Refer to the Safety section of the RPS Installation Manual, and the supplied SDSs for more details.



Storage, Handling and Environment

- 1) Always store adhesive kits in a cool dry location; 40°F. to 75°F. (4°C. to 24°C.).
- 2) Do not use adhesive after expiration date on label.
- 3) Do not use adhesive that has started to turn rubbery or hard.
- 4) Ideal working conditions are between 10°C and 30°C. Exceeding these may affect cure.
- 5) Protect bonding surfaces and adhesive from contamination. Ambient temperature should exceed the dew point temperature by 3°C (5°F). Water or condensate will contaminate a joint.
- 6) Bonding surfaces can be dried with the RPS Heating Collar. When outdoors, a portable shelter over the joint can protect from moisture or strong sunlight.
- 7) In cold weather, warm the adhesive and catalyst, or adhesive and hardener, to 68°F. - 77°F. (20°C. - 25°C.) before mixing.
- 8) Do not try to split a kit. Always put the contents of one catalyst pouch in one can of adhesive, or contents of one hardener container in one can of adhesive.



Pipe & Fittings Installation

- 9) Properly dispose unused adhesive by first curing any uncured resin and curing agents, and then burying in an approved sanitary landfill area.
- 10) Clean up all spills with sand, sawdust, or vermiculite and arrange disposal with an approved waste disposal agency.
- 11) Follow your safety rules.

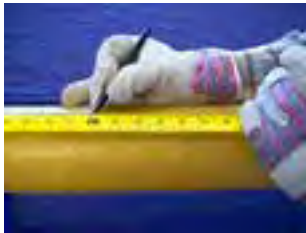
Joint Preparation

1) Inspection

Carefully inspect pipe and fittings for damage. Pay particular attention to pipe ends. Damaged areas will generally appear as bruises on the exterior and/or cracks or crazing on the interior. Do not use damaged fittings. Damaged pipe sections must be cut out and discarded.

2) Measuring and Cutting

Measure the length of pipe required, allowing for insertion depth in fitting, and mark a line around the pipe using a pipefitters' wrap-around.



Cut the pipe on the line using a hacksaw, port-a-band, or a circular saw with an abrasive blade.



Pipe end must be square to within tolerance (face to center-line dimension $\pm 1/8$ " up to and including 12" dia.).

3) End Preparation

Well-abraded, clean, dry bonding surfaces are critical to making good joints.

Fittings are supplied with factory prepared bell or socket ends. Pipe is supplied with straight cut, plain ends.

Taper the pipe end using RPS' Type 'B' taper tool. This tool is designed to cut a precise male taper at the correct angle to match the fitting bell taper angle for each size.



Refer to the Type 'B' Taper Tool Instructions, at end of BPS, for correct use and adjustment of the tapering tool.

4) Check the Fit

Dry fit the joint to check for correct insertion depth.

The joint should fit with no play in the joint. If the pipe is "under-inserted" by more than $1/16$ ", retaper to the correct insertion depth as per "Tapered Adhesive Insertion Lengths (inches)" below.



NOTE: In fitting to fitting joints, the fitting ends must not touch. If ends touch, the fit must be corrected to the correct gap as per fitting dimension sheets (see RPS Dimensions Catalogue for dimensions).

Item	Diameter	Tolerance
Spigot Edge Thickness	1" to 12"	+0.030"/-0.015"
Insertion Depth	1" to 12"	+0.120"/-0.060"

TAPERED ADHESIVE INSERTION LENGTHS (inches)

PIPE DIA.		LENGTH	
25mm	1"	42mm	1 3/8"
40mm	1.5"	38mm	1 3/8"
50mm	2"	38mm	1 3/8"
80mm	3"	40mm	1 3/8"
100mm	4"	42mm	1 3/8"
150mm	6"	47mm	1 3/4"
200mm	8"	91mm	3 9/16"
250mm	10"	105mm	4 1/8"
300mm	12"	124mm	4 7/8"

5) Secure the Joint

Steps must be taken to ensure joints are not disturbed during the curing process. This can be accomplished by securely blocking the components using friction clamps and turnbuckles, or come-alongs. Clamps and other securing devices must be placed so as not to interfere with application of the heating collar over the joint.



Pipe & Fittings Installation

6) Install Clean-out Pig

When assembling adhesive bonded joints, some adhesive will squeeze out on the inside of the joint. Up to 1/16" bead is normal, and generally does not present a problem if the proper amount of adhesive has been used. If excess adhesive has been applied, a larger, undesirable bead will occur inside the pipe.



To correct this occurrence, prepare a ball of clean rags or paper "Pig" large enough to fit snugly inside the pipe, and attach to a length of twine.



Insert the Pig into the pipe on one side of the joint, and thread the rope through the pipe on the other side.



Do not pull the Pig through the pipe until the joint has been secured.

7) Cleaning

Thoroughly clean the ground bonding surfaces by hand sanding with clean 60-100 grit sandpaper and wiping with a clean, dry brush; cloth; or paper towel.

Adhesive Application



1) Mix Adhesive

RPS P1500 and H1500 Adhesives are two part systems; adhesive and catalyst.

RPE1500 Adhesive is also a two part system; Adhesive and hardener.

For P1500 and H1500 all of the catalyst in one pillow pouch must be added to all the adhesive in one can to develop full joint strength.

For E1500, all of the hardener in one container must be added to all the adhesive in one can to develop full joint strength.



DO NOT TRY TO SPLIT THE KITS FOR ONLY A FEW JOINTS.

NOTE: The P1500 and H1500 catalyst pillow pouch contains ingredients that tend to separate after a short time. To ensure all of the ingredients are added to the adhesive, mix the contents by hand prior to opening the pouch. Gently mix by squeezing with your fingers until the two (2) catalysts are well mixed. Be careful not to apply excessive pressure, as this may result in damage to the pouch.

For P1500 and H1500 mix the catalyst with the adhesive thoroughly. For E150, mix the white hardener into the black adhesive thoroughly until the mixture is a uniform grey colour without any streaks.



Scrape the sides and bottom of the can. Stir well, then scrape the sides and bottom again to make certain there is a thorough mixing of catalyst and adhesive or hardener and adhesive. The colder the material, the more mixing you must do.

2) Apply the Adhesive

Fully wet both bonding surfaces with adhesive using the tongue depressor provided. Apply sufficient adhesive to pipe end to ensure joint area is completely filled. Apply an additional 1/16" to 1/8" bead of adhesive to entrance of bell and to leading edge of pipe.



3) Joint Assembly

1) Align the ends of the pipe and fitting so that the adhesive will not be scraped off during insertion. Fully insert the pipe end into the fitting until it bottoms out.

Check for squeeze out of adhesive around entire joint circumference. If squeeze out is not complete, joint must be remade.

Pipe & Fittings Installation

- 2) Secure the joint. YOU MUST BE CERTAIN THE JOINT IS NOT MOVED UNTIL IT IS COMPLETELY CURED. DO NOT ALLOW THE PIPE TO BACK OUT OF THE JOINT. Remove the clean out "pig."



Curing

1) Applying Heating Collar

Tapered adhesive bonded joints MUST be cured with a heating collar to develop full joint strength and corrosion resistance.



Apply a heating collar immediately. Wrap the heating collar around the joint making sure it is snug around the pipe, and the thermostat is on the outside of the wrap. Secure the heating collar in place with a piece of soft wire or tape. When flanges are attached to pipe, the heating collar is rolled up on the inside of the joint, for joints 100mm (4") and larger.



A special interior heating collar is used for flange joints 3" and smaller. Make sure that contact is made between the heating collar and pipe wall. Heat for the recommended time.



P1500
HEATING COLLAR APPLICATION TIME
(FOR 50°F./10°C. AND ABOVE)

PIPE SIZE		APPLICATION TIME (minutes)
1" - 6"	25-150mm	50
8" - 12"	200-300mm	70

H1500
HEATING COLLAR APPLICATION TIME
(FOR 50°F./10°C. AND ABOVE)

PIPE SIZE		APPLICATION TIME (minutes)
1" - 6"	25-150mm	80
8" - 12"	200-300mm	100

E1500
HEATING COLLAR APPLICATION TIME
(FOR 50°F./10°C. AND ABOVE)

PIPE SIZE	APPLICATION TIME (minutes)
1" - 4"	105
6"	110
8"	120
10"	125
12"	130

NOTE: If temperature is below 50°F./10°C., Refer to 3) - Cold Weather Curing, below.

CHECK THE HEATING COLLAR DURING THE CURE. A properly operating heating collar will be too hot to hold your hand on. Periodically, check the heating collar for power draw with an ammeter or watt meter. If the draw is less than 2/3 of the rating on the collar, the collar should be discarded.

Periodically check the temperature of the heating collar by inserting a thermometer underneath the collar. The temperature should be in the range listed in the appropriate table in section (4), following.

2) Check the Cure

Remove the collar (not the clamps) and allow the pipe to cool. Scratch the fillet radius of adhesive with a knife or nail. It should be as hard as pipe or fitting surface. If slightly rubbery or soft, reheat the joint until it tests flint hard. If the inside of the joint can be reached, it also should be checked for hardness. IF ADHESIVE REMAINS SOFT, JOINT MUST BE REDONE.

3) Cold Weather Curing

If the ambient temperature is below 50°F./10°C.:

- Warm both joining surfaces to a minimum of 50°F./10°C. The heating collars can be used for this, but the surfaces should not be hot to the touch (ie. should not be greater than 95°F./35°C.), or working time of the adhesive will be too short.
- Warm adhesive and catalyst to 68°F.- 77°F. (20°C.- 25°C.) before mixing.

Pipe & Fittings Installation

- Control ambient air temperature to at least 50°F./10°C. by enclosing joint in local shelter or wrapping with insulation.
- Eliminate cold air movement through the pipe.

4) RPS Heating Collar

RPS supplies two (2) basic types of heating collars; overlap type and interior type. The overlap type heating collar can be used for all outside of joint curing, and only for 4" through 12" inside of joint curing. For 1" through 3" inside of joint curing, use interior type heating collar.

INTERIOR HEATING COLLAR

PIPE SIZE	HEATING COLLAR SIZE (Length x Width)	TEMP.	MAXIMUM NUMBER OF HEATING COLLARS PER EXTENSION CORD*
1"	25mm 3" x 4" 80x100mm	260°F. ± 20°F. 127°C±10°C	8
1.5"	40mm 4.5" x 4" 115x100mm	260°F. ± 20°F. 127°C±10°C	8
2"	50mm 6" x 4" 150x100mm	260°F. ± 20°F. 127°C±10°C	8
3"	80mm 9" x 4" 230x100mm	260°F. ± 20°F. 127°C±10°C	4

OVERLAP HEATING COLLAR

PIPE SIZE	HEATING COLLAR SIZE	EMP.	MAXIMUM NUMBER OF HEATING COLLARS PER EXTENSION CORD*
1" to 2"	25 to 50mm 20" x 4" 510 x 100mm	260°F. ± 20°F. 127°C±10°C.	8
3" to 6"	80 to 150mm 46" x 4" 1130 x 100mm	260°F. ± 20°F. 127°C±10°C	3
8" to 12"	200 to 300mm 88" x 5" 2235 x 100mm	280°F. ± 20°F. 138°C±10°C	1

* Ensure extension cords are 14 AWG minimum

Abuse can damage the heating collar thermostat. A protective metal shield over the thermostat is provided, however, handle with care. A damaged thermostat can result in a poorly cured or burnt joint.

5) Inspection Check List

Visually inspect the joint for alignment, fill, intrusion of the adhesive into the interior, and cure. Refer to ASME B31.1 or B31.3 for minimum inspection frequencies.

General Guidance criteria:

a) Contamination

Ensure there is no contamination of bonding surfaces (no grease, tar, soot, oil, water, or other dirt).

b) Mixing

Check that materials (paste and resin) are mixed exactly per instructions. Mix thoroughly.

c) Application

Check that adhesive materials are applied exactly per instructions.

d) Movement

Ensure there is no pipe movement before joint is cured.

e) Void Spots

Ensure there are no void or adhesive starved spots around the fillet.

f) Squeeze Out

Inspect if possible to ensure minimal intrusion of adhesive "squeeze-out" into the interior bore of the pipe. This bead should not exceed 1/4 the wall thickness.

h) Curing

The adhesive resin must be cured. A minimum barcol hardness of 30 is required.

Barcol hardness can be measured with a barcol tester. Ensure that the tester has been properly calibrated. If a barcol tester is not available, use a knife point to ensure that the cured resin is as hard as the pipe. If not, call RPS for assistance.

Tips and Warnings

- Female ends cannot be made on site. Sleeve couplings are available.
- When making multiple joints at one time, prepare all bonding surfaces immediately prior to joining to prevent accidental use of a contaminated surface.



Pipe & Fittings Installation

3) Do not (under any circumstances) move the assembled joint before the adhesive is cured. Always use clamps.



4) If the adhesive does not cure or is rubbery in spots, it may indicate that the adhesive was not mixed thoroughly. Redo the joint.

Pipe & Fittings Installation

RPS TYPE 'B' TAPERING TOOL OPERATING INSTRUCTIONS (FOR 1" - 12" (25 TO 300MM) DIAMETER)



General

The RPS pipe tapering machine was designed as a tool for cutting outside tapers on RPS pipe. Each machine is fitted with a dust extractor hood over the sanding drum. Any high-velocity, heavy-duty vacuum cleaner fitted with a 2" I.D. intake hose (such as the Black & Decker #54840) can be used with this grinder. (Vacuum cleaner and stand not supplied with tool.)

The machine is designed to cut a 7° taper on 1" - 6" (25-150mm) pipe, and a 4° taper on 8" - 12" (200-300mm) pipe. It can be conveniently mounted on a pipefitters power drive stand, e.g. Rigid Tristand No. 1206, as shown in the illustration above.

Drive

Dewalt Saw Motor Model #DW384 (Type 3),
5800 RPM, 120 volt, AC/DC, 15 amp.

Safety

See the Safety section, Page 6, and MSDS', Page 9.

Mounting Tapering Tool

Attach the taper tool to the Mounting Plate (Item 18) using the bolts (Item 19) and Motor Base Shim (Item 34) provided. For 1" to 6" (25 to 150mm) the shim angle is 70, and for 8" to 12" (200 to 300mm) it is 40. Mount the Taper Tool and Mounting Plate on a solid table or stand. Ensure the Base Plate (Item 25) or Adapter Plate (Item 35) is vertical.

Holding Long Lengths of Pipe

For tapering long lengths of pipe, set up "V" roller stands for handling and rotating the pipe. Ensure the pipe is level and perpendicular to tapering tool base plate.



Tapering 8" - 12" (200-300mm) Diameter Pipe

To taper 8", 10", or 12" (200, 250, or 300mm) diameter pipe, the guides (Item 23) must be in position in the appropriate holes in the



base plate (Item 25). The top set of holes is for 8" (200mm) pipe, the center set is for 10" (250mm), and the bottom set is for 12" (300mm) pipe. Select the pipe size to be tapered and put the guides in their appropriate holes.



Position the pipe on 'V' roller stands and apply a strap wrench over the pipe. Insert the pipe over the machine guide (Item 23) and roller (Item 20). Rotate the pipe on the guide to check

the fit and ensure the pipe is level. Do not make contact with the grinding stone.

To compensate for variations in pipe inside diameter, the guides have eccentric mounting studs. Adjustment of a guide can be made by slackening the guide nut (Item 29), inserting a 1/4" diameter pin (Item 31) in the hole, and rotating the guide with the pin until a light contact is made with the pipe inside. Usually only one (1) guide needs adjustment.

Start the vacuum unit. Start the tapering tool.

CAUTION: CHECK ROTATION OF GRINDER SO THE STRAP WRENCH IS SECURED THE RIGHT WAY; AGAINST THE DIRECTION OF THE CUTTER, WHEN THE PIPE IS GROUND.

Pipe & Fittings Installation

Slowly push the pipe forward until about 1" of pipe is tapered. Now slowly rotate the pipe one (1) revolution (rotate pipe against rotation of grinding stone). Continuing to repeat this operation in 1" maximum steps, slowly push the pipe until the pipe is pressing against the base plate (Item 25). Make one (1) more revolution with pipe against the base plate. Now move the pipe back from the cutter and turn the tapering tool and vacuum off.



THE END OF THE TAPERED PIPE SHOULD FEATHER OUT TO 1/32" THICK FOR TAPERED ADHESIVE JOINTS, If not, adjustment of the gap between the roller (Item 20) and the grinding stone (Item 14) can be made by slackening the four (4) 3/8" diameter bolts (Item 24), readjusting for correct gap, and tightening the bolts.

WARNING: Excessive force on the grinding stone may cause the motor to run too hot and, thus, BURN OUT. Allow a hot motor to COOL DOWN. For best performance and longest motor life, allow the tapering tool to operate at high RPM.

Tapering 1" - 6" (25-150mm) Diameter Pipe

To taper 1" - 6" (25-150mm) diameter pipe, the roller assembly (Item 20 & 21) and guide pins (Item 23) must be removed. To remove roller, insert a 3/8" diameter pin (Item 15) in hole at the end of roller shaft and unscrew the roller from the base plate (Item 25). To remove guide (Item 23), loosen and remove nuts and washers (Item 29 & 30).

Install guide mandrel (Item 37 - 42) on adapter plate (Item 35) using bolt and washer (Item 43). There are six (6) holes in adapter plate for mandrel location, one (1) for each size of pipe. The closest to the grinder is for 1" (25mm) pipe, and the farthest is for 6" (150mm) pipe. Secure adapter plate to base plate (Item 25) using 1/4" diameter bolts (Item 36).

Position the pipe on 'V' roller stands and apply a strap wrench over the pipe. Insert the pipe over the guide mandrel (Items 37 - 42). Rotate the pipe on



the mandrel to check the fit and ensure the pipe is level. Do not make contact with the grinding stone. Refer to "Tapering 8" - 12" Diameter Pipe", Pages 25.

Start the vacuum unit. Start the tapering tool.

CAUTION: CHECK ROTATION OF GRINDER SO THE STRAP WRENCH IS SECURED THE RIGHT WAY, AGAINST THE DIRECTION OF THE CUTTER, WHEN THE PIPE IS GROUND.

Slowly push the pipe forward until about 1" of pipe is tapered. Now, slowly rotate the pipe one (1) revolution (rotate pipe against rotation of grinding stone). Then slowly push the pipe into the base plate (Item 25) and slowly rotate the pipe one (1) revolution. Make one (1) more revolution with the pipe against the base plate. Now move the pipe back from the cutter and turn the tapering tool and vacuum off. Refer to "Tapering 8" - 12" Diameter Pipe", Pages 25.

THE END OF THE TAPERED PIPE SHOULD FEATHER OUT TO 1/32" THICK FOR TAPERED ADHESIVE, AND TO 1/8" THICK FOR TAPERED BUTT JOINTS. If not, adjustment of the gap between the mandrel and the grinding stone (Item 14) can be made by slackening the three (3) 1/4" diameter bolts (Item 36), readjusting for correct gap, and tightening the bolts.

WARNING: Excessive force on the grinding stone may cause the motor to run too hot and, thus, BURN OUT. Allow a hot motor to COOL DOWN. For best performance and longest motor life, allow the tapering tool to operate at high RPM.

Replacing Grinding Stones

Disconnect power and insert the 3/8" diameter pin (Item 15) through the bearing housing (Item 6) and then into the hole in the shaft (Item 9). The shaft is now locked. Remove the nut (Item 17) and washer (Item 16). Slide the grinding stone (Item 14) off the shaft. Install the replacement grinding stone in reverse order. Do not over tighten the nut. Remove the pin.

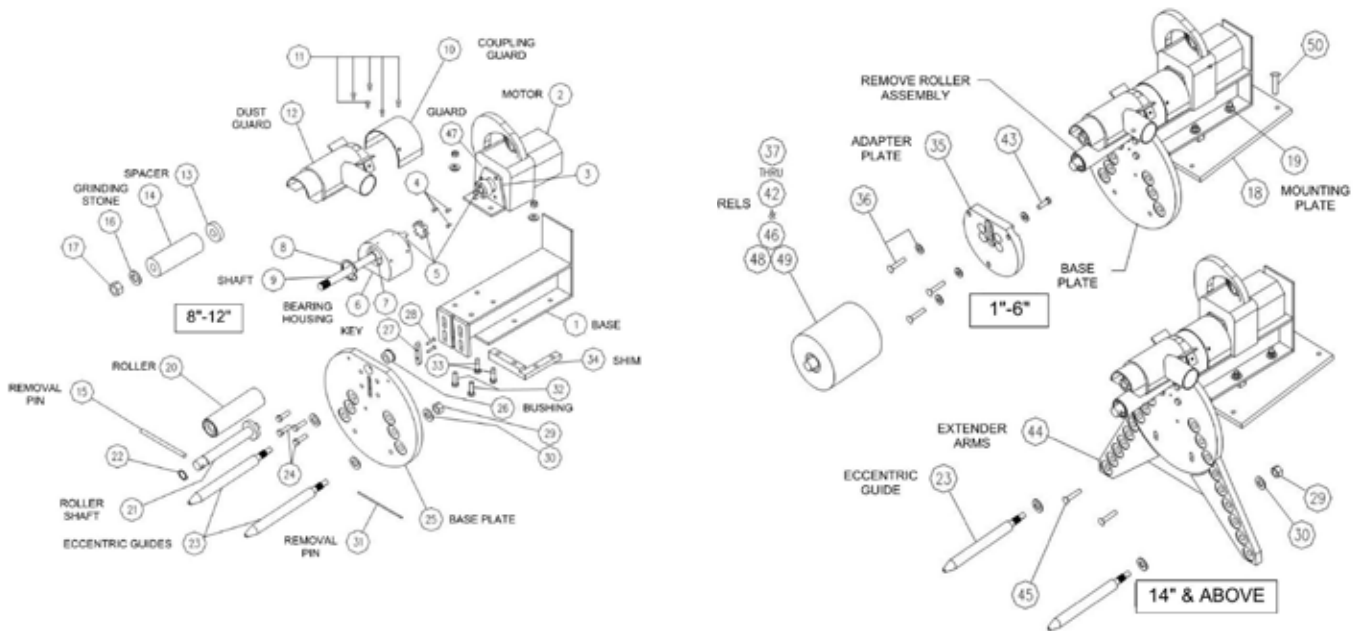
Pipe & Fittings Installation

CAUTION - TO PREVENT MOTOR DAMAGE:

- Taper at high RPM only - slowing motor will cause burn out.
- Protect line with 15 AMP time delay fuse, eg. Fusetron Type TC
- 115 to 125 volts only
- Maximum extension cord lengths and conductor sizes:
 - 25ft.-No.14
 - 35ft.-No.12
 - 55ft.-No.10
 - 90ft.-No. 8

Pipe & Fittings Installation

RPS TYPE 'B' TAPER TOOL ASSEMBLY



RPS POWER TYPE 'B' TAPERING TOOL PARTS LIST

ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	1	Motor Base	26	1	Bushing
2	1	Motor (Dewalt Saw Motor Model DW384Type 3), 5800 RPM, 120V, AC/DC, 15 amp.)	27	1	Key
3	1	Motor Mounting Bracket	28	2	Machine Screw (10-24 UNCx3/4" CSK HD SS)
4	3	Machine Screw (M4 x 0.7 x 25mm CSK HD SS)	29	2	Nut (5/8"-11 UNC HX Nut SS)
5	1	Lovejoy Coupling (#L-075 0.500)	30	4	Washer (11/16" I.D.x1 1/2" O.D.x1/16" THK SS)
6	1	Bearing Housing	31	1	1/4"x6" LG Removal Pin
7	2	Bearing (SKF 6205 2RS)	32	2	Bolt (3/8"-16 UNCx1" HX HD SS)
8	2	Retaining Ring (Truarc #5000-200)	33	2	Bolt (3/8"-16 UNCx1 1/4" HX HD c/w Nut & L'washer SS)
9	1	Shaft	34	1	Motor Base Shim
10	1	Coupling Guard	35	1	Adapter Plate
11	5	Machine Screw (1/4-20 UNC x 1/2" HX HD SS)	36	3	Machine Screw (round HD 1/4"-20 UNC x 1 1/4" c/w L'washer SS)
12	1	Dust Extractor and Guard	37	1	1 1/2" dia. Mandrel
13	1	Spacer	38	1	2" dia. Mandrel
14	1	Grinding Stone (Dwg. #FB-6265)	39	1	3" dia. Mandrel
15	1	3/8"x6" LG Removal Pin	40	1	4" dia. Mandrel
16	1	Washer (3/4" dia. SS)	41	1	5" dia. Mandrel
17	1	Hex Nut (3/4"-10 UNC SS)	42	1	6" dia. Mandrel
18	1	Mounting Plate	43	1	Bolt (3/8"-16 UNC x 1" long HX HD c/w L'washer SS)
19	4	Bolt (3/8"-16 UNC x 2 1/2" CSK c/w L'washer & Nut SS)	44	1	Extender Arm Unit
20	1	Roller	45	2	Bolt (3/8"-16 UNC x 2 1/4" long HX HD c/w Nut & L'washer SS)
21	1	Roller Shaft	46	1	1" dia. Mandrel
22	1	Retaining Ring (Truarc #5000-100)	47	1	Modified Guard
23	2	Guide (Eccentric)	48	1	32mm Mandrel
24	4	Bolt (3/8"-16 UNC x 1 3/4" HX HD c/w HX Nut & L'washer SS)	49	1	65mm Mandrel
25	1	Base Plate	50	4	Bolt (3/8"-16 UNC x 2 1/4" long HX HD c/w Nut & 2 L'washers SS)

Pipe & Fittings Installation

Bonding Procedure Specification for RPS 150psi BUTT & WRAP JOINTS(Qualified by PQR SP-2720-013 Rev A)

This Bonding Procedure Specification (BPS) is to provide fabrication details for making a straight Reinforced Thermosetting Plastic (RTR) butt & wrap joint complying with B31.1 Power Piping Code or B31.3 Process Piping Code. All joints shall be made by bonders who have training in RTR piping and have satisfactorily passed the qualification tests of the appropriate code.

Kit Material

The RPS Butt Joint Kit contains all the necessary materials to join RPS P150, A150 & H150 pipe to produce a strong, reliable butt joint. The kit reinforcement is precut E or ECR glass, stacked in sequence of lamination, and wrapped in polyethylene to protect it from moisture. An instruction sheet giving step by step joint laminating sequence is enclosed with each kit. Glass kits can be cut from the attached table from appropriate material if required. The kit's vinyl ester resin, paste, catalyst, etc. are packed in quantities to suit the customer's needs, [See section 5 for resin/catalyst details] ie:

- an exact amount for single joints, or
- a bulk amount for many joints

A graduated one pound (1 lb.) container and a graduated syringe are also included with each set of kits to aid accurate mixing of small quantities of materials.

Equipment

Application Equipment

- | Application Equipment | Source |
|--|---------------------------------|
| 1) Graduated 1 lb. container: | RPS |
| 2) Syringes: | RPS |
| 3) 3" Laminating Roller: | RPS |
| 4) Tapering Tool Type 'B': | RPS |
| 5) Vacuum unit for 'B' Tool - Industrial canister type: | Black & Decker #54840 or equiv. |
| 6) Hacksaw cutting disc or circular saw with diamond coated or abrasive blade: | Ind. Tool Supplier |
| 7) Power disc grinder with 24 or 36 grit sanding pads: | Ind. Tool Supplier |
| 8) Pipe strap wrench: | RPS, Ind. Tool Supp. |
| 9) Grease pencil: | Hardware Store |
| 10) Measuring tape: | Hardware Store |

- | | |
|--|---------------------|
| 11) Slotted head screwdriver: | Hardware Store |
| 12) Wrap-around or stiff paper: | Hardware Store |
| 13) 120 grit sandpaper: | Hardware Store |
| 14) Coarse file: | Hardware Store |
| 15) Paint Brushes (2" - 4"): | Hardware Store |
| 16) 6" Paint Roller: | Hardware Store |
| 17) Level: | Hardware Store |
| 18) Knife or utility knife: | Hardware Store |
| 19) 1 Gallon & 5 gallon pails: | Hardware Store |
| 20) Scissors: | Hardware Store |
| 21) Clean rags: | Hardware Store |
| 22) Mixing sticks: | Hardware Store |
| 23) Weighing scale (10 – 20 lbs. max.): | Industrial Supplier |
| 24) Cardboard or heavy paper (3' - 4' wide): | Hardware Store |
| 25) Solvent (Acetone): | RPS, Ind. Supplier |
| 26) Heat lamp (Cold Weather): | Industrial Supplier |

Safety Equipment

- | Safety Equipment | Source |
|--|--------------------|
| 1) Leather/leather palm gloves: | Hardware Store |
| 2) Rubber gloves: | Hardware Store |
| 3) Safety glasses: | Hardware Store |
| 4) Half mask with organic vapour canister: | Safety supply shop |
| 5) Dust mask: | Hardware Store |
| 6) Ear plugs: | Hardware Store |

All local safety regulations must be followed.



Safety Instructions

- 1) All resin, paste, 'air dry', DMA, and catalyst, separately or combined, will cause skin irritation to some people. Avoid contact with skin and eyes. Wear rubber gloves and safety glasses. In case of contact, wash with flowing water and soap. For eyes, flush with plenty of water for at least 15 minutes

Pipe & Fittings Installation

- and get medical attention. See the Safety section of the RPS Installation Manual, and the supplied MSDSs for more details.
- 2) Wear leather gloves, safety glasses and appropriate PPE when handling and grinding pipe.
 - 3) Left over catalyzed resin in pot will become very hot (150°C. or 300°F. approx.) after gelation. It is advisable to put this hot pot in a bucket of water to reduce fire hazard and unpleasant odor.
 - 4) Do not smoke or have an open flame near work area.
 - 5) Work in a well ventilated area and wear PPE as required by local regulations.
 - 6) Contain nuisance dust when cutting & grinding.
 - 7) DO NOT MIX PROMOTERS (DMA or COBALT NAPHTHANATE) AND CATALYST (MEKP OR BPO) TOGETHER. RAPID OXIDATION WILL TAKE PLACE AND A FIRE MAY RESULT.
 - 8) Follow your safety rules.

Storage, Handling and Environment

- a) Always store resin, paste, and catalyst in a cool, dry place (10°C. to 25°C. or 50°F. to 80°F.).
- b) Store catalysts separately from promoters and resins.
- c) All resins are shipped from RPS with expiry dates on the label. Do not use resin or paste, which has started to turn stringy, rubbery or hard, because of age or improper storage.
- d) Reinforcing material must be stored in dry conditions. Do not use material showing signs of moisture or condensation.
- e) Ideal working conditions are between 10oC and 30oC. Exceeding these may affect cure.
- f) Keep the joint area free of moisture, including condensation. Ambient temperature should exceed the dew temperature by 3°C (5°F). When outdoors, build a portable shelter over the joint.
- g) The working time or “pot life” of resin varies with temperature. The warmer it is, the shorter the working time. At 24°C. (75°F.), you have 15 to 30 minutes, and at 18°C. (65°F.), you have 30 to 60 minutes. Do not use the resin once it has started to gel.
- h) Clean your tools regularly while working; shake and dry out tools completely before using them to laminate again. Solvent or cleaning fluids in the resin will ruin the cure.

- i) Properly dispose of used and unused surplus resin by first curing any uncured resin, and then bury in an approved sanitary landfill area.
- j) Clean up all spills with sand, sawdust, or vermiculite while wearing appropriate PPE (see MSDS). Arrange disposal with an approved waste disposal agency.

Joint Preparation

1) Factory Prepared Ends

- a) Pipe and pre-spoiled pieces are available from the factory with or without prepared ends. For straight butt joints, pipe and fittings are usually supplied with butt edges coated with resin. The ends are then sanded in the field in preparation for making the joint.



b) PEEL-A-BOND™

The pipe and fittings can be supplied with completely prepared ends. In this case, all sanding is done at the factory, and the surfaces are covered with a peel-ply. [RPS PEEL-A-BOND™]. In this case, no sanding, grinding, or cleaning is required in the field.



When PEEL-A-BOND is supplied, the only joint preparation required, before applying reinforcement to bonding surfaces, is the removal of the protective layer; RPS PEEL-A-BOND. Grab the overlap tab and pull firmly, removing the PEEL-A-BOND strip from the whole

Pipe & Fittings Installation

circumference of the joint. This should be the last action before lamination is applied, and the surface should not be otherwise touched or cleaned after removal of the protective strip. If the PEEL-A-BOND has been removed prematurely, either in transit or on the jobsite, clean the surface to remove any grease, oil, or other contaminant by lightly sanding the contaminated surface. See PEEL-A-BOND section, Page 51.

2) Field Prepared Ends

a) Measuring and Cutting

Measure the length of pipe required and, using a wrap-around, scribe a line around the pipe. Cut on the line using a hacksaw or a circular saw with a diamond coated wheel or abrasive blade.



Pipe end must be square to within tolerance (face to center-line dimension $\pm 1/8"$ up to and including 12" dia., or $\pm 3/16"$ for 14" dia. and larger).



b) Field preparation is usually done using a high-speed 4 1/2" or 7" grinder, 24-36 grit (all sizes).

c) For area shown as "C" in Figure 2 for straight butt joints, the surface should be thoroughly sanded to remove all brushcoat, wax, grease, dirt, or any other contaminant.

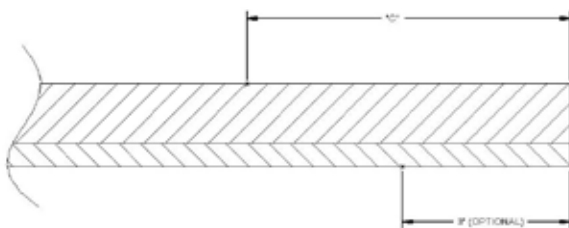


Figure 2

SANDING REQUIREMENT	
PIPE DIA.	C (in.)
1"	2
1 1/2"	2
2"	2
3"	2.5
4"	2.5
5"	3
6"	3
8"	4.5
10"	4.5
12"	5.5
14"	6
16"	7
18"	7.5
20"	8.5
24"	10
30"	12
36"	14.5
42"	16.5
48"	19

Table No. 1

- e) Perhaps the single most important aspect of making a successful joint is ensuring the bonding surfaces are clean. Sanded areas can very quickly become contaminated by airborne dirt and moisture. It is, therefore, recommended that the time between sanding and lay-up not exceed 4 hours. In fact, lay-up should begin as soon as possible after sanding. If lay-up cannot begin within 4 hours, the surfaces should be lightly re-sanded prior to lay-up. It is very important to have the bonding surfaces perfectly clean to achieve a strong joint.
- f) It is recommended that an inside lay-up be done whenever the joint is accessible. If the inside of the joint is not accessible, the pipe I.D. is not to be sanded.
- g) Coat butt edges of pipe or fittings with lay-up resin to ensure the edges are properly sealed.



Pipe & Fittings Installation

h) Alignment

Align the pipe assembly and support the pipe firmly together to prevent any movement during the lamination of the joint.



Item	Diameter	Tolerance
Axial gap	1" to 12"	+0.125"
	14" to 24" larger	+0.188"
	larger	+0.25
Radial offset	1" to 12"	+0.125"/-0.125"
	14" to 24"	+0.188"/0.188"
	larger	+0.25"/-0.25"
Angularity	All sizes	+/-0.5 degrees

i) Hot Patch

When working with large diameter pipe, it may be necessary to "tack weld" the two pipes together to hold them in place. To do this, use a RPS Hot Patch Kit and apply its reinforcement in four (4) evenly spaced locations on the joint while holding both parts securely. After curing, the first step of the joint can be laminated between patches without fear of movement or misalignment. The hot patches should then be removed and pasting and laminating in those areas completed.

j) It is advisable to mark the pipe with a pencil at a known distance just beyond the sanded area. This mark will serve as a reference in locating the centerline of the joint. This will aid in ensuring all layers are centered over the joint.

3) Joint Lamination

a) Look up the appropriate Joint Lamination Sequence in the table found at the end of this section. Refer to this sheet for the required amounts of paste, resin, catalyst, etc. Written instruction for the joint are included in all RPS reinforcement kits.

b) Apply Liner Paste

Catalyze liner paste and apply to joint crevice only. DO NOT FORCE THE PASTE THROUGH THE CREVICE AND INTO THE PIPE INTERIOR. THIS WILL IMPEDE FLOW. Avoid a gap of

more than 1/8" by trimming the edge. At 21°C. (70°F.), the liner paste will cure in 10 to 20 minutes. In cold weather, a heat lamp should be used to achieve a proper cure.

Cured paste should be as hard as pipe surface. If slightly rubbery or soft, it needs more time. If it will not cure, the joint process will have to be repeated

CAUTION: The heat lamp will cause bubbling, blistering, or smoke if held too close or too long to the paste. Remember, the materials are flammable.

c) Apply Reinforcement

Open the kit material and lay the strips of reinforcement near the work area in sequence of application. Measure out the amount of resin required. Lay a cardboard or heavy paper sheet next to the work area.



Using a paintbrush, coat a strip down the center of the cardboard sheet with a generous amount of catalyzed resin. Take the first piece (narrowest) of reinforcement and lay it binder (finished or smoothest) side up on the wet strip. Impregnate the reinforcement until all the fibers are

Pipe & Fittings Installation

soaked. Now carefully lift the reinforcement and wrap it around the joint area. Do not stretch the glass. Using a paintbrush, force air bubbles out of the laminate. Do this with a jabbing motion with the ends of the bristles. Do not use a painting motion. ALL AIR MUST BE FORCED FROM BETWEEN THE LAYERS. A laminating roller or paint roller will also help to force out the air.

The first two (2) layers must be applied singularly, however, the remaining reinforcement, may be applied singularly or in groups of 2, 3, or 4 layers. Make sure all overlapped ends are staggered around the joint. NEVER ALLOW THE GLASS TO SAG.



After each step of reinforcement (5 layers) is applied, the lay-up must be allowed to cure for 30 minutes to 2 hours depending on the temperature and the amount of catalyst added. During cure, the lay-up generates a considerable amount of heat. Do not commence the next step until the lay-up has cooled (you should be able to hold your hand comfortably on the laminate).

NOTE: For large joints, do not mix more resin than can be used within a 15 to 20 minute period. Use maximum 10 lb. (4.5 kg) lots.

If the ambient temperature is below 50°F./10°C.:

- Warm both joining surfaces to a minimum of 50°F./10°C. Heating collars can be used for this, but the surfaces should not be hot to the touch (ie. should not be greater than 95°F./35°C.), or working time of the resins will be too short.
- Warm the resins to 68°F.-77°F. (20°C.-25°C.) before mixing.
- Control ambient air temperature to at least 50°F./10°C. by enclosing joint in local shelter or wrapping with insulation.
- Eliminate cold air movement through the pipe.

d) Interior Lay-up

All joints greater than 20" diameter, where accessible, shall receive an inside joint overlay as specified in the butt joint instructions.

e) Brushcoat

Mix brushcoat per attached laminating sequence sheet and apply over joint exterior laminate. When there is an interior laminate, brush-coating is also required.



4) Inspection Check List

Visually inspect to criteria and tolerances in RPS WI-IT-008 on next page (essentially ASTM D2563 Level 3). Refer to ASME B31.1 or B31.3 for minimum inspection frequencies.

General Guidance criteria:

a) Contamination

Ensure there is no contamination of bonding surfaces (no grease, tar, soot, oil, water, or other dirt).

b) Mixing

To ensure all resin components are properly dispersed, all laminating resin mixes should be stirred immediately prior to use.

Check that materials (paste and resin) are mixed exactly per instructions. Mix thoroughly.

c) Application

Check that materials (paste, resin, glass, and brushcoat) are applied exactly per instructions.

d) Movement

Ensure there is no pipe movement while laminating or before joint is cured.

e) Sags or Drooping Glass

There should be no sags, drooping, or slipping of wet reinforcement at the bottom of a joint (caused by resin rich laminate, by applying too many layers at a time, or by improper rolling). Check repeatedly until cured.

Pipe & Fittings Installation

f) **Dry Spots**

Ensure there are no dry or resin starved spots.

g) **Delamination**

There should be no delamination or blisters.

i) **Brushcoat**

Check that brushcoat has been applied. If in doubt, use the acetone test. Apply a small amount of acetone on the resin surface and rub lightly with the finger until the acetone evaporates. If the surface softens or becomes tacky, brushcoat has not been applied or is too thin.

j) **Curing**

The resin must be cured. A minimum barcol hardness of 30 is required for most resins. Barcol hardness is measured with a barcol tester. Ensure that the tester has been properly calibrated. If a barcol tester is not available, use a knife point to ensure that the cured resin is as hard as the pipe. If not, call RPS for assistance.

5) Materials:

Resin Material:

Crevice Paste: Vinyl ester resin with thixotrope

Structural Resin: Vinyl ester resin

Catalyst: MEKP – methylethyl ketone peroxide suitable for vinyl ester per manufacturer's instructions

AirDry: a mix of paraffin & styrene

All adhesives, paste, and resins are shipped from the factory with labeled expiry dates. THESE MATERIALS SHALL NOT BE USED AFTER THE LABELED EXPIRY DATE.

Reinforcements:

Veil: Nexus or C glass

E or ECR glass in chopped strand mat and woven roving formats.

Pipe & Fittings Installation

ACCEPTANCE CRITERIA FOR APPEARANCE OF LAMINATES

This Specification defines the acceptance criteria for appearance of laminates. It shall be used for all projects (including standard products) unless a project-specific specification is issued. These criteria are generally in accordance with ASTM D-2563 Level II for liners, and level III for structural layers. Refer to ASTM D-2563 for definition of terms.

ALLOWABLE DEFECTS

DEFECT	DESCRIPTION	LINER	STRUCTURAL LAYERS
1. Air bubble (void)	Air entrapped within and between the plies of reinforcement	Max. dia., 1.5 mm. (1/16"); Max 2 per in ²	Max. dia., 3.0 mm. (1/8"); Max. 4 per in ²
2. Pit (pithole)	Small crater in surface of laminate	Max. dia., 1.5 mm. (1/16"); Max. depth 0.8mm (1/32")	Max. dia. 3.2 mm. (1/8"); Max. depth 1.5mm (1/16")
3. Blister	Rounded elevation on surface of laminate	Max. dia., 3.0 mm.(1/8"); height from surface not to be outside drawing	Max. dia., 6.5 mm. (1/4"); height from surface not to be outside drawing tolerance
4. Burn	Showing evidence of thermal decomposition	None	None
5. Chip	Small piece broken off edge or surface	Max. dimension of break, 3.0 mm. (1/8")	Max. dimension of break, 6.5 mm. (1/4")
6. Crack	Crack in laminate	None	None
7. Crazing	Fine cracks at or under surface of laminate	None	Max. dimension of crazing, 25 mm. (1")
8. Delamination, edge	Separation of the layers of material layers of material in the laminate	Max. dimension, 3.0 mm. (1/8")	Max. dimension, 6.5 mm. (1/4")
9. Delamination, internal	Separation of the layers of material in the laminate	None	None
10. Dry spot	Area of incomplete resin wet-out on surface	None	Max. dia., 14 mm. (9/16")
11. Foreign Inclusion	Particles included in laminate which are foreign to its composition	Max. dimension 0.8mm (1/32"); Max. 1 per ft ²	Max. dimension, 1.5 mm. (1/16"); Max. 1per ft ²
12. Fracture	Rupture of laminate surface without complete penetration	None	Max. dimension, 29mm. (1 1/8")
13. Exposed Glass	Filaments of glass protruding from surface and not encased in resin	None	None
14. Exposed Cut Edges	Edges of laminate where reinforcement has not been wetted with resin	None	None
15. Porosity of 50 pits (pinhole)	Accumulation of numerous small pits	Max. of 25 pits pinholes per 10 in ²	Max. of 50 pits (pinholes) per 10 in ²
16. Resin-rich edge	Insufficient reinforcing material at edge material at edge of molded laminate	Max., 0.4 mm. (1/64") from the edge	Max., 0.8 mm. (1/32") from the edge
17. Scratch	Shallow mark, groove, furrow, or channel caused by improper handling or storage	Max. length, 25 mm. (1"); max. depth 0.125 mm (0.005")	Max. length, 25 mm. (1"); max. depth 0.255 mm. (0.010")
18. Wrinkles	Appears as a wave molded into one or more plies of reinforcement	3.2 mm. (1/8") but must not decrease laminate thickness	Not applicable

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	1"	1½"	2"	3"	4"	5"
Paste + Catalyst MEKP	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	0.25 lb. + 2 cc	0.25 lb. + 2 cc	0.25 lb. + 2 cc	0.38 lb. + 3 cc	0.50 lb. + 4 cc	0.25 lb. + 2 cc
Apply Reinforcement	2" x 7" NV 2" x 7" M	2" x 9" NV 2" x 9" M	2" x 10" NV 2" x 10" M	2" x 13" NV 3" x 13" M	2" x 17" NV 2" x 17" M	2" x 19" NV 2" x 19" M
Mat = M	3" x 7" M	3" x 9" M	3" x 10" M	3" x 13" M	3" x 17" M	3" x 19" M
Woven Roving = WR	3" x 7" M	3" x 9" M	3" x 10" M	4" x 13" M	3" x 17" M	
Nexus Veil = NV	3" x 7" M	3" x 9" M	3" x 10" M	4" x 13" M	3" x 17" WR 4" x 17" M	
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP						0.75 lb. + 6 cc
Apply Reinforcement						3" x 21" M 3" x 21" WR 4" x 21" M 4" x 21" WR 5" x 21" M
Cure						Cure
Resin + Air Dry + Catalyst MEKP	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:						
Liner Paste	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.
Resin	0.5 lb.	0.5 lb.	0.5 lb.	0.63 lb.	0.75 lb.	1.25 lbs.
Air Dry Solution	11 cc	11 cc	11 cc	11 cc	11 cc	11 cc
Catalyst MEKP	0.25 oz.	0.25 oz.	0.25 oz.	0.28 oz.	0.32 oz.	0.46 oz.
Nexus Veil	0.01 lb.	0.01 lb.	0.01 lbs.	0.01 lbs.	0.01 lbs.	0.01 lbs.
1½ oz. Mat	0.05 lb.	0.07 lb.	0.07 lb.	0.12 lb.	0.13 lb.	0.23 lb.
Woven Roving					0.06 lb.	0.17 lb.

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	6"	8"	10"	12"	14"	16"
Paste + Catalyst MEKP	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.55 cc	6 oz. + 3.5 cc	0.75 lb. + 7 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	0.25 lb. + 2 cc	1.38 lbs. + 10.5 cc	1.75 lbs. + 13.5 cc	0.75 lbs. + 6cc	2.25 lbs. + 17 cc	1.50 lbs + 11.5 cc
Apply Reinforcement	2" x 23" NV 2" x 23" M	3" x 30" NV 4" x 30" M	2 of 3" x 19" NV 2 of 4" x 19" M	3 of 3" x 22" NV 2 of 3" x 22" M	2 of 3" x 25" NV 2 of 4" x 25" M	2 of 3" x 29" NV 2 of 4" x 29" M
Mat = M	3" x 23" M	4" x 30" M	2 of 4" x 19" M	2 of 4" x 25" M	2 of 4" x 25" M	2 of 4" x 29" M
Woven Roving = WR		5" x 30" M	2 of 5" x 19" M	Cure	2 of 5" x 25" M	2 of 5" x 29" M
Nexus Veil = NV		5" x 30" WR 6" x 30" M	2 of 5" x 19" WR 2 of 6" x 19" M	2.25 lbs. + 17 cc 2 of 5" x 22" M	2 of 5" x 25" WR 2 of 6" x 25" M	Cure 3.38 lbs. + 25.5 cc
Cure	Cure	Cure	Cure	2 of 5" x 22" WR	Cure	2 of 6" x 29" M
Resin + Catalyst MEKP	0.88 lb. + 6.5 cc	1.5 lbs. + 11.5 cc	2.25 lbs. + 17 cc	2 of 6" x 22" M	3.25 lbs. + 24.5 cc	2 of 6" x 29" WR
Apply Reinforcement	3" x 24" M 3" x 24" WR	6" x 31" M 6" x 31" WR	2 of 6" x 20" M 2 of 6" x 20" WR	2 of 6" x 22" WR 2 of 7" x 22" M	2 of 6" x 26" M 2 of 6" x 26" WR	2 of 7" x 29" M 2 of 7" x 29" WR
Mat = M	4" x 24" M	7" x 31" M	2 of 7" x 20" M	Cure	2 of 8" x 26" M	2 of 8" x 29" M
Woven Roving = WR	4" x 24" WR 5" x 24" M	8" x 31" M	2 of 7" x 20" WR 2 of 8" x 20" M	3.25 lbs. + 25 cc 2 of 8" x 23" M	2 of 8" x 26" WR 2 of 9" x 26" M	Cure 4.88 lbs. + 36.5 cc
Cure	Cure	Cure	Cure	2 of 8" x 23" WR	Cure	2 of 9" x 30" M
Resin + Catalyst MEKP				2 of 9" x 23" M	3.63 lbs. + 27 cc	2 of 9" x 30" WR
Apply Reinforcement				2 of 9" x 23" WR 2 of 10" x 23" M	2 of 9" x 27" M 2 of 9" x 27" WR	2 of 10" x 30" M 2 of 10" x 30" WR
Mat = M				Cure	2 of 10" x 27" M	2 of 11" x 30" M
Woven Roving = WR					2 of 11" x 27" M	Cure
Cure					Cure	3.88 lbs. + 29 cc
						2 of 12" x 30" M
						2 of 12" x 30" WR
						2 of 13" x 30" M
						Cure
Resin + Air Dry + Catalyst MEKP	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.38 lb. + 17 cc + 3.5 cc	0.5 lb. + 23 cc + 4.5 cc	0.63 lb. + 28 cc + 5.0 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:						
Liner Paste	4 oz.	4 oz.	4 oz.	4 oz.	6 oz.	0.75 lb.
Resin	1.38 lbs.	3.13 lbs.	4.25 lbs.	6.63 lbs.	9.13 lbs.	14.26 lbs.
Air Dry Solution	11 cc	11 cc	11 cc	17 cc	23 cc	27 cc
Catalyst MEKP	0.48 oz.	0.95 oz.	1.25 oz.	1.90 oz.	2.70 oz.	4.04 oz.
Nexus Veil	0.01 lb.	0.01 lb.	0.01 lbs.	0.01 lbs.	0.01 lbs.	0.01 lbs.
1½ oz. Mat	0.26 lb.	0.79 lb.	1.02 lbs.	1.58 lbs.	2.45 lbs.	3.46 lbs.
Woven Roving	0.19 lb.	0.39 lb.	0.82 lb.	1.49 lbs.	1.69 lbs.	3.05 lbs.

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	18"	20"	24"	30"	36"
Paste + Catalyst MEKP	0.88 lb. + 7.5 cc	1.13 lb. + 10 cc	1.5 lb. + 13.0 cc	2.13 lb. + 18.5 cc	3 lb. + 26.5 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	1.13 lbs. + 8.5 cc	1.25 lbs. + 9.5 cc	2.13 lbs. + 16.0 cc	1.63 lbs. + 12.0 cc	2.13 lbs. + 16.0 cc
Apply Reinforcement	2 of 3" x 32" NV 2 of 4" x 32" M	3 of 3" x 24" NV 3 of 4" x 24" M	3 of 3" x 28" NV 3 of 4" x 28" M	3 of 3" x 34" NV 3 of 4" x 34" M	4 of 3" x 31" NV 4 of 4" x 31" M
Mat = M	2 of 4" x 32" M	3 of 4" x 24" M	3 of 4" x 28" M	3 of 4" x 34" M	4 of 4" x 31" M
Cure	Cure	Cure	3 of 5" x 28" M	Cure	4 of 5" x 31" M
	3.38 lbs. + 25.5 cc	3.50 lbs. + 26.5 cc	Cure	4.75 lbs. + 40.5 cc	Cure
Woven Roving = WR	2 of 5" x 33" M	3 of 5" x 24" M	4.88 lbs. + 36.5 cc	3 of 5" x 35" M	7.38 lbs. + 55.5 cc
Nexus Veil = NV	2 of 5" x 33" WR	3 of 5" x 24" WR	3 of 6" x 28" M	3 of 5" x 35" WR	4 of 6" x 31" M
Resin + Catalyst MEKP	2 of 6" x 33" M 2 of 6" x 33" WR	3 of 6" x 24" M 3 of 6" x 24" WR	3 of 6" x 28" WR 3 of 7" x 28" M	3 of 7" x 35" M 3 of 7" x 35" WR	4 of 6" x 31" WR 4 of 8" x 31" M
	2 of 8" x 33" M	3 of 8" x 24" M	3 of 7" x 28" WR	3 of 8" x 35" M	4 of 8" x 31" WR
Cure	Cure	Cure	3 of 9" x 28" M	Cure	4 of 9" x 31" M
Resin + Catalyst MEKP	5.0 lbs. + 37.5 cc	5.63 lbs. + 42.0 cc	Cure	8.38 lbs. + 63 cc	Cure
Apply Reinforcement	2 of 8" x 33" M	3 of 8" x 25" M	7.25 lbs. + 54.5 cc	3 of 9" x 35" M	10.88 lbs. + 81.5 cc
Cure	2 of 8" x 33" WR	3 of 8" x 25" WR	3 of 9" x 29" M	3 of 9" x 35" WR	4 of 10" x 31" M
Resin + Catalyst MEKP	2 of 9" x 33" M	3 of 10" x 25" M	3 of 9" x 29" WR	3 of 10" x 35" M	4 of 10" x 31" WR
Mat = M	2 of 9" x 33" WR	3 of 10" x 25" WR	3 of 11" x 29" M	3 of 10" x 35" WR	4 of 11" x 31" M
Woven Roving = WR	2 of 10" x 33" M	3 of 11" x 25" M	3 of 11" x 29" WR	3 of 12" x 35" M	4 of 11" x 31" WR
Cure	Cure	Cure	3 of 12" x 29" M	Cure	4 of 13" x 31" M
Resin + Catalyst MEKP	7.0 lbs. + 52.5 cc	7.38 lbs. + 55.5 cc	Cure	11.75 lbs. + 88.5 cc	Cure
Apply Reinforcement	2 of 11" x 34" M	3 of 11" x 25" M	9.75 lbs. + 73.5 cc	3 of 13" x 35" M	15.25 lbs. + 114.5 cc
Cure	2 of 11" x 34" WR	3 of 11" x 25" WR	3 of 13" x 29" M	3 of 13" x 35" WR	4 of 14" x 32" M
Resin + Catalyst MEKP	2 of 13" x 34" M	3 of 13" x 25" M	3 of 13" x 29" WR	3 of 14" x 35" M	4 of 14" x 32" WR
Mat = M	2 of 13" x 34" WR	3 of 13" x 25" WR	3 of 14" x 29" M	3 of 14" x 35" WR	4 of 15" x 32" M
Woven Roving = WR	2 of 14" x 34" M	3 of 14" x 25" M	3 of 14" x 29" WR	3 of 16" x 35" M	4 of 15" x 32" WR
Cure	Cure	Cure	3 of 16" x 29" M	Cure	4 of 17" x 32" M
Resin + Catalyst MEKP		5.88 lbs. + 44.0 cc	Cure	14.88 lbs. + 112.0 cc	Cure
Apply Reinforcement		3 of 15" x 26" M	12.5 lbs. + 94.0 cc	3 of 16" x 36" M	18.63 lbs. + 140.0 cc
Cure		3 of 15" x 26" WR	3 of 16" x 30" M	3 of 16" x 36" WR	4 of 17" x 32" M
		3 of 16" x 26" M	3 of 16" x 30" WR	3 of 18" x 36" M	4 of 17" x 32" WR
			3 of 18" x 30" M	3 of 18" x 36" WR	4 of 19" x 32" M
			3 of 18" x 30" WR	3 of 19" x 36" M	4 of 19" x 32" WR
Cure		Cure	3 of 19" x 30" M	Cure	4 of 20" x 32" M
Resin + Catalyst MEKP			Cure	18.38 lbs. + 138.0 cc	Cure
Apply Reinforcement				3 of 20" x 36" M	22.75 lbs. + 171.0 cc
				3 of 20" x 36" WR	4 of 21" x 32" M
				3 of 22" x 36" M	4 of 21" x 32" WR
				3 of 22" x 36" WR	4 of 23" x 32" M
				3 of 23" x 36" M	4 of 23" x 32" WR
Cure				Cure	4 of 24" x 32" M
					Cure

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	18"	20"	24"	30"	36"
Resin + Catalyst MEKP					27.25 lbs. + 205.0 cc
Apply Reinforcement					4 of 25" x 33" M 4 of 25" x 33" WR 4 of 26" x 33" M 4 of 26" x 33" WR 4 of 28" x 33" M
Cure					Cure
Resin + Catalyst MEKP (Inside lay-up when accessible)			1.63 lbs. + 12 cc 4 of 4" x 20" M 4 of 5" x 20" M 4 of 6" x 20" NV	1.88 lbs. + 14 cc 4 of 4" x 24" M 4 of 5" x 24" M 4 of 6" x 24" NV	2.25 lbs. + 17 cc 5 of 4" x 23" M 5 of 5" x 23" M 5 of 6" x 23" NV
Cure			Cure	Cure	Cure
Resin + Air Dry + Catalyst MEKP	0.75 lb. + 34 cc + 7.0 cc	0.88 lb. + 40 cc + 8.0 cc	1.25 lb. + 57 cc + 11 cc	1.88 lbs. + 85.0 cc + 16.5 cc	2.63 lbs. + 120 cc + 23 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:					
Liner Paste	0.88 lb.	1.13 lb.	1.5 lb.	2.13 lb.	3 lb.
Resin	17.26 lbs.	24.52 lbs.	39.39 lbs.	63.53 lbs.	109.2 lbs.
Air Dry Solution	34 cc	40 cc	57 cc	85 cc	120 cc
Catalyst MEKP	4.88 oz.	6.90 oz.	11.0 oz.	1.2 lbs.	1.8 lbs.
Nexus Veil	0.01 lbs.	0.01 lbs.	0.04 lbs.	0.05 lbs.	0.06 lbs.
1½ oz. Mat	4.04 lbs.	6.11 lbs.	9.78 lbs.	15.82 lbs.	27.36 lbs.
Woven Roving	4.03 lbs.	5.92 lbs.	9.58 lbs.	16.55 lbs.	28.96 lbs.

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	42"	42" (Cont'd)	48"	48" (Cont'd)
Paste + Catalyst MEKP	4.13 lb. + 36 cc		5.38 lb. + 48 cc	
Apply Paste	Apply Paste		Apply Paste	
Cure	Cure		Cure	
Resin + Catalyst MEKP	5.13 lbs. + 38.5 cc	37.25 lbs. + 280 cc	6.13 lbs. + 46 cc	43.5 lbs. + 327 cc
Apply Reinforcement	5 of 3" x 29" NV 5 of 4" x 29" M 5 of 4" x 29" M	5 of 29" x 31" M 5 of 29" x 31" WR 5 of 31" x 31" M	5 of 3" x 33" NV 5 of 4" x 33" M 5 of 5" x 33" M	5 of 30" x 35" M 5 of 30" x 35" WR 5 of 32" x 35" M
Mat = M	5 of 5" x 29" M	5 of 31" x 31" WR	5 of 5" x 33" M	5 of 32" x 35" WR
Cure	5 of 6" x 29" M Cure	5 of 32" x 31" M Cure	5 of 6" x 33" M Cure	5 of 33" x 35" M Cure
Resin + Catalyst MEKP	9.63 lbs. + 72 cc		10.88 lbs. + 81.5 cc	49.88 lbs. + 375 cc
Apply Reinforcement	5 of 7" x 30" M		5 of 7" x 34" M	5 of 34" x 36" M
Mat = M	5 of 7" x 30" WR		5 of 7" x 34" WR	5 of 34" x 36" WR
Woven Roving = WR	5 of 8" x 30" M 5 of 8" x 30" WR		5 of 8" x 34" M 5 of 8" x 34" WR	5 of 35" x 36" M 5 of 35" x 36" WR
Cure	5 of 10" x 30" M Cure		5 of 10" x 34" M Cure	5 of 37" x 36" M Cure
Resin + Catalyst MEKP	13.63 lbs. + 103 cc		16.25 lbs. + 122 cc	
Apply Reinforcement	5 of 10" x 30" M		5 of 11" x 34" M	
Mat = M	5 of 10" x 30" WR		5 of 11" x 34" WR	
Woven Roving = WR	5 of 12" x 30" M 5 of 12" x 30" WR		5 of 12" x 34" M 5 of 12" x 34" WR	
Cure	5 of 13" x 30" M Cure		5 of 14" x 34" M Cure	
Resin + Catalyst MEKP	18.38 lbs + 138 cc		21.625 lbs. + 163 cc	
Apply Reinforcement	5 of 14" x 30" M		5 of 15" x 34" M	
Mat = M	5 of 14" x 30" WR		5 of 15" x 34" WR	
Woven Roving = WR	5 of 16" x 30" M 5 of 16" x 30" WR		5 of 16" x 34" M 5 of 16" x 34" WR	
Cure	5 of 17" x 30" M Cure		5 of 18" x 34" M Cure	
Resin + Catalyst MEKP	22.63 lbs. + 170 cc		26.38 lbs. + 198 cc	
Apply Reinforcement	5 of 18" x 30" M		5 of 18" x 34" M	
Mat = M	5 of 18" x 30" WR		5 of 18" x 34" WR	
Woven Roving = WR	5 of 19" x 30" M 5 of 19" x 30" WR		5 of 20" x 34" M 5 of 20" x 34" WR	
Cure	5 of 21" x 30" M Cure		5 of 22" x 34" M Cure	
Resin + Catalyst MEKP	28.25 lbs. + 213 cc		32.38 lbs. + 243 cc	
Apply Reinforcement	5 of 22" x 31" M		5 of 22" x 35" M	
Mat = M	5 of 22" x 31" WR		5 of 22" x 35" WR	
Woven Roving = WR	5 of 23" x 31" M 5 of 23" x 31" WR		5 of 24" x 35" M 5 of 24" x 35" WR	
Cure	5 of 25" x 31" M Cure		5 of 25" x 35" M Cure	

Pipe & Fittings Installation

P150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	42"	42" (Cont'd)	48"	48" (Cont'd)
Resin + Catalyst MEKP	32.38 lbs. + 243 cc		38 lbs. + 285.5 cc	
Apply Reinforcement	5 of 25" x 31" M		5 of 26" x 35" M	
Mat = M	5 of 25" x 31" WR		5 of 26" x 35" WR	
Woven Roving = WR	5 of 27" x 31" M		5 of 28" x 35" M	
	5 of 27" x 31" WR		5 of 28" x 35" WR	
Cure	5 of 28" x 31" M		5 of 29" x 35" M	
	Cure		Cure	
Resin + Catalyst MEKP (Inside lay-up when accessible)		2.75 lbs. + 21 cc		3.13 lbs. + 23.5 cc
		6 of 4" x 23" M		7 of 4" x 23" M
		6 of 5" x 23" M		7 of 5" x 23" M
Cure		6 of 6" x 23" NV		7 of 6" x 23" NV
		Cure		Cure
Resin + Air Dry + Catalyst MEKP		3.63 lb. + 165 cc		4.75 lb. + 216 cc
Apply Brushcoat		+ 32 cc		+ 42 cc
Cure		Apply Brushcoat		Apply Brushcoat
		Cure		Cure
Kit Material:				
Liner Paste	4.25 lb.		5.38 lb.	
Resin	173.66 lbs.		252.29 lbs.	
Air Dry Solution	165 cc		216 cc	
Catalyst MEKP	3lb		4lb 5 oz.	
Nexus Veil	0.07 lbs.		0.08 lbs.	
1½ oz. Mat	43.14 lbs.		62.81 lbs.	
Woven Roving	46.22 lbs.		68.24 lbs.	

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	1"	1½"	2"	3"	4"	5"
Paste + Catalyst MEKP	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	0.25 lb. + 2 cc	0.25 lb. + 2 cc	0.25 lb. + 2 cc	0.38 lb. + 3 cc	0.50 lb. + 4 cc	0.25 lb. + 2 cc
Apply Reinforcement						
	2" x 7" M	2" x 9" M	2" x 10" M	3" x 13" M	2" x 17" M	2" x 19" M
Mat = M	3" x 7" M	3" x 9" M	3" x 10" M	3" x 13" M	3" x 17" M	3" x 19" M
Woven Roving = WR	3" x 7" M	3" x 9" M	3" x 10" M	4" x 13" M	3" x 17" M	
Nexus Veil = NV	3" x 7" M	3" x 9" M	3" x 10" M	4" x 13" M	3" x 17" WR 4" x 17" M	
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP						0.75 lb. + 6 cc
Apply Reinforcement						3" x 21" M 3" x 21" WR 4" x 21" M 4" x 21" WR 5" x 21" M
Cure						Cure
Resin + Air Dry + Catalyst MEKP	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc	0.25 lb. + 11 cc + 2.5 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:						
Liner Paste	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.
Resin	0.5 lb.	0.5 lb.	0.5 lb.	0.63 lb.	0.75 lb.	1.25 lbs.
Air Dry Solution	11 cc	11 cc	11 cc	11 cc	11 cc	11 cc
Catalyst MEKP	0.25 oz.	0.25 oz.	0.25 oz.	0.28 oz.	0.32 oz.	0.46 oz.
Nexus Veil	0.01 lb.	0.01 lb.	0.01 lbs.	0.01 lbs.	0.01 lbs.	0.01 lbs.
1½ oz. Mat	0.05 lb.	0.07 lb.	0.07 lb.	0.12 lb.	0.13 lb.	0.23 lb.
Woven Roving					0.06 lb.	0.17 lb.

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	6"	8"	10"	12"	14"	16"
Paste + Catalyst MEKP	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	4 oz. + 2.5 cc	6 oz. + 3.5 cc	0.75 lb. + 7 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	0.25 lb. + 2 cc	1.38 lbs. + 10.5 cc	1.75 lbs. + 13.5 cc	0.75 lbs. + 6 cc	2.25 lbs. + 17 cc	1.50 lbs. + 11.5 cc
Apply Reinforcement						
	2" x 23" M	4" x 30" M	2 of 4" x 19" M	2 of 3" x 22 M	2 of 4" x 25" M	2 of 4" x 29" M
Mat = M	3" x 23" M	4" x 30" M	2 of 4" x 19" M	2 of 4" x 22" M	2 of 4" x 25" M	2 of 4" x 29" M
Woven Roving = WR		5" x 30" M	2 of 5" x 19" M	Cure	2 of 5" x 25" M	2 of 5" x 29" M
Nexus Veil = NV		5" x 30" WR	2 of 5" x 19" WR	2.25 lbs. + 17 cc	2 of 5" x 25" WR	Cure
		6" x 30" M	2 of 6" x 19" M	2 of 5" x 22" M	2 of 6" x 25" M	3.38 lbs. + 25.5 cc
Cure	Cure	Cure	Cure	2 of 5" x 22" WR	Cure	2 of 6" x 29" M
Resin + Catalyst MEKP	0.88 lb. + 6.5 cc	1.5 lbs. + 11.5 cc	2.25 lbs. + 17 cc	2 of 6" x 22" M	3.25 lbs. + 24.5 cc	2 of 6" x 29" WR
Apply Reinforcement						
	3" x 24" M	6" x 31" M	2 of 6" x 20" M	2 of 6" x 22" WR	2 of 6" x 26" M	2 of 7" x 29" M
	3" x 24" WR	6" x 31" WR	2 of 6" x 20" WR	2 of 7" x 22" M	2 of 6" x 26" WR	2 of 7" x 29" WR
Mat = M	4" x 24" M	7" x 31" M	2 of 7" x 20" M	Cure	2 of 8" x 26" M	2 of 8" x 29" M
Woven Roving = WR	4" x 24" WR	8" x 31" M	2 of 7" x 20" WR	3.25 lbs. + 25 cc	2 of 8" x 26" WR	Cure
	5" x 24" M		2 of 8" x 20" M	2 of 8" x 23" M	2 of 9" x 26" M	4.88 lbs. + 36.5 cc
Cure	Cure	Cure	Cure	2 of 8" x 23" WR	Cure	2 of 9" x 30" M
Resin + Catalyst MEKP				2 of 9" x 23" M	3.63 lbs. + 27 cc	2 of 9" x 30" WR
Apply Reinforcement				2 of 9" x 23" WR	2 of 9" x 27" M	2 of 10" x 30" M
				2 of 10" x 23" M	2 of 9" x 27" WR	2 of 10" x 30" WR
				Cure	2 of 10" x 27" M	2 of 11" x 30" M
Mat = M					2 of 11" x 27" M	Cure
Woven Roving = WR					Cure	3.88 lbs. + 29 cc
Cure						2 of 12" x 30" M
						2 of 12" x 30" WR
						2 of 13" x 30" M
						Cure
Resin + Catalyst (MEKP)	0.25 lb. + 2.5 cc	0.25 lb. + 2.5 cc	0.25 lb. + 2.5 cc	0.38 lb. + 3.5 cc	0.5 lb. + 4.5 cc	0.63 lb. + 5.0 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:						
Liner Paste	4 oz.	4 oz.	4 oz.	4 oz.	6 oz.	0.75 lb.
Resin	1.38 lbs.	3.13 lbs.	4.25 lbs.	6.63 lbs.	9.13 lbs.	14.26 lbs.
Air Dry Solution	11 cc	11 cc	11 cc	17 cc	23 cc	27 cc
Catalyst MEKP	0.48 oz.	0.95 oz.	1.25 oz.	1.90 oz.	2.70 oz.	4.04 oz.
Nexus Veil	0.01 lb.	0.01 lb.	0.01 lbs.	0.01 lbs.	0.01 lbs.	0.01 lbs.
1½ oz. Mat	0.26 lb.	0.79 lb.	1.02 lbs.	1.58 lbs.	2.45 lbs.	3.46 lbs.
Woven Roving	0.19 lb.	0.39 lb.	0.82 lb.	1.49 lbs.	1.69 lbs.	3.05 lbs.

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	18"	20"	24"	30"	36"
Paste + Catalyst MEKP	0.88 lb. + 7.5 cc	1.13 lb. + 10 cc	1.5 lb. + 13.0 cc	2.13 lb. + 18.5 cc	3 lb. + 26.5 cc
Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste	Apply Paste
Cure	Cure	Cure	Cure	Cure	Cure
Resin + Catalyst MEKP	1.13 lbs. + 8.5 cc	1.25 lbs. + 9.5 cc	2.13 lbs. + 16.0 cc	1.63 lbs. + 12.0 cc	2.13 lbs. + 16.0 cc
Apply Reinforcement					
Mat = M	2 of 4" x 32" M	3 of 4" x 24" M	3 of 4" x 28" M	3 of 4" x 34" M	4 of 4" x 31" M
Cure	2 of 4" x 32" M	3 of 4" x 24" M	3 of 4" x 28" M	3 of 4" x 34" M	4 of 4" x 31" M
Cure	Cure	Cure	3 of 5" x 28" M	Cure	4 of 5" x 31" M
Resin + Catalyst MEKP	3.38 lbs. + 25.5 cc	3.50 lbs. + 26.5 cc	Cure	4.75 lbs. + 40.5 cc	Cure
Woven Roving = WR	2 of 5" x 33" M	3 of 5" x 24" M	4.88 lbs. + 36.5 cc	3 of 5" x 35" M	7.38 lbs. + 55.5 cc
Nexus Veil = NV	2 of 5" x 33" WR	3 of 5" x 24" WR	3 of 6" x 28" M	3 of 5" x 35" WR	4 of 6" x 31" M
Resin + Catalyst MEKP	2 of 6" x 33" M	3 of 6" x 24" M	3 of 6" x 28" WR	3 of 7" x 35" M	4 of 6" x 31" WR
	2 of 6" x 33" WR	3 of 6" x 24" WR	3 of 7" x 28" M	3 of 7" x 35" WR	4 of 8" x 31" M
	2 of 8" x 33" M	3 of 8" x 24" M	3 of 7" x 28" WR	3 of 8" x 35" M	4 of 8" x 31" WR
Cure	Cure	Cure	3 of 9" x 28" M	Cure	4 of 9" x 31" M
Resin + Catalyst MEKP	5.0 lbs. + 37.5 cc	5.63 lbs. + 42.0 cc	Cure	8.38 lbs. + 63 cc	Cure
Apply Reinforcement	2 of 8" x 33" M	3 of 8" x 25" M	7.25 lbs. + 54.5 cc	3 of 9" x 35" M	10.88 lbs. + 81.5 cc
Cure	2 of 8" x 33" WR	3 of 8" x 25" WR	3 of 9" x 29" M	3 of 9" x 35" WR	4 of 10" x 31" M
Resin + Catalyst MEKP	2 of 9" x 33" M	3 of 10" x 25" M	3 of 9" x 29" WR	3 of 10" x 35" M	4 of 10" x 31" WR
Mat = M	2 of 9" x 33" WR	3 of 10" x 25" WR	3 of 11" x 29" M	3 of 10" x 35" WR	4 of 11" x 31" M
Woven Roving = WR	2 of 11" x 33" M	3 of 11" x 25" M	3 of 11" x 29" WR	3 of 12" x 35" M	4 of 11" x 31" WR
Cure	Cure	Cure	3 of 12" x 29" M	Cure	4 of 13" x 31" M
Resin + Catalyst MEKP	7.0 lbs. + 52.5 cc	7.38 lbs. + 55.5 cc	Cure	11.75 lbs. + 88.5 cc	Cure
Apply Reinforcement	2 of 11" x 34" M	3 of 11" x 25" M	9.75 lbs. + 73.5 cc	3 of 13" x 35" M	15.25 lbs. + 114.5 cc
Cure	2 of 11" x 34" WR	3 of 11" x 25" WR	3 of 13" x 29" M	3 of 13" x 35" WR	4 of 14" x 32" M
Resin + Catalyst MEKP	2 of 13" x 34" M	3 of 13" x 25" M	3 of 13" x 29" WR	3 of 14" x 35" M	4 of 14" x 32" WR
Mat = M	2 of 13" x 34" WR	3 of 13" x 25" WR	3 of 14" x 29" M	3 of 14" x 35" WR	4 of 15" x 32" M
Woven Roving = WR	2 of 14" x 34" M	3 of 14" x 25" M	3 of 14" x 29" WR	3 of 16" x 35" M	4 of 15" x 32" WR
Cure	Cure	Cure	3 of 16" x 29" M	Cure	4 of 17" x 32" M
Resin + Catalyst MEKP		5.88 lbs. + 44.0 cc	Cure	14.88 lbs. + 112.0 cc	Cure
Apply Reinforcement		3 of 15" x 26" M	12.5 lbs. + 94.0 cc	3 of 16" x 36" M	18.63 lbs. + 140.0 cc
Cure		3 of 15" x 26" WR	3 of 16" x 30" M	3 of 16" x 36" WR	4 of 17" x 32" M
		3 of 16" x 26" M	3 of 16" x 30" WR	3 of 18" x 36" M	4 of 17" x 32" WR
			3 of 18" x 30" M	3 of 18" x 36" WR	4 of 19" x 32" M
			3 of 18" x 30" WR	3 of 19" x 36" M	4 of 19" x 32" WR
Cure		Cure	3 of 19" x 30" M	Cure	4 of 20" x 32" M
Resin + Catalyst MEKP			Cure	18.38 lbs. + 138.0 cc	Cure
Apply Reinforcement				3 of 20" x 36" M	22.75 lbs. + 171.0 cc
				3 of 20" x 36" WR	4 of 21" x 32" M
				3 of 22" x 36" M	4 of 21" x 32" WR
				3 of 22" x 36" WR	4 of 23" x 32" M
				3 of 23" x 36" M	4 of 23" x 32" WR
Cure				Cure	4 of 24" x 32" M
					Cure

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	18"	20"	24"	30"	36"
Resin + Catalyst MEKP					27.25 lbs. + 205.0 cc
Apply Reinforcement					4 of 25" x 33" M 4 of 25" x 33" WR 4 of 26" x 33" M 4 of 26" x 33" WR 4 of 28" x 33" M
Cure					Cure
Resin + Catalyst MEKP (Inside lay-up when accessible)			1.63 lbs. + 12 cc 4 of 4" x 20" M 4 of 5" x 20" M 4 of 6" x 20" NV	1.88 lbs. + 14 cc 4 of 4" x 24" M 4 of 5" x 24" M 4 of 6" x 24" NV	2.25 lbs. + 17 cc 5 of 4" x 23" M 5 of 5" x 23" M 5 of 6" x 23" NV
Cure			Cure Cure	Cure	Cure
Resin + Catalyst (MEKP)	0.75 lb. + 7.0 cc	0.88 lb. + 8.0 cc	1.25 lb. + 11 cc	1.88 lbs. + 16.5 cc	2.63 lbs. + 23 cc
Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat	Apply Brushcoat
Cure	Cure	Cure	Cure	Cure	Cure
Kit Material:					
Liner Paste	0.88 lb.	1.13 lb.	1.5 lb.	2.13 lb.	3 lb.
Resin	17.26 lbs.	24.52 lbs.	39.39 lbs.	63.53 lbs.	109.2 lbs.
Air Dry Solution	34 cc	40 cc	57 cc	85 cc	120 cc
Catalyst MEKP	4.88 oz.	6.90 oz.	11.0 oz.	1.2 lbs.	1.8 lbs.
Nexus Veil		0.03 lbs.	0.03 lbs.	0.06 lbs.	
1½ oz. Mat	4.04 lbs.	6.11 lbs.	9.78 lbs.	15.82 lbs.	27.36 lbs.
Woven Roving	4.03 lbs.	5.92 lbs.	9.58 lbs.	16.55 lbs.	28.96 lbs.

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	42"	42" (Cont'd)	48"	48" (Cont'd)
Paste + Catalyst MEKP	4.13 lb. + 36 cc		5.38 lb. + 48 cc	
Apply Paste	Apply Paste		Apply Paste	
Cure	Cure		Cure	
Resin + Catalyst MEKP	5.13 lbs. + 38.5 cc	37.25 lbs. + 280 cc	6.13 lbs. + 46 cc	43.5 lbs. + 327 cc
Apply Reinforcement	5 of 4" x 29" M	5 of 29" x 31" M	5 of 4" x 33" M	5 of 30" x 35" M
Mat = M	5 of 4" x 29" M	5 of 29" x 31" WR	5 of 5" x 33" M	5 of 30" x 35" WR
Woven Roving = WR	5 of 5" x 29" M	5 of 31" x 31" M	5 of 5" x 33" M	5 of 32" x 35" M
	5 of 6" x 29" M	5 of 31" x 31" WR	5 of 6" x 33" M	5 of 32" x 35" WR
Cure	Cure	5 of 32" x 31" M	Cure	5 of 33" x 35" M
		Cure		Cure
Resin + Catalyst MEKP	9.63 lbs. + 72 cc		10.88 lbs. + 81.5 cc	49.88 lbs. + 375 cc
Apply Reinforcement	5 of 7" x 30" M		5 of 7" x 34" M	5 of 34" x 36" M
Mat = M	5 of 7" x 30" WR		5 of 7" x 34" WR	5 of 34" x 36" WR
Catalyst MEKP	5 of 8" x 30" M		5 of 8" x 34" M	5 of 35" x 36" M
	5 of 8" x 30" WR		5 of 8" x 34" WR	5 of 35" x 36" WR
Cure	5 of 10" x 30" M		5 of 10" x 34" M	5 of 37" x 36" M
	Cure		Cure	Cure
Resin + Catalyst MEKP	13.63 lbs. + 103 cc		16.25 lbs. + 122 cc	
Apply Reinforcement	5 of 10" x 30" M		5 of 11" x 34" M	
Mat = M	5 of 10" x 30" WR		5 of 11" x 34" WR	
Woven Roving = WR	5 of 12" x 30" M		5 of 12" x 34" M	
	5 of 12" x 30" WR		5 of 12" x 34" WR	
Cure	5 of 13" x 30" M		5 of 14" x 34" M	
	Cure		Cure	
Resin + Catalyst MEKP	18.38 lbs + 138 cc		21.625 lbs. + 163 cc	
Apply Reinforcement	5 of 14" x 30" M		5 of 15" x 34" M	
Mat = M	5 of 14" x 30" WR		5 of 15" x 34" WR	
Woven Roving = WR	5 of 16" x 30" M		5 of 16" x 34" M	
	5 of 16" x 30" WR		5 of 16" x 34" WR	
	5 of 17" x 30" M		5 of 18" x 34" M	
	Cure		Cure	
Resin + Catalyst MEKP	22.63 lbs.+ 170 cc		26.38 lbs. + 198 cc	
Apply Reinforcement	5 of 18" x 30" M		5 of 18" x 34" M	
Mat = M	5 of 18" x 30" WR		5 of 18" x 34" WR	
Woven Roving = WR	5 of 19" x 30" M		5 of 20" x 34" M	
	5 of 19" x 30" WR		5 of 20" x 34" WR	
Cure	5 of 21" x 30" M		5 of 22" x 34" M	
	Cure		Cure	
Resin + Catalyst MEKP	28.25 lbs. + 213 cc		32.38 lbs. + 243 cc	
Apply Reinforcement	5 of 22" x 31" M		5 of 22" x 35" M	
Mat = M	5 of 22" x 31" WR		5 of 22" x 35" WR	
Woven Roving = WR	5 of 23" x 31" M		5 of 24" x 35" M	
	5 of 23" x 31" WR		5 of 24" x 35" WR	
Cure	5 of 25" x 31" M		5 of 25" x 35" M	
	Cure		Cure	

Pipe & Fittings Installation

A150 - Lamination Sequence (see Butt & Wrap Joints section 2 above for preparatory steps, including coating edges with catalyzed resin)

PIPE SIZE	42"	42" (Cont'd)	48"	48" (Cont'd)
Resin + Catalyst MEKP	32.38 lbs. + 243 cc		38 lbs. + 285.5 cc	
Apply Reinforcement	5 of 25" x 31" M		5 of 26" x 35" M	
Mat = M	5 of 25" x 31" WR		5 of 26" x 35" WR	
Woven Roving = WR	5 of 27" x 31" M		5 of 28" x 35" M	
	5 of 27" x 31" WR		5 of 28" x 35" WR	
Cure	5 of 28" x 31" M		5 of 29" x 35" M	
	Cure		Cure	
Resin + Catalyst MEKP	(Cont'd Next	2.75 lbs. + 21 cc	(Cont'd Next	3.13 lbs. + 23.5 cc
(Inside lay-up when	Column)	6 of 4" x 23" M	Column)	7 of 4" x 23" M
accessible)		6 of 5" x 23" M		7 of 5" x 23" M
Cure		6 of 6" x 23" NV		7 of 6" x 23" NV
		Cure		Cure
Resin + Catalyst		3.63 lb. + 32 cc		4.75 lb. + 42 cc
(MEKP)				
Apply Brushcoat		Apply Brushcoat		Apply Brushcoat
Cure		Cure		Cure
Kit Material:				
Liner Paste	4.25 lb.		5.38 lb.	
Resin	173.66 lbs.		252.29 lbs.	
Air Dry Solution	165 cc		216 cc	
Catalyst MEKP	3lb		4lb 5 oz.	
Nexus Veil	0.05 lbs.		0.05 lbs.	
1½ oz. Mat	43.14 lbs.		62.81 lbs.	
Woven Roving	46.22 lbs.		68.24 lbs.	

Pipe & Fittings Installation

P150 Lamination sequence, sample instructions

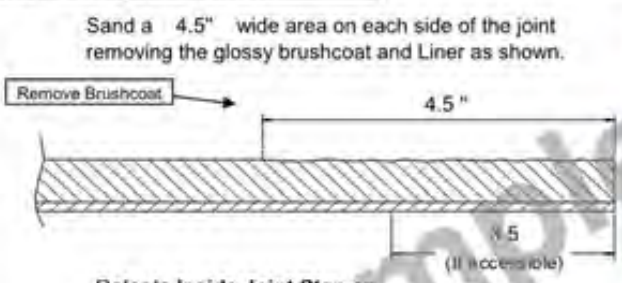

NOTE: See Individual Product Specification for actual dimensions and sequence.

 RPS COMPOSITE Manufacturing Specification	8"Ø P-150 Field Butt Joint	SP-0104-002 September 17, 2009 Revision: F
---	-----------------------------------	---

KIT MATERIAL:				
Crevice Paste	FS-1618-M	0 lb	4 oz.	Total Reinforcement 1.19 lbs
				1.5 oz. Mat 0.79 lbs
Structural Resin	FS-1616-M	3 lbs	6 oz.	24 oz. Woven Roving ... 0.39 lbs
				Nexus 0.01 lbs
MEKP Catalyst		0 lb	2 oz.	
Airdry Solution	FS-0047-S	0 lb	1 oz.	
				Total Width of 1.5 oz. Mat = 40"
				Total Width of 24 oz. Woven = 11"

Preparation Step 1 - SANDING

Sand a 4.5" wide area on each side of the joint removing the glossy brushcoat and Liner as shown.


NOTE: Both joining surfaces must have the **same OD**; therefore, sand off any high spots to achieve this. The joint lay-up must begin within **4 hours** after sanding, or re-sanding is required.

For general instructions on Butt & Wrap joining, refer to the RPS Installation Manual

Preparation Step 2 - RESIN COAT THE CUT ENDS

Using 0.25 lbs (109 ml) Structure Resin (FS-1616-M)
 add 1 to 3 cc MEKP

Mix this resin thoroughly and apply to the **CUT EDGES** of the pipe and allow to cure.




Preparation Step 3 - APPLY THE CREVICE PASTE

Position pipe/fittings together and hold in place.

Using 0.25 lbs (93 ml) Crevice Paste (FS-1618-M)
 Add 1 to 3 cc MEKP catalyst

Apply the paste to the crevice area only!
DO NOT apply paste to the flat sanded surfaces. Allow to cure.



REV: F	Description: Revised resin formulae.	Apprv'd:
	Page 1 of 3	Date:

Pipe & Fittings Installation



SP-0104-002
September 17, 2009
Revision: F

8"ø P-150 Field Butt Joint

LAMINATING SEQUENCES



GET THE REINFORCEMENT - WET OUT THE REINFORCEMENT - APPLY THE REINFORCEMENT - ROLL OUT THE REINFORCEMENT

Sequence Step 1

Using 1.375 lbs (601 ml) Structural Resin (FS-1616-M)

Add 7 to 14 cc MEKP Catalyst and mix thoroughly

Using this resin mixture apply & allow to cure:

1 piece	Nexus Veil	3" x 30"
1 piece	1.5 oz. Mat	4" x 30"
1 piece	1.5 oz. Mat	4" x 30"
1 piece	1.5 oz. Mat	5" x 30"
1 piece	24 oz. Woven Roving	5" x 30"
1 piece	1.5 oz. Mat	6" x 30"

Sequence Step 2

Using 1.5 lbs (656 ml) Structural Resin (FS-1616-M)

Add 8 to 15 cc MEKP Catalyst and mix thoroughly

Using this resin mixture apply & allow to cure:

1 piece	1.5 oz. Mat	6" x 31"
1 piece	24 oz. Woven Roving	6" x 31"
1 piece	1.5 oz. Mat	7" x 31"
1 piece	1.5 oz. Mat	8" x 31"

*** Apply Exterior Brushcoat as detailed on page 3 ***

Pipe & Fittings Installation



SP-0104-002
September 17, 2009
Revision: F

8"ø P-150 Field Butt Joint

Exterior Brushcoat Step - COMPLETE Laminating Sequences 1 to 2 BEFORE COMPLETEING THIS STEP

This will be the **last step** in the procedure. This step is to be completed **only after all** reinforcement has been applied.
(Refer to laminating sequences 1 to 2)



Using	0.25 lbs (109 ml)	Structural Resin (FS-1616-M)
add	11 cc	Airdry Solution (FS-0047-S)
add	1	to 3 cc MEKP catalyst

Mix thoroughly and apply this brushcoat mixture to all lay-ups and exposed surfaces and allow to cure.

Inside Joint Step

The inside joint material is not included with this kit - Do not sand inside pipe

Inside Joint Brushcoat

Pipe & Fittings Installation

PEEL-A-BOND™

1) Purpose



RPS pipe, fittings, or prespooled pieces may be factory prepared for field joining and protected with PEEL-A-BOND™. This eliminates the need for sanding or cleaning in the field, greatly reducing joint preparation time, and minimizing dust and noise.

2) Handling & Storage

- a) The ends of pipe and fittings are factory protected against damage during shipment.
- b) The end protection is to be left in place as long as possible while handling the pipe.

3) Premature Removal of PEEL-A-BOND



If the PEEL-A-BOND has been removed prematurely (either in transit or on the jobsite), lightly sand contaminated surface to remove any grease, oil, or other contaminant.

4) Removal of PEEL-A-BOND

- a) The only joint preparation required before beginning lay-up or adhesive application is the removal of the protective layer of RPS PEEL-A-BOND (immediately before lay-up or adhesive application).
- b) Grab the overlap tab and pull firmly, removing the RPS PEEL-A-BOND strip from the whole circumference of the joint.

NOTE:This should be the last action before lay-up or adhesive application begins, and the surface should not be otherwise touched or cleaned after removal of the protective strip.



Pipe & Fittings Installation

FLANGE JOINING

1) Drilling

Unless otherwise specified, all flanges are drilled in accordance with the ANSI B16.5, Cl.150 drilling pattern for pipe sizes up to 24" in diameter, and ANSI B16.47 Series A Cl.150 drilling pattern for pipe larger than 24" in diameter.

2) Gaskets

a) Use a full face gasket with a Shore A hardness of 60 - 70. Recommended gasket thicknesses are:

- 1" - 6" = 1/8"
- 8" - 18" = 3/16"
- ≥ 20" = 1/4"

b) Care must be taken when using specialized gaskets such as fluoropolymer ribbed, partial envelope, or ring gaskets. These gaskets act as raised faces and should be treated as such; see **5) Raised-Face Flanges**, Page 55.

c) Ensure that gaskets used in ABRASION SYSTEMS have an inside diameter that is at least 1/4" larger than the pipe's inside diameter. This will prevent the gasket from protruding into the flow and causing turbulence that would result in an abnormally high rate of pipe erosion.

3) Alignment

Be sure mating flanges align well. Misaligned flanges may be damaged during bolting.

4) Torque

Tighten nuts in the sequence shown using the suggested increments. Do not exceed the bolt torques outlined in the table. Go through the bolting sequence as often as is required to reach the recommended torque level. After doing this, check all bolts to ensure no relaxation has occurred. Bolt torques may decrease

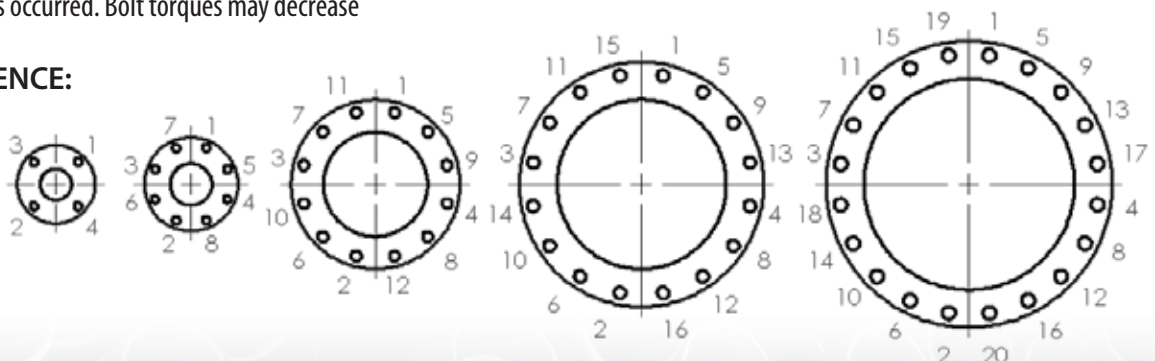
over time due to gasket relaxation, compression set, extrusion, etc. Retorquing may be necessary to ensure a leak tight joint.

NOTE: Success of bolted joints depends on specific characteristics of the gasket material, the pipe alignment, external loads, etc. As a result, RPS cannot accept responsibility for sealing beyond the performance of the flange itself.

RECOMMENDED BOLT TORQUES FOR RPS P150 A150 OR H150 FLANGES*

FULL FACE Flanges				
Pipe		Recommended	Max. Torque	Increments
Dia.		Torque (ft.lb.)	(ft.lb.)	(ft.lb.)
1"	25mm	10	15	5
1½"	40mm	15	23	5
2"	50mm	25	38	5
3"	80mm	35	53	5
4"	100mm	25	38	10
6"	150mm	35	53	10
8"	200mm	40	60	10
10"	250mm	40	60	10
12"	300mm	50	75	10
14"	350mm	65	98	10
16"	400mm	60	90	10
18"	450mm	70	105	10
20"	500mm	70	105	15
22"	550mm	85	125	15
24"	600mm	100	150	15
28"	700mm	100	150	15
30"	750mm	105	158	15
32"	800mm	145	218	15
36"	900mm	145	218	15
42"	1100mm	155	233	15
48"	1200mm	150	225	15

TORQUEING SEQUENCE:



Pipe & Fittings Installation

LAP Joint Style Flange				
Pipe Dia.		Recommended	Max. Torque	Increments
Torque (ft.lb.)		(ft.lb.)	(ft.lb.)	
1"	25mm	5	8	2.5
1½"	40mm	5	8	2.5
2"	50mm	10	15	5
3"	80mm	15	23	5
4"	100mm	15	23	5
6"	150mm	20	30	5
8"	200mm	20	30	5
10"	250mm	20	30	5
12"	300mm	30	45	10
14"	350mm	40	60	10
16"	400mm	40	60	10
18"	450mm	40	60	10
20"	500mm	40	60	10
22"	550mm	55	80	15
24"	600mm	65	98	15
28"	700mm	70	105	15
30"	750mm	75	112	15
32"	800mm	100	150	15
36"	900mm	100	150	15
42"	1100mm	110	165	15
48"	1200mm	110	165	15

* Recommended bolt torques are based upon a full face gasket with Shore A hardness of 60 - 70 and sealing rings on the flange faces.

5) Raised-Face Flanges

The use of raised-face flanges should be avoided when mating to FRP flanges. Damage to the FRP flange may result during bolt torquing.

If raised-face flanges must be used, take one of the following precautions:

- Use a Lap Joint style FRP flange.
- Fill the space around the raised portion of the flange with a hard shim (eg. metal, PVC, etc.)
- Use a steel back-up ring on the back of the FRP flange

6) Leaking

Bring bolt torque to maximum allowed. If leaks persist, do not exceed the maximum torque, but determine the true cause:

- Check the gasket for material flaws.
- Check the faces of mating flanges for dirt or grit, or any deep scratches across the flange face.
- Check for misalignment.

7) Restraining Rods on Expansion Joints - Flange Stress

Expansion joints often have restraining rods. The expansion joint should not in any way, at any time, be restrained by rods, which restrain the RPS flanges directly. Use substantial metal backing rings, etc. to prevent excessive stress in the flanges.

In general, avoid the use of restraining rods.

8) Suggested Bolt Length (RPS P/A/H150 Full Faced Flanges)*

SIZE	RPS P/H150 to	RPS P/H150 to ANSI B16.5 150# STEEL
25mm	1"	3"
40mm	1½"	3"
50mm	2"	3"
80mm	3"	3"
100mm	4"	3½"
150mm	6"	3½"
200mm	8"	4"
250mm	10"	4½"
300mm	12"	5½"

* Allowed for 1/8" gasket & 2 washers (American Standard SAE flat washers)

- When disassembling flanged joints, it is important to not release all of the torque on any bolt in one step. The bolt torques should be decreased in a minimum of 3 steps using the same sequence as was used to assemble the joint (see Step 4).

Suggested FRP Flange Connections

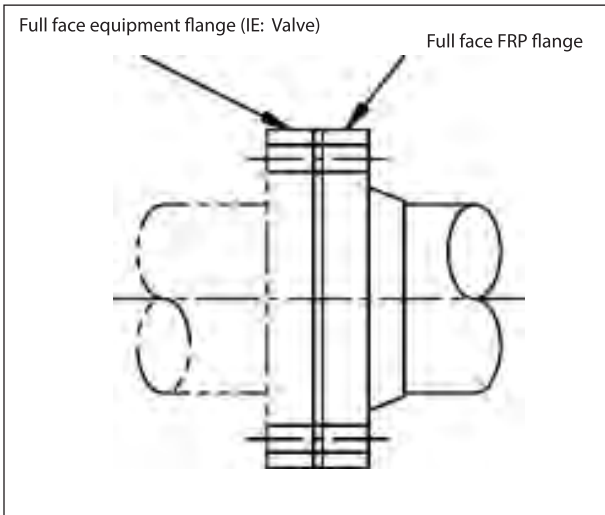


Fig 1 - Full face flange connection. Full bearing surface

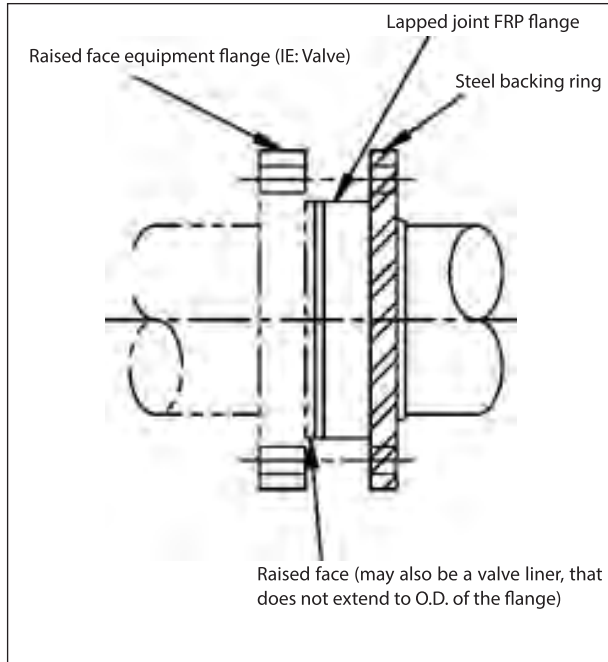


Fig 2 - Raised face flange connection

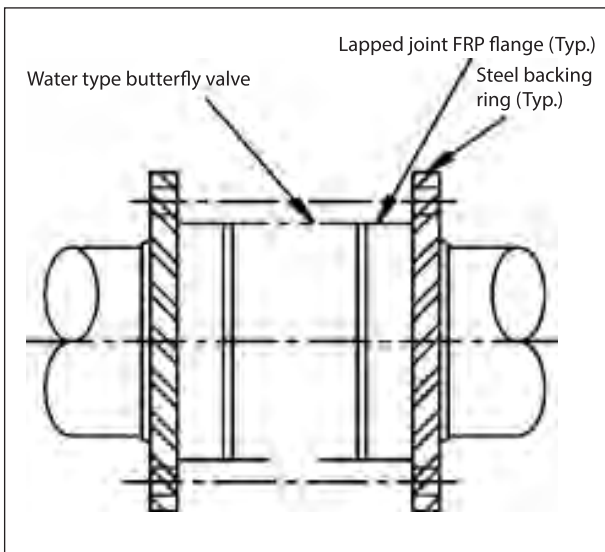


Fig 3 - Water type valve

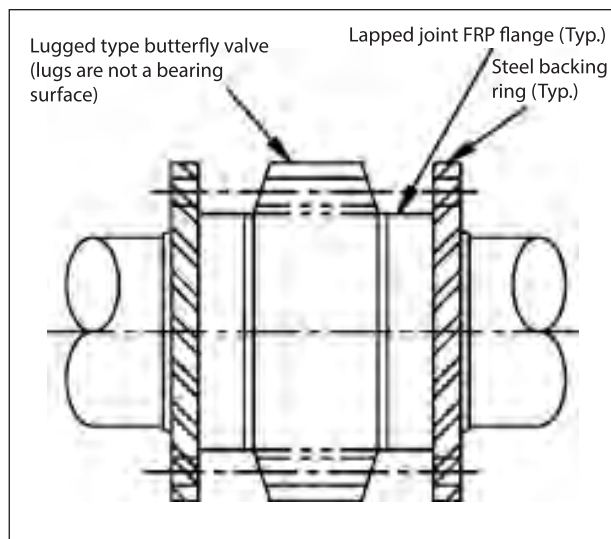


Fig 4 - Lugged type valve

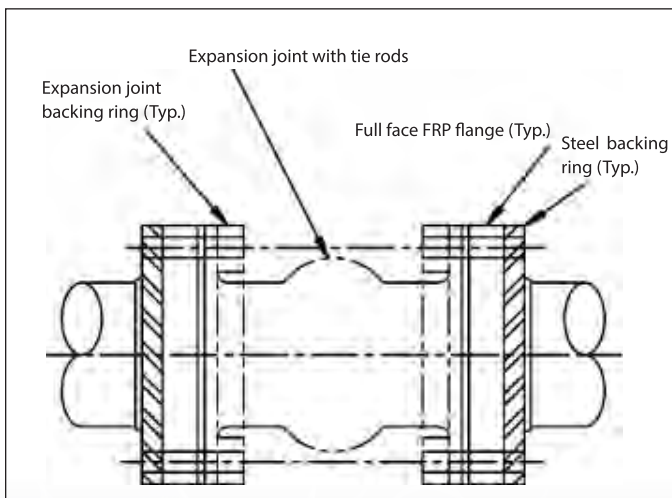


Fig 5 - Face flange connection (with backing ring) at expansion joint with tie rods

Pipe & Fittings Installation

O-RING JOINING

1) General

O-Ring joints are made using factory machined, grooved spigots and accurate bells; which provide the required compression of the O-Ring gasket.

2) Before Insertion

- a) Check bell surface and groove bottom to make sure that there are no deep scratches, resin spills, or delaminations, which could cause leaks.
- b) Protect the inside bottom of bell with carpet or board, as personnel may walk in and out during testing and inspection.
- c) Check edge of bell is free from sharp ridges, which could cut in the gasket while assembling.
- d) Check O-Ring to ensure it is not damaged and that splice is solidly bonded.
- e) Lubricate O-Ring and bell generously with non-petroleum base lubricant (margarine or other vegetable fat).
- f) Position splice in O-Ring at bottom during installation.
- g) Immobilize previously installed pipe, as substantial forces may be exerted on it during insertion.

3) During Insertion

- a) Direction of insertion should be straight in line with pipe. Make sure O-Ring gaskets are not displaced.



- b) Joining force can be applied with come-a-longs and cables, attached between lugs, provided for that purpose. Do not push joint together with excavating machinery.



- c) Insert to specified depth or to marks on spigot end. If joints are spaced more than 60' apart, the required insertion depth varies with pipe length, pipe temperature at the time of installation, and operating temperature. In that case, contact RPS Engineering for instructions.
- d) Lifting of pipe slightly during insertion can be helpful. Use rope or web slings, never chains, as it could damage the pipe.



- e) Align the pipes in line with each other within $\pm 1/2^\circ$.

4) After Insertion

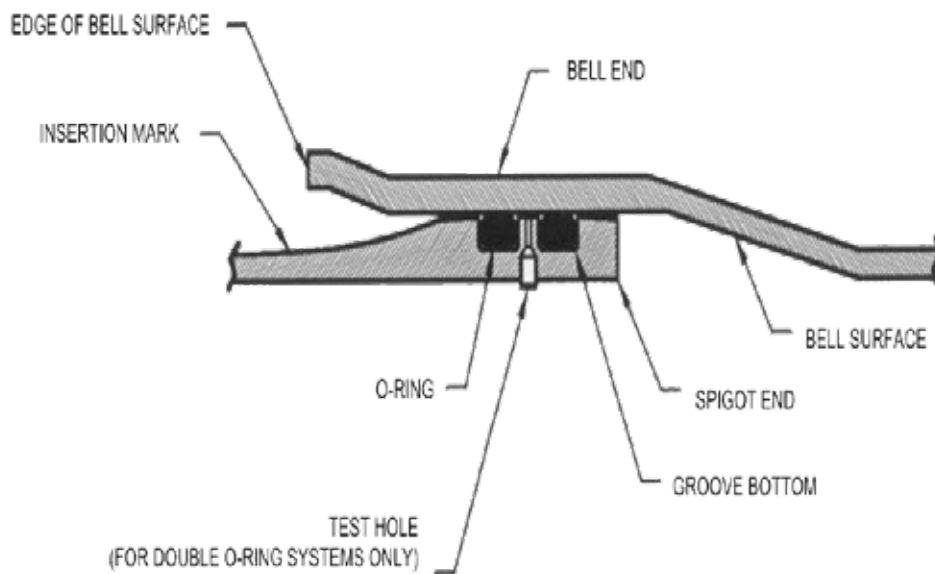
- a) Pressure test between O-Rings if a double O-Ring system is being used.

If a single O-Ring system is being used, conduct a hydrostatic test, if possible.

Pipe & Fittings Installation

Follow specified and approved procedures only, as hazardous conditions can develop if the test is improperly performed. See Testing section, Page 18, for additional information.

- b) Plug test hole as specified on applicable drawings.
- c) Check pipe support, if outside, to ensure that pipe rests evenly on soil and there are no unsupported lengths or point loads from rocks or other objects.



FIELD BONDER QUALIFICATION PROCEDURE (ASME B31.3)

General

This procedure is suitable for qualifying bonders for jointing RPS P-150, A-150, or H-150 piping in sizes 1" - 24" (25-600mm) dia. in accordance with ASME B31.3 "Process Piping" (see note 5). The joint types covered by this procedure are the "Tapered Adhesive Joint" and the "Butt & Wrap Joint".

NOTE: The bonder must be familiar with the RPS Installation manual, and in particular, read the sections on Materials, Safety, Adhesive Bonded Joining, and Butt & Wrap Joining, before beginning the qualification process.

References:

- 1) RPS P1500 1" - 12" Tapered Adhesive Joint Instructions
- 2) RPS Pipe & Fittings Installation Manual
- 3) RPS WI-IT-007 Barcol Hardness Testing.
- 4) RPS WI-IT-008 Acceptance Criteria for Appearance of Laminates

Notes:

- 1) Jointing instructions are detailed in the RPS Pipe & Fittings Installation Manual. A copy of Reference 1 is included in every P1500 Kit; specific butt jointing instructions are included in every butt jointing kit.
- 2) The Test Assemblies to be used for the qualification procedure are shown on Page 60. Only one of the two assemblies needs to be fabricated and tested, the choice of which depends upon the availability of pipe end closures (ie. swell plugs).
- 3) This procedure may also be used to qualify bonders for jointing RPS piping of lesser pressure ratings than 150 psi. For example, this procedure would also qualify bonders for jointing RPS 100 psi rated pipe.
- 4) This procedure is to be carried out under the supervision of a qualified technician, so designated by RPS.
- 5) To qualify bonders for jointing piping larger than 24" (600mm) dia., contact RPS for appropriate instructions.

Procedure:

Step 1: Assemble the appropriate Test Assembly shown on Page 60 in strict accordance with the appropriate jointing procedures.

Notes:

- a) The bonder must demonstrate his/her knowledge of the safe handling procedures for resins, catalysts, and reinforcements. He/She must also be aware of the possible health hazards involved in using the materials (refer to Material Safety Data Sheets).
- b) The bonder must demonstrate his/her ability to correctly catalyze the resin, and must be familiar with the types of reinforcement used in the laminate.
- c) The bonder must be able to recognize the effects of ambient temperatures on catalyst action and curing time.

Note: The qualified technician will complete a written test to ensure he/she comprehends a), b), & c) above. The test results will be kept on file with RPS QA.

Step 2: The joints must be allowed to cure at least eight (8) hours at no less than 20°C.

Step 3: The Test Assembly shall be examined for workmanship and dimensional accuracy by the qualified technician. Visual quality must meet or exceed RPS WI-IT-008 "Acceptance Criteria for Appearance of Laminates". Dimensional accuracy must be in accordance with the fabrication tolerances stated in the RPS Dimensions Catalogue. Degree of cure of the joints must meet or exceed RPS WI-IT-007 "Barcol Hardness Testing".

Step 4: Subject the Test Assembly to a hydrostatic test at a pressure of 450 psig.

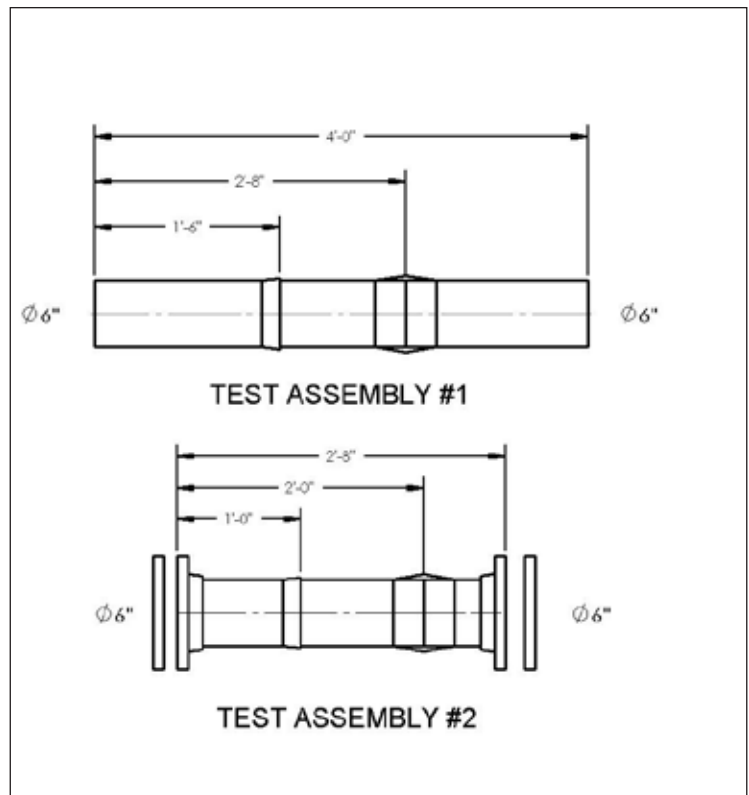
Caution: Refer to the Testing section of this Manual for procedures and safety precautions associated with hydrostatic testing.

The pressure shall be held for a period of one (1) hour. There shall be no evidence of leaking or damage to the joints.

Pipe & Fittings Installation

Notes:

- 1) Failure to meet all requirements of this Procedure will necessitate a full re-qualification of the bonder.
- 2) Re-qualification of a bonder is also required when:
 - a) The bonder has not made RPS P-150, A-150 or H-150 joints for a period of six (6) months.
 - b) There is specific evidence to question the bonder's ability to make acceptable joints.



NOTES:

1. Joining procedure shall be in accordance with "RPS P-1500 Tapered adhesive joint instructions" RPS pipe and fittings installation manual
2. Joining procedure shall be in accordance with "butt & wrap joining" RPS pipe and fittings installation manual.
3. Bolt up blind flanges (for hydrotest) in accordance with "flange joining" RPS pipe RPS pipe and fittings installation manual
4. Seal end with swell plug
5. Material P-150, A-150 or H-150

Pipe & Fittings Installation

RPS 'A' Liner Repair Paste Kit

Intended Use

Areas of type 'A' pipe or fittings, that have exhibited gradual localized wear, can be repaired with a RPS 'A' Liner Repair Paste Kit. The kit is designed to repair abrasion resistant liner areas only, and is not intended for structural repairs. Where structural areas have been eroded, the affected section should be replaced or repaired before the liner paste is applied.



Each RPS 'A' Liner Repair Paste Kit contains paste, hardener, instruction sheet, mylar, and mixing stick.



Kit Sizes

The RPS 'A' Liner Repair Paste Kit is available in three (3) sizes:

SIZE (gm/oz)	COVERAGE for 3mm or 1/8" THICK (cm x cm/in. x in.)
400/14	28 x 28/11 x 11
800/28	39 x 39/15 x 15
1600/56	55 x 55/22 x 22

Application Equipment Required

- 1) Rotary Die or Disc Grinder with carbide grit (60 grit or coarser)
- 2) 40 to 60 grit sandpaper
- 3) Drill Motor for mixing (using mixing blade)
- 4) Putty Knives for spreading paste
- 5) Trowel for spreading paste

Safety Equipment Required

- 1) Rubber gloves
- 2) Safety glasses

- 3) Bucket filled with water
- 4) Dust mask
- 5) Ear plugs
- 6) Leather or leather palm gloves

All local safety regulations must be followed.

Safety Instructions

- a) All paste and hardener; separately or combined; will cause skin irritation to some people. Hardeners, in particular, should be handled with care. Avoid contact with skin and eyes. Wear rubber gloves and safety glasses. In case of contact, wash with flowing water and soap. For eyes, flush with plenty of water for at least 15 minutes and get medical attention. See Safety Section, Page 6, of RPS Installation Manual for details.
- b) Leftover paste in can will become very hot (100°C. or 210°F.) after going hard. It is advisable to put cans of leftover paste in a bucket of water to reduce fire hazard and unpleasant odor.
- c) DO NOT smoke or have an open flame near work area.
- d) Work in well ventilated area.
- e) Wear leather gloves and safety glasses when handling and grinding pipe (See Safety Section, Page 6, and MSDS', Page 9, of RPS Installation Manual).
- f) Sanding with a power tool generates a large amount of dust, which can be a nuisance. Wear suitable dust mask and glasses, and use a vacuum unit to collect dust. Build a protective shelter around work area to keep dust away from fellow workers and adjacent machinery and equipment.

Repair Procedures

These procedures cover:

1) Surface Preparation (Sanding)

When a worn liner area is to be repaired, mark a perimeter line 75mm (3") back around the worn area. Thoroughly dry the area using rags, towels, heat lamp, or heat gun. Ensure the entire area is dry, since the smallest amount of moisture will hamper the bonding of the 'A' Liner Repair Paste. Using a power sander

Pipe & Fittings Installation

with 40 to 60 grit, roughen the worn area. All glossy and shiny surfaces shall be removed.

NOTE: The rougher the surface, the better the adhesion of the 'A' Liner Repair Paste.



Remove all loose dirt and dust with a rag or a blast of dry, oil-free air.

2) Repair Paste Application

The 'A' Liner Repair Paste is a two (2) part system:

- 1) 'A' Liner Repair Paste
- 2) Hardener

When mixing the hardener and paste together, ALL of the Hardener in one (1) container must be added to ALL the Paste in the other can to develop full repair strength. DO NOT try to split the kit for small repair jobs.

Mix the white Hardener into the black 'A' Liner Repair Paste thoroughly till the mixture is a uniform color without any streaks. Scrape the sides and bottom to make certain there is a complete blend of hardener and paste. The colder the material, the more mixing you must do.



NOTE: The smaller kits can be mixed by hand fairly easy, but the larger kits will require a drill motor and a mixing blade to help mix the two (2) components more thoroughly.

When applying the 'A' Liner Repair Paste, use a putty knife or trowel to cover the outlined area with a 3mm (1/8") thick (minimum) layer of paste. Smooth and feather out all edges.

Apply mylar over paste and smooth out by hand while removing trapped air. Use mylar in strip form, since larger sheets will wrinkle too much.



3) Curing

Ambient Temperature at least 16°C. (60°F.)

Allow the 'A' Liner Repair Paste to cure for a minimum of two (2) hours.

After two (2) hours, check the cure by scratching the paste with a knife or nail. It should be as hard as the pipe or fitting surface. If slightly rubbery or soft, allow the paste to cure for another two (2) hours. If after four (4) at 16°C. (60°F.) or higher, the paste remains soft; the paste should be removed and the repair redone.

Cold Weather Curing Below 16°C. (60°F.): If the ambient temperature is below 16°C. (60°F.), pre-heat the repair area with heating collars, heat lamp, or hot air (oil and moisture free). The paste and hardener must be warmed

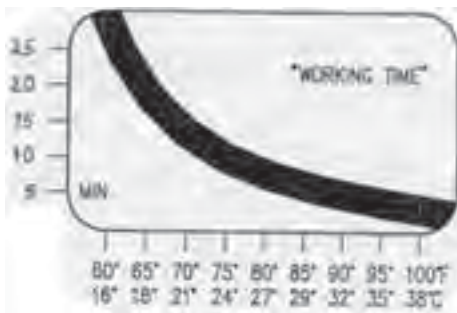
Apply the paste. Cure it with a heat lamp or hot air. In general, for cold weather curing, the 'A' Liner Repair Work should be carried out in a heated shelter.

Tips and Warnings

- a) DO NOT use 'A' Liner Repair Paste after expiration date on label.
- b) Always store 'A' Liner Repair Paste Kits in a cool, dry place (10° to 27°C. or 50° to 80°F.).

Pipe & Fittings Installation

- c) If stored at low temperature, the 'A' Liner Repair Paste and Hardener may become too hard for mixing. In that case, heat the closed can above 35°C. (95°F.) until the contents are liquid. Do not exceed 100°C. (210°F.). Cool below 29°C. (85°F.) before using.
- d) The "working time" or "pot life" of catalyzed paste varies with the temperature. The warmer it is, the shorter the working time. At 24°C. (75°F.), you have 10 to 20 minutes; and at 16°C. (60°F.), you have 25 to 35 minutes before the paste starts to harden in the can. See chart for approximate temperature times. DO NOT use the paste once it has started to harden.



Pipe & Fittings Installation

SADDLES

Purpose

RPS' belled, flanged, and plain-ended saddles have been factory prepared to allow simple field assembly of a stub-in after the piping system has been installed. Since a hole must be cut through the pipe wall exposing the structure and liner, RPS Engineering should be contacted to determine if the service is suited to this method of fabrication and what type of adhesive should be used. Operating conditions such as temperature, pressure, and fluid components are to be considered in determining the correct adhesive; or if a field installed stub-in would be more appropriate.

Installation

a) Drill the required diameter hole in the pipe.

b) Thoroughly sand an area where the pipe saddle is to be bonded. Remove brushcoat only, or any high spots that prevent pipe saddle from fitting flush to pipe exterior. The sanded area should equal the length and width of the pipe saddle plus 13mm (1/2"). For dimensions, see RPS Design Graphics Manual Doc. No. DGM1, Sections 4.9 and 4.10. For proper safety procedures, see Safety Section, Page 6, and MSDS, Page 9.



c) Remove PEEL-A-BOND™ material from pipe saddle. Refer to RPS Pipe and Fittings Installation Manual, Page 53.



d) Mix RPS Adhesive (Refer to RPS Pipe and Fittings Installation Manual, Page 20, on general use of P1500, H1500, or E1500 adhesive).

e) Apply 1.5mm to 3mm (1/16" to 1/8") thick layer of RPS adhesive to bonding area of pipe saddle and sanded surface of pipe. Also apply a smooth layer of adhesive to the cut edge of



drilled hole in the pipe to aid in the corrosion protection of the pipe structure.

f) Position saddle over pipe; squeeze tightly against pipe until adhesive squeezes out around all of the edges; then hold in place with clamps, soft wire, or steel strapping.



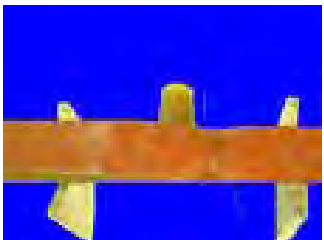
g) Using a mixing stick - smooth out excess adhesive forming a neat fillet at the edges of the saddle, and remove any adhesive that may block the hole in the pipe.



h) Apply two (2) heating collars; one (1) to **each side** of pipe saddle for 105 minutes. Do not attempt to combine steps h) and i), as overlapping may damage a heating collar thermostat and lead to an uncured or overheated joint.



i) Apply two (2) heating collars **longitudinally to each side** of pipe saddle for 105 minutes.



Number of Bonds per Adhesive Kit*

PIPE SADDLE SIZE	ADHESIVE KIT (P1500-1, H1500-1, or E1500-1)
1" into 3"	2
1" into 4" - 12"	2
1½" into 3"	2
1½" into 4" - 12"	2
2" into 4" - 12"	2
3" into 6" - 12"	1
4" into 8" - 12"	1

* The number of bonds per kit may be limited by time between applications

Pipe & Fittings Installation

PEEL-A-BOND™ is a trademark of RPS

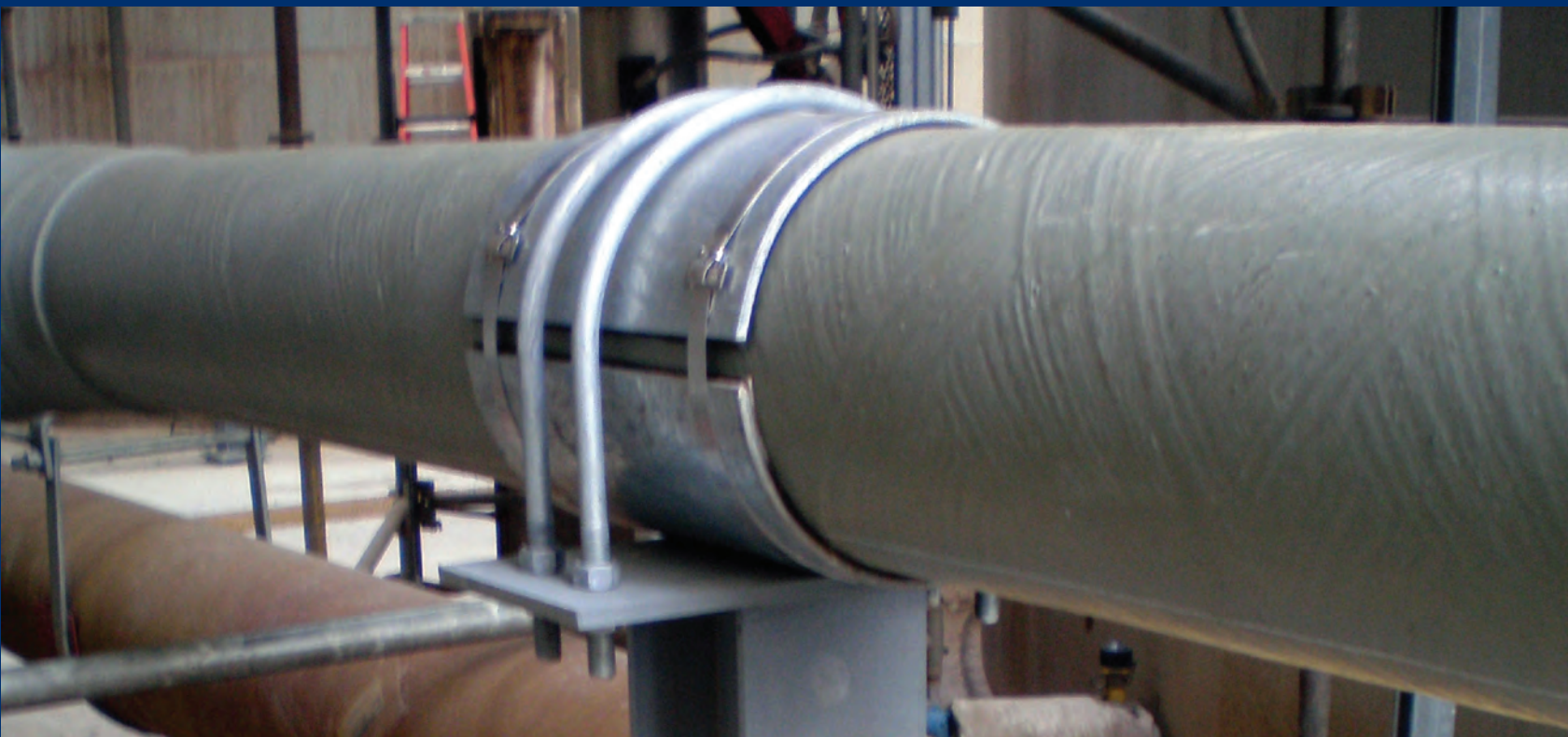
RPS Composites Inc.

740 Main Street
P.O. Box 299
Mahone Bay, Nova Scotia
Canada B0J 2E0
Tel: (902) 624.8383 | (800) 343.9355
Fax: (902) 624.6395
www.rpscomposites.com

RPS Installation Manual - 06/18



RPS Pipe Supports



Engineered Composite Solutions



Pipe Supports

Table of Contents

General Notes	Page 5
Pictorial Index	
Pipe Supports.....	Page 7
Duct Supports	Page 12
Pipe Supports	
Figure S1: U-Strap W/ Shield (1" – 12" Diameter)	Page 14
Figure S2: U-Bolt W/ Shield (1" – 12" Diameter)	Page 15
Figure S4: Clevis Hanger (1" – 18" Diameter)	Page 16
Figure S5: Wide Clamp Hanger (1" – 18" Diameter)	Page 17
Figure S5: Wide Clamp Hanger (20" – 60" Diameter).....	Page 18
Figure S7: FRP Wear Pad (1" – 12" Diameter)	Page 19
Figure S8: Slide Shield (1" – 12" Diameter)	Page 20
Figure S9: Pipe Cradle (1" – 10" Diameter).....	Page 21
Figure S9B: Pipe Cradle (12" – 60" Diameter).....	Page 22
Figure S10: Pipe Stand - Fixed Height (1" – 8" Diameter).....	Page 23
Figure S11: Pipe Stand - Adjustable Height (1" – 8" Diameter).....	Page 24
Figure S12: Flange Slide (1" – 10" Diameter).....	Page 25
Figure S12B: Flange Slide (12" – 30" Diameter).....	Page 26
Figure S12B: Flange Slide (36" – 60" Diameter).....	Page 27
Figure S13: Flange Guide (1" – 10" Diameter)	Page 28
Figure S13B: Flange Guide (12" – 30" Diameter)	Page 29
Figure S13B: Flange Guide (36" – 60" Diameter)	Page 30
Figure S14: Flange Anchor (1" – 30" Diameter)	Page 31
Figure S14: Flange Anchor (36" – 60" Diameter)	Page 32
Figure S15: Flange Linestop (1" – 10" Diameter)	Page 33
Figure S15B: Flange Linestop (12" – 30" Diameter).....	Page 34
Figure S15B: Flange Linestop (36" – 60" Diameter).....	Page 35
Figure S16: Flange Hanger (1" – 18" Diameter)	Page 36
Figure S17: Flange Riser Guide (12" – 30" Diameter).....	Page 37
Figure S17: Flange Riser Guide (36" – 60" Diameter).....	Page 38
Figure S18: Flange Riser Support (12" – 60" Diameter).....	Page 39

Pipe Supports

Figure S19: Flange Riser Support W/ Guides (12" – 60" Diameter)	Page 40
Figure P7: Elbow Support Slide Plate (2" – 10" Diameter).....	Page 41
Figure P7B: Elbow Support Slide Plate (12" – 24" Diameter)	Page 42
Figure P8: Base Slide (1" – 10" Diameter)	Page 43
Figure P8L: Base Slide – Low Profile (1" – 10" Diameter).....	Page 44
Figure P9: Base Guide (1" – 10" Diameter).....	Page 45
Figure P9L: Base Guide – Low Profile (1" – 10" Diameter)	Page 46
Figure P10: Base Anchor (1" – 10" Diameter)	Page 47
Figure P10L: Base Anchor – Low Profile (1" – 10" Diameter)	Page 48
Figure P13: Riser Guide (1" – 20" Diameter).....	Page 49
Figure P13: Riser Guide (24" - 60" Diameter)	Page 50
Figure P14: Riser Support (1" - 10" Diameter).....	Page 51
Figure P14: Riser Support (12" - 30" Diameter).....	Page 52
Figure P14: Riser Support (36" - 60" Diameter)	Page 53
Figure P15: Double Rod Riser Hanger (1" - 10" Diameter).....	Page 54
Figure P15: Double Rod Riser Hanger (12" – 30" Diameter).....	Page 55
Figure P16: Riser Support W/ Guides (1" – 10" Diameter)	Page 56
Figure P16: Riser Support W/ Guides (12" – 30" Diameter)	Page 57
Figure P16: Riser Support W/ Guides (36" – 60" Diameter)	Page 58
Figure P17: Base Linestop (12" – 30" Diameter).....	Page 59
Figure P17: Base Linestop (36" – 60" Diameter).....	Page 60
Figure P18: Base Slide (12" – 30" Diameter).....	Page 61
Figure P18: Base Slide (36" – 60" Diameter)	Page 62
Figure P19: Base Guide (12" – 30" Diameter)	Page 63
Figure P19: Base Guide (36" – 60" Diameter)	Page 64
Figure P20: Base Anchor (12" – 30" Diameter)	Page 65
Figure P20: Base Anchor (36" – 60" Diameter).....	Page 66
Figure XL12: Extra Large Slide (66" – 108" Diameter).....	Page 67
Figure XL13: Extra Large Guide (66" – 108" Diameter)	Page 68
Figure XL14: Extra Large Anchor (66" – 108" Diameter)	Page 69

Pipe Supports

Duct Supports

Figure D1: Duct Clamp Hanger (20" – 60" Diameter).....	Page 70
Figure D3: Duct Cradle Base Slide (20" – 60" Diameter)	Page 71
Figure D4: Duct Base Linestop (20" – 36" Diameter)	Page 72
Figure D4: Duct Base Linestop (42" – 60" Diameter)	Page 73
Figure D5: Duct Base Slide (20" – 36" Diameter)	Page 74
Figure D5: Duct Base Slide (42" – 60" Diameter)	Page 75
Figure D6: Duct Base Guide (20" – 36" Diameter)	Page 76
Figure D6: Duct Base Guide (42" – 60" Diameter)	Page 77
Figure D7: Duct Base Anchor (20" – 36" Diameter).....	Page 78
Figure D7: Duct Base Anchor (42" – 60" Diameter)	Page 79
Figure D16: Duct Riser Guide (20" – 30" Diameter)	Page 80
Figure D16: Duct Riser Guide (36" – 60" Diameter)	Page 81
Figure D17: Duct Riser Support W/ Guides (20" – 30" Diameter).....	Page 82
Figure D17: Duct Riser Support W/ Guides (36" – 60" Diameter).....	Page 83
Support Options	
Figure 01: Variable Spring Hanger Supports.....	Page 84
Figure 02: Slide Bearings.....	Page 85
Figure 03: Base Plates	Page 86
Figure 04: Guide Clips	Page 87
Figure 05: Expansion Joint W/ Control Rods.....	Page 88
Painting Specification	Page 89

Pipe Support General Notes

- 1) The following catalog support configurations are designed for the listed allowable loads. If actual load requirements differ from the defined allowable loads, configurations and materials can be altered to accommodate the load requirements. The defined vertical loads are downward in direction unless otherwise noted. Please specify all load requirements with placement of order.
 - 2) The defined support loads and designs are based on typical FRP and plastic pipe/duct system arrangements, design parameters and spans between supports. Support designs and configurations can be altered to accommodate specific project needs.
 - 3) Allowable loads for pipe supports are based on 150 PSI rated FRP pipe wall thicknesses. Allowable loads and designs for duct supports are based on 25 PSI rated FRP wall thicknesses. If the actual pressure ratings differ, the support designs can be altered to safely distribute the required loading.
 - 4) All supports are designed to maximize load distribution and to avoid point loading of the pipe at the support.
 - 5) Large diameter supports are custom engineered to meet specific load and functionality requirements. Expected loads and movements are required to engineer and optimize support configuration and design. Where large diameter supports are used without slide bearings allowing steel on steel contact, supports will need to be evaluated for axial loads due to increased frictional loading.
 - 6) Structural and supplementary steel structures are assumed to be near rigid. The length of the support should be centered on the supporting structures to limit the torsional loading of the steel. Flexibility in structural steel may induce unanticipated loads into the pipe/duct.
 - 7) The width of the supporting structural steel should be considered for support bearing. Structural or supplementary steel should provide a bearing surface of at least 50% of the support base length. If this is not possible, larger or thicker support base plates or stiffeners may be required. If additional installation plates or larger support base plates are needed, please specify size (length, width and thickness) with placement of order.
 - 8) Pipe/duct supports are available in sizes up to 60" in diameter. Larger sizes are available and are designed to suit the project requirements.
 - 9) All pipe/duct sizes are considered nominal. The outer diameter (O.D.) may vary depending on the manufacturer. The maximum O.D. must be specified with placement of order.
 - 10) Support dimensions are based on typical wall thicknesses and may vary depending on the actual O.D. and load requirements (See Note 3).
 - 11) Flange support dimensions for sizes up to 24" diameter pipe are based on ANSI B16.5 CL150 flange drilling and may vary depending on the actual drilling class and load requirements.
 - 12) Flange support dimensions for sizes above 24" diameter pipe are based on ASME B16.47 Series A CL150 flange drilling and may vary depending on the actual drilling class and load requirements.
 - 13) FRP flanges require a full back facing for use with flange plate supports.
 - 14) The standard material for RPS supports is carbon steel. Other materials such as aluminum, stainless steel and other alloys are available upon request.
 - 15) The standard finishes for RPS pipe/duct supports are:

1" to 30" diameter:	Hot dipped galvanized
36" diameter and up:	Painted per RPS painting specification (see page 89)
- Other types of paint finishes and Mill finish are available upon request.
Please specify desired finish with placement of order.
- 16) All saddle and clamp type supports include cushioning material to assure best fit and to minimize exterior pipe wear.
 - 17) Supports that require attachment to a structure are designed for welded installations. If bolted installations are preferred, please specify details with placement of order. See Support Options (Page 84) for details.
 - 18) Sizing of field welds for supports, clips, brackets, lugs, etc. to supporting structures are to be determined by others.
 - 19) Guide clips provided with the non-slide bearing type guide supports are designed to be field welded to the supporting structure. Guide clips for bolted installations to the supporting structure are available. Please specify the preferred attachment method with placement of order. See Figure O4 (Page 87) for details.
 - 20) The standard horizontal gap for guide and linestop supports is $\pm 1/8"$ with factory installed clips. Supports can be adjusted for specific displacements as required for project needs. Please specify with placement of order.



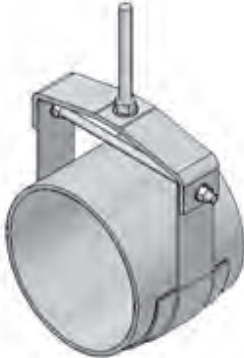
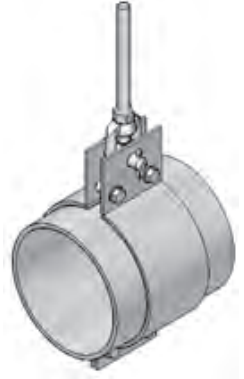
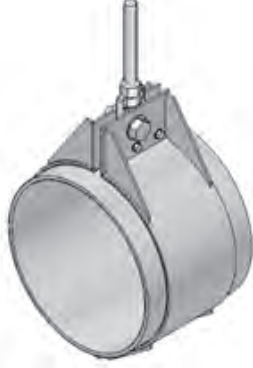




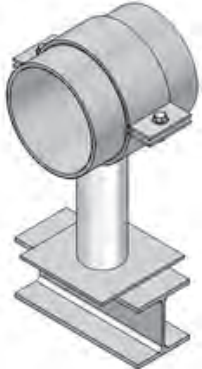

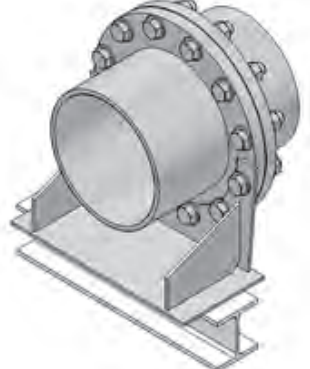
Pipe Supports

- 21) The upwards vertical gap for our guide and linestop style supports is $\pm 1/8"$ with factory installed clips. The vertical of supports with slide bearings may vary depending on the style of clip required. Where uplift or overturning is a concern, please provide vertical limit requirements or overturning loads at placement of order and supports can be adjusted to accommodate the specified limits and loads.
- 22) Slide bearings are recommended for supports with moderate to severe displacements and loads on systems having long runs with design pressures over 75 PSI for FRP or plastic pipe. Slide bearings are recommended for piping systems above 10" diameter where temperature gradients from ambient are greater than 60°F may occur. See Figure O2 (Page 84) for details. The incorporation of slide bearings is to minimize loads transferred to the supporting structure.
- 23) If pipe/duct requires insulated, slots can be incorporated into the support design to accommodate insulation banding. Please specify insulation thickness and details at placement of order.
- 24) Supplementary steel supporting structures are not included with RPS supports. Supplementary supporting structures can be provided upon request.
- 25) All materials such as pipe, duct, flanges and shear collars are not included with RPS supports. This material should be sourced from the piping manufacturer.
- 26) Shield banding and buckles are not included with RPS supports. Banding and buckles can be provided upon request. Material will be provided in bulk form.
- 27) Hanger hardware to suspend a support from a structure above is not included with RPS supports. Hanging hardware can be provided upon request.

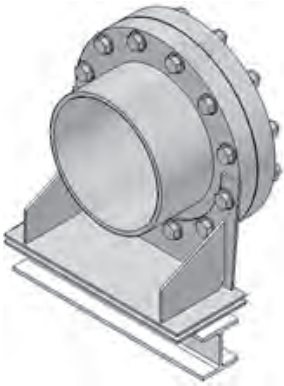
Pipe Supports

Pictorial Index

Pipe Supports

 <p>S1 U-Strap W/ Shield (1"-12" Dia.)</p>	 <p>S2 U-Bolt W. Shield (1"-12" Dia.)</p>	 <p>S4 Clevis Hanger (1"-18" Dia.)</p>	 <p>S5 Wide Clamp Hanger (1"-18" Dia.)</p>
 <p>S5 Wide Clamp Hanger (20"-60" Dia.)</p>	 <p>S7 FRP Wear Pad (1"-12" Dia.)</p>	 <p>S8 Slide Shield (1"-12" Dia.)</p>	 <p>S9 Pipe Cradle (1"-10" Dia.)</p>
 <p>S9B Pipe Cradle (12"-60" Dia.)</p>	 <p>S10 Pipe Stand - Fixed Height (1"-8" Dia.)</p>	 <p>S11 Pipe Stand - Adjustable Height (1"-8" Dia.)</p>	 <p>S12 Flange Slide (1"-10" Dia.)</p>

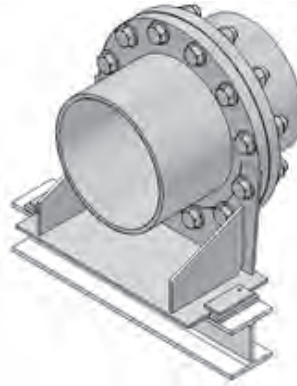
Pipe Supports



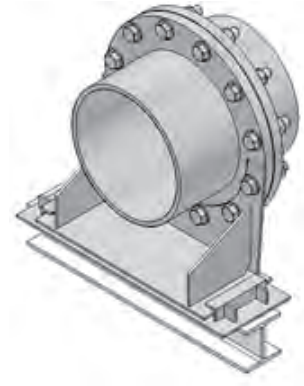
S12B
Flange Slide
(12"-30" Dia.)



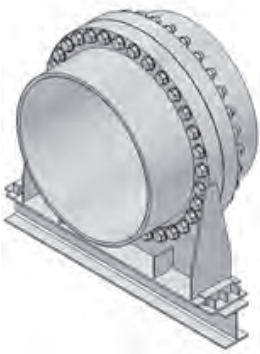
S12B
Flange Slide
(36"-60" Dia.)



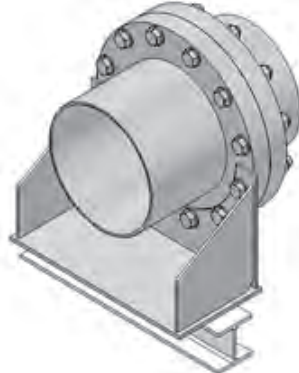
S13
Flange Guide
(1"-10" Dia.)



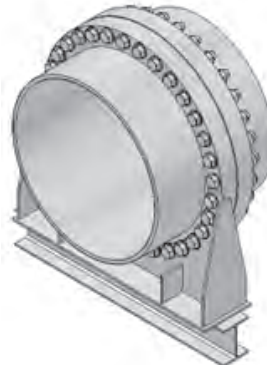
S13B
Flange Guide
(12"-30" Dia.)



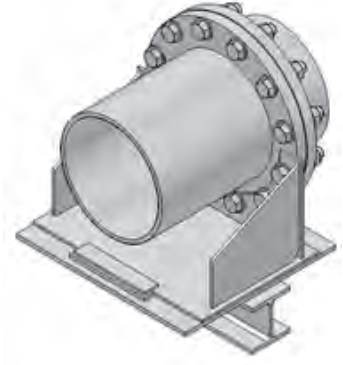
S13B
Flange Guide
(36"-60" Dia.)



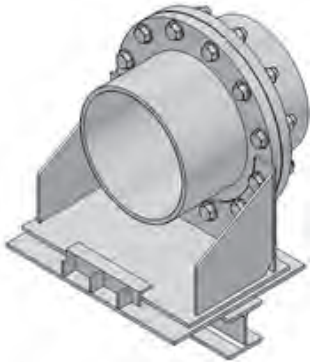
S14
Flange Anchor
(1"-30" Dia.)



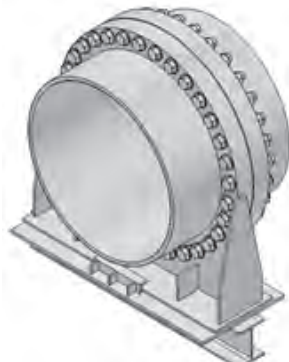
S14
Flange Anchor
(36"-60" Dia.)



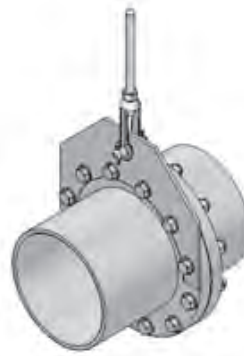
S15
Flange Linestop
(1"-10" Dia.)



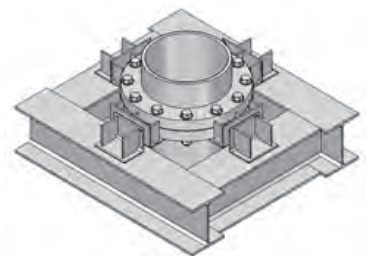
S15B
Flange Linestop
(12"-30" Dia.)



S15B
Flange Linestop
(36"-60" Dia.)

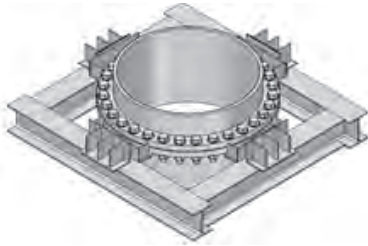


S16
Flange Hanger
(1"-18" Dia.)

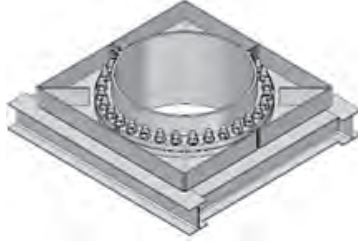


S17
Flange Riser Guide
(12"-30" Dia.)

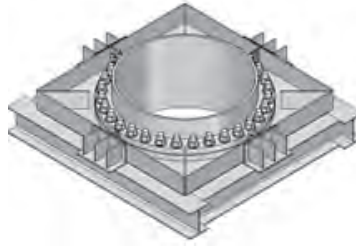
Pipe Supports



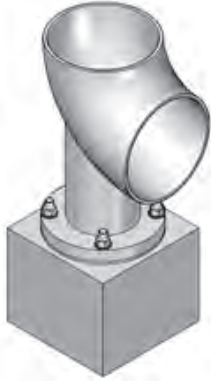
S17
Flange Riser Guide
(36"-60" Dia.)



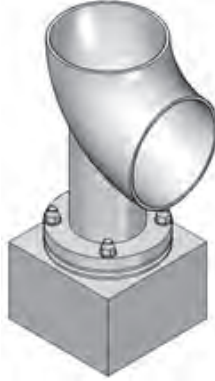
S18
Flange Riser Support
(12"-60" Dia.)



S19
Flange Riser Support w/Guides
(12"-60" Dia.)



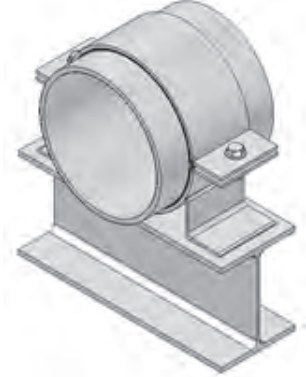
P7
Elbow Support Slide Plate
(2"-10" Dia.)



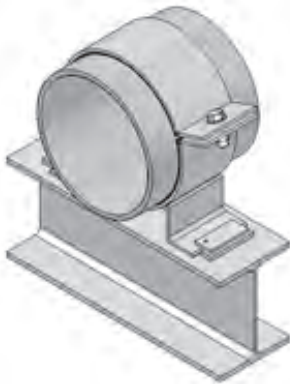
P7B
Elbow Support Slide Plate
(12"-24" Dia.)



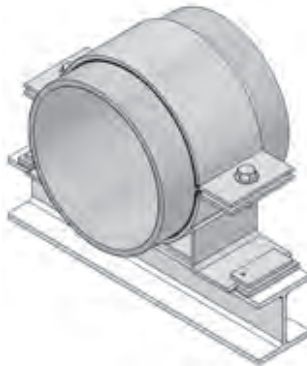
P8
Base Slide
(1"-10" Dia.)



P8L
Base Slide - Low Profile
(1"-10" Dia.)



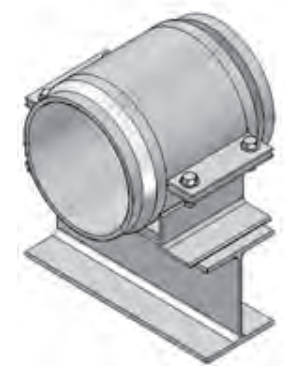
P9
Base Guide
(1"-10" Dia.)



P9L
Base Anchor - Low Profile
(1"-10" Dia.)

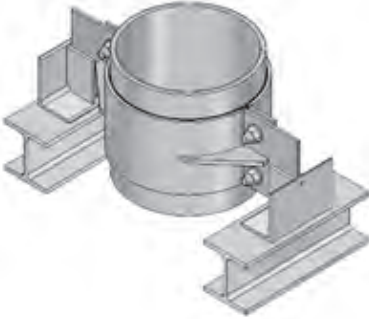
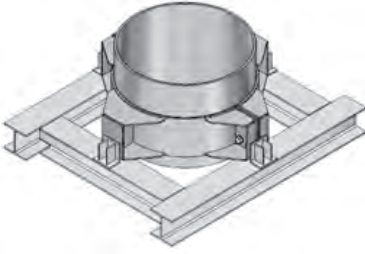
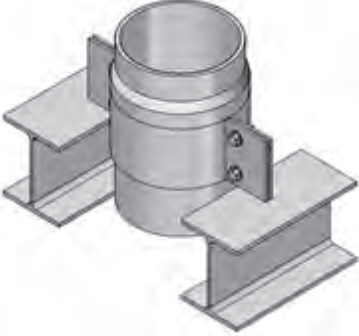
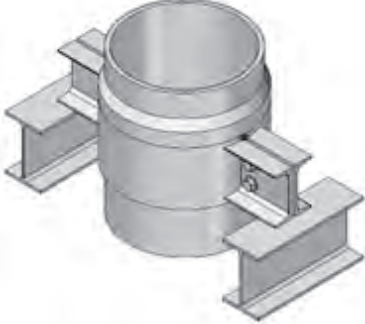
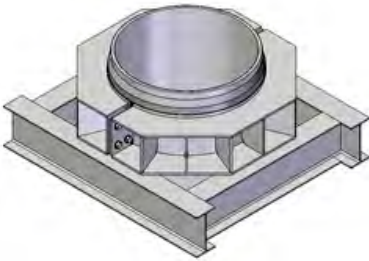
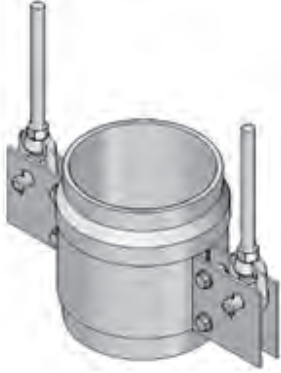
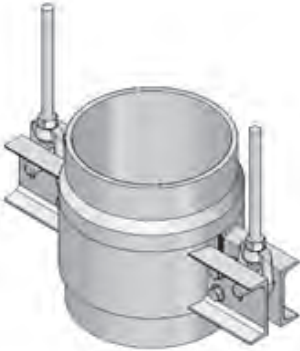
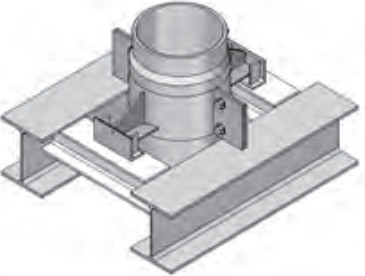
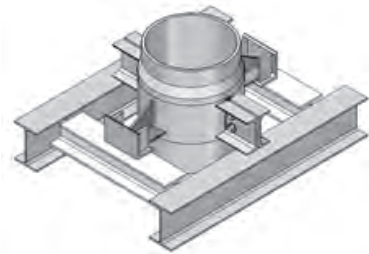
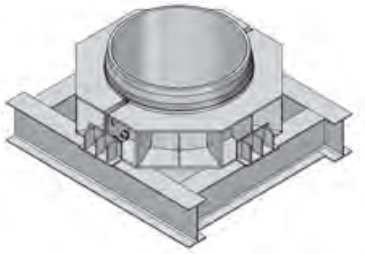




P10
Base Anchor
(1"-10" Dia.)



P10L
Base Anchor - Low Profile
(1"-10" Dia.)

Pipe Supports

 <p>P13 Riser Guide (1"-20" Dia.)</p>	 <p>P13 Riser Guide (24"-60" Dia.)</p>	 <p>P14 Riser Support (1"-10" Dia.)</p>	 <p>P14 Riser Support (12"-30" Dia.)</p>
 <p>P14 Riser Support (36"-60" Dia.)</p>	 <p>P15 Double Rod Riser Hanger (1"-10" Dia.)</p>	 <p>P15 Double Rod Riser Hanger (12"-30" Dia.)</p>	 <p>P16 Riser Support W/ Guides (1"-10" Dia.)</p>
 <p>P16 Riser Support W/ Guides (12"-30" Dia.)</p>	 <p>P16 Riser Support W/ Guides (36"-60" Dia.)</p>	 <p>P17 Base Linestop (12"-30" Dia.)</p>	 <p>P17 Base Linestop (36"-60" Dia.)</p>

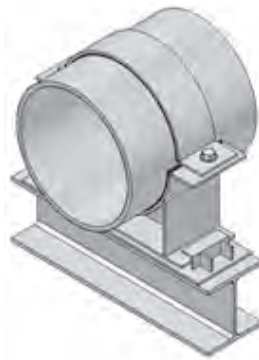
Pipe Supports



P18
Base Slide
(12"-30" Dia.)



P18
Base Slide
(36"-60" Dia.)



P19
Base Guide
(12"-30" Dia.)



P19
Base Guide
(36"-60" Dia.)



P20
Base Anchor
(12"-30" Dia.)



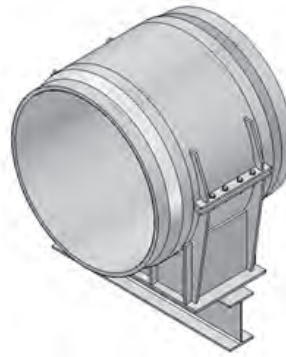
P20
Base Anchor
(36"-60" Dia.)



XL12
Extra Large Slide
(66"-108" Dia.)



XL13
Extra Large Guide
(66"-108" Dia.)



XL14
Extra Large Anchor
(66"-108" Dia.)

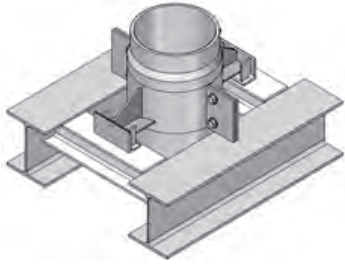
Pipe Supports

Pictorial Index

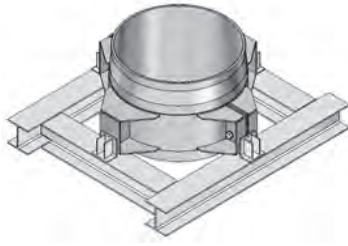
Duct Supports

 <p>D1 Duct Clamp Hanger (20"-60" Dia.)</p>	 <p>D3 Duct Cradle Base Slide (20"-60" Dia.)</p>	 <p>D4 Duct Base Linestop (20"-36" Dia.)</p>	 <p>D4 Duct Base Linestop (42"-60" Dia.)</p>
 <p>D5 Duct Base Slide (20"-36" Dia.)</p>	 <p>D5 Duct Base Slide (42"-60" Dia.)</p>	 <p>D6 Duct Base Guide (20"-36" Dia.)</p>	 <p>D6 Duct Base Guide (42"-60" Dia.)</p>
 <p>D7 Duct Base Anchor (20"-36" Dia.)</p>	 <p>D7 Duct Base Anchor (42"-60" Dia.)</p>	 <p>D16 Duct Riser Guide (20"-30" Dia.)</p>	 <p>D16 Duct Riser Guide (36"-60" Dia.)</p>

Pipe Supports



D17
Duct Riser Support W/ Guides
(20"-30" Dia.)



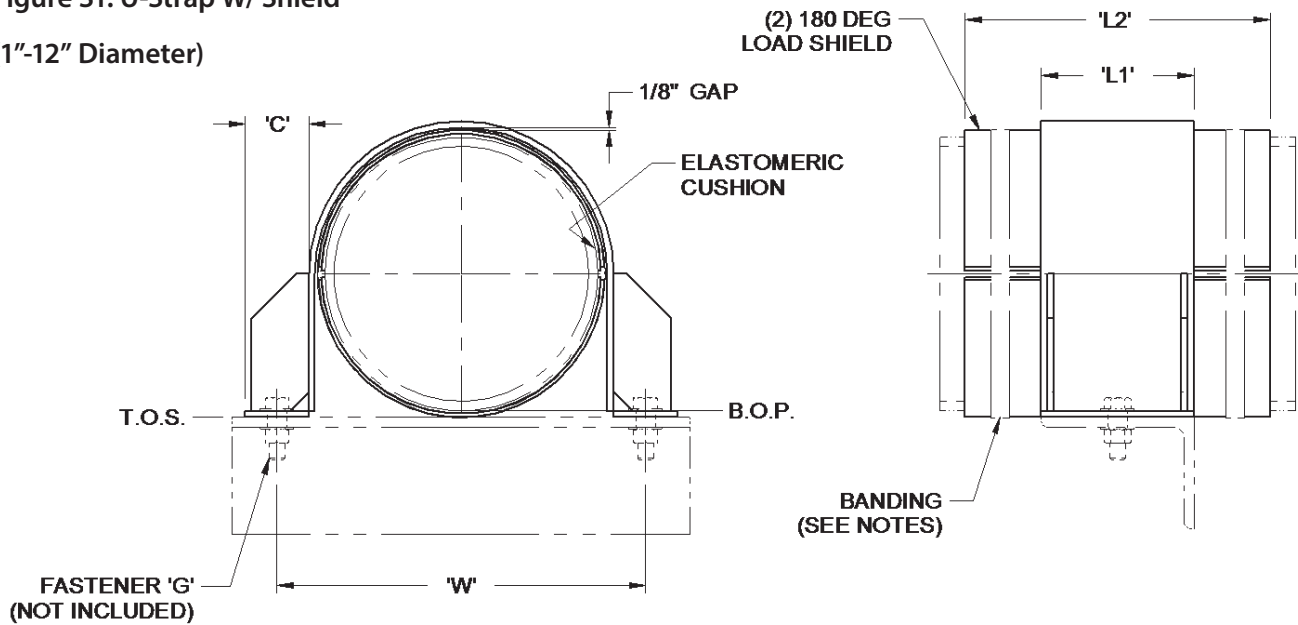
D17
Duct Riser Support W/ Guides
(36"-60" Dia.)

Pipe Supports

Pipe Supports

Figure S1: U-Strap W/ Shield

(1"-12" Diameter)



Finish:

Electroplated, hot-dipped galvanized

See General Note 15, page 5.

Service:

To provide wear protection for pipe while allowing freedom of axial movement and limiting lateral movement

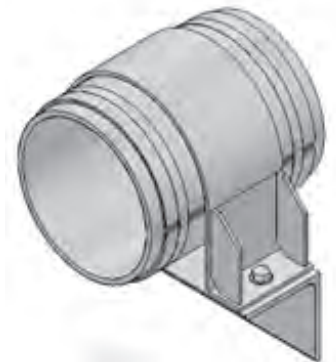
Material:

Carbon steel

See General Note 14, page 5.

Notes:

Base width (W) must be fully supported. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Load shield rests on supporting structure. Banding can be provided (in bulk) upon request. See General Note 26, page 6.

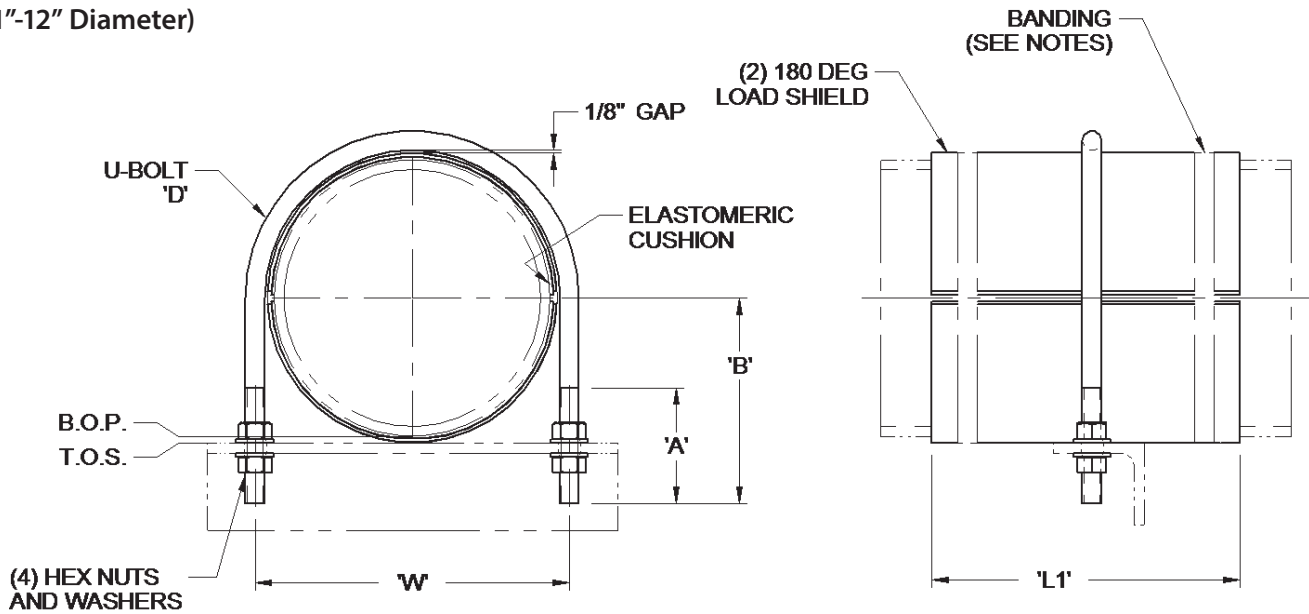


Pipe Size [in]	C [in]	G [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
						Lateral	Vertical
1	1 1/2	3/8	3	12	3 7/8	80	80
1 1/2	1 1/2	3/8	3	12	4 3/8	90	90
2	2	3/8	4	12	5 3/8	100	110
3	2	3/8	4	12	6 3/8	200	200
4	2	3/8	4	12	7 1/2	300	280
6	2	1/2	4	12	9 7/8	600	540
8	2	1/2	4	12	11 7/8	700	800
10	2 1/2	5/8	6	12	14 1/2	1300	1200
12	2 1/2	5/8	6	12	16 3/4	1300	1600

Pipe Supports

Figure S2: U-Strap W/ Shield

(1"-12" Diameter)



Finish:

Electroplated, hot-dipped galvanized

See General Note 15, page 5.

Service:

To provide wear protection for pipe while allowing freedom of axial movement and limiting lateral movement

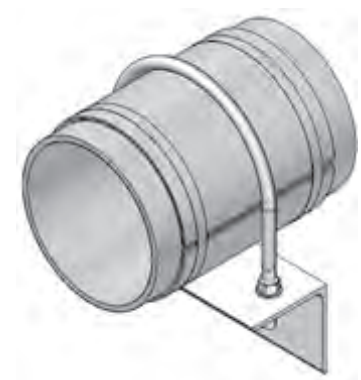
Material:

Carbon steel

See General Note 14, page 5.

Notes:

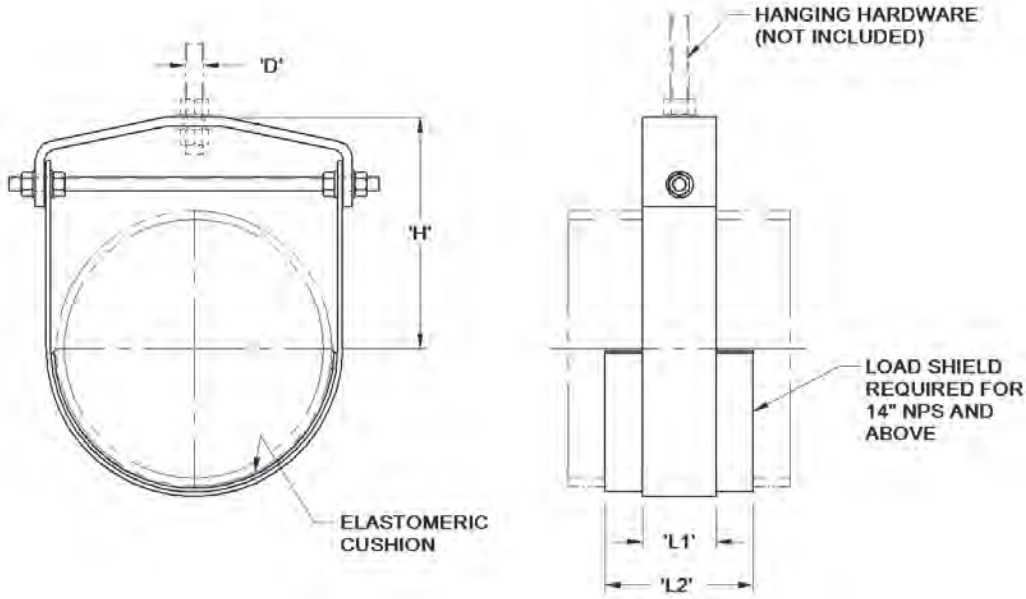
Base width (W) must be fully supported. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Load shield rests on supporting structure. Banding can be provided (in bulk) upon request. See General Note 26, page 6.



Pipe Size [in]	A [in]	B [in]	D [in]	L1 [in]	W [in]	Allowable Loads [lb]	
						Lateral	Vertical
1	1 3/4	2	3/8	12	2 3/8	20	80
1 1/2	1 7/8	2 1/4	3/8	12	2 7/8	20	90
2	2 1/4	2 3/4	3/8	12	3 3/8	20	110
3	3	3 1/2	1/2	12	4 1/2	45	200
4	3	4	1/2	12	5 5/8	70	280
6	3 1/2	5 1/2	5/8	12	8	150	540
8	3 1/2	6 1/2	5/8	12	10	170	800
10	4	8	3/4	12	12 1/4	200	1200
12	4 1/2	9 1/2	3/4	12	14 1/2	210	1600

Pipe Supports

Figure S4: Clevis Hanger
(1"-18" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe from above while allowing freedom of movement

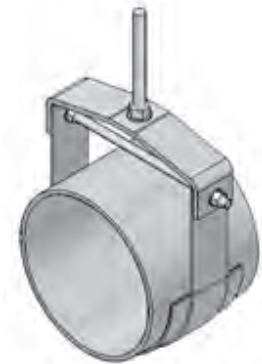
Material:

Carbon steel

See General Note 14, page 5.

Notes:

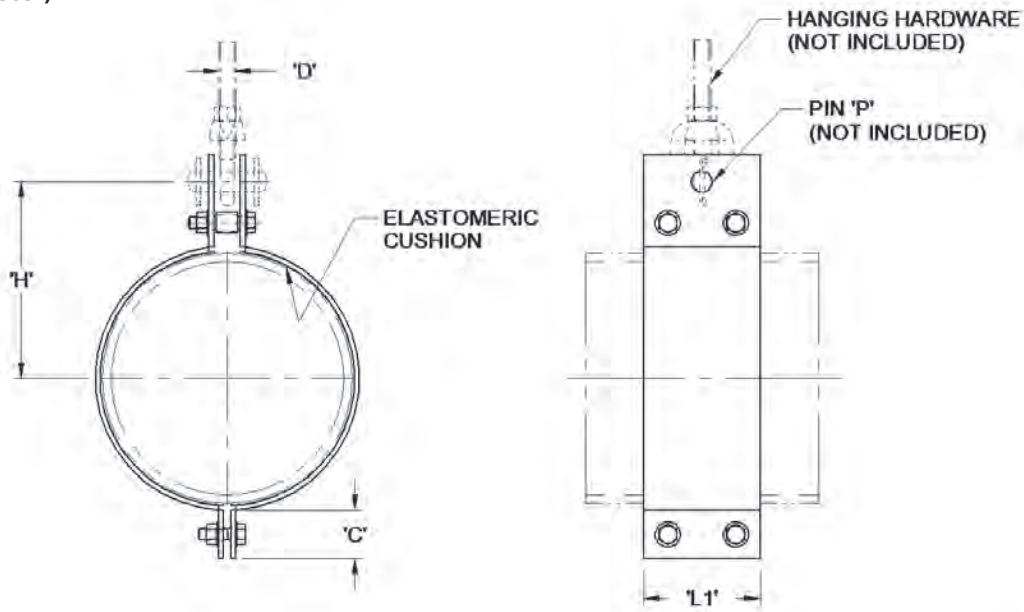
Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See General Notes, pages 5 and 6.



Pipe Size [in]	D [in]	H [in]	L1 [in]	L2 [in]	Allowable Loads [lb]
					Vertical
1	3/8	3 1/4	3	----	100
1 1/2	3/8	3 1/4	3	----	150
2	3/8	3 1/4	3	----	240
3	1/2	4 1/2	3	----	315
4	5/8	5 1/2	3	----	420
6	3/4	7	4	----	840
8	3/4	8 1/2	4	----	1120
10	7/8	10	6	----	1800
12	7/8	11 1/2	6	----	2160
14	1	12 1/2	4	8	2800
16	1	14	4	8	3300
18	1	16	4	10	3500

Pipe Supports

Figure S5: Wide Clamp Hanger
(1"-18" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe from above while allowing freedom of movement

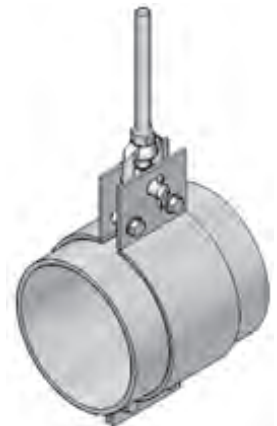
Material:

Carbon steel

See General Note 14, page 5.

Notes:

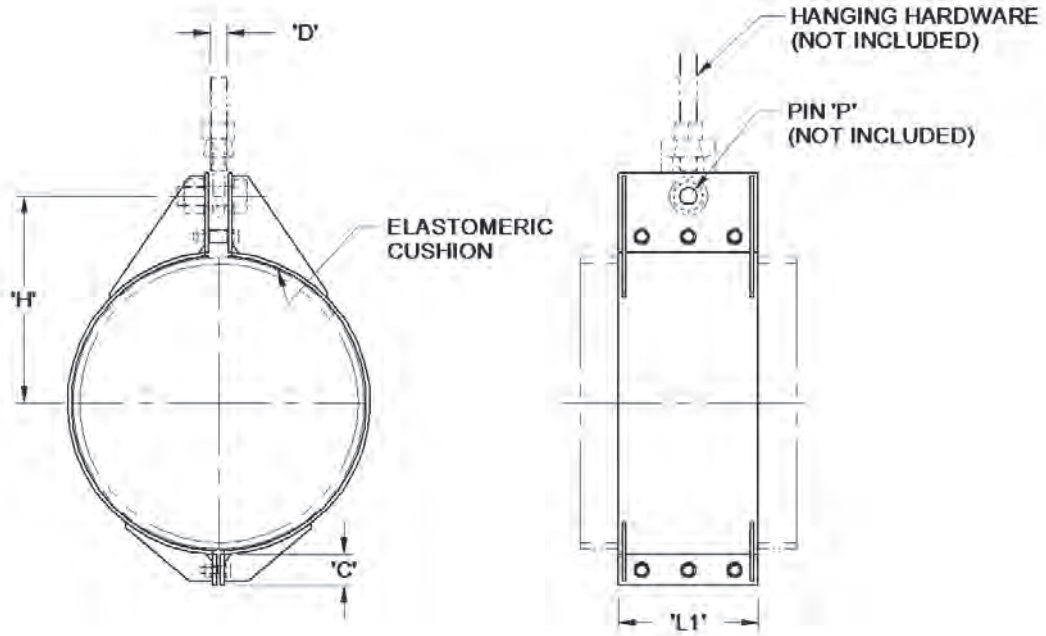
Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See page 18 for sizes 20" - 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	D [in]	H [in]	L1 [in]	P [in]	Allowable Loads [lb]
						Vertical
1	1 1/2	3/8	4	3	1/2	100
1 1/2	1 1/2	3/8	4 1/4	3	1/2	150
2	1 1/2	3/8	4 9/16	3	1/2	240
3	1 1/2	1/2	5 1/16	3	5/8	315
4	1 1/2	5/8	5 9/16	3	3/4	420
6	2	3/4	6 3/4	4	7/8	840
8	2	3/4	7 3/4	4	7/8	1120
10	2 1/2	7/8	9 1/16	6	1	1800
12	2 1/2	7/8	10 1/8	6	1	2160
14	2 1/2	1	11 1/4	8	1 1/8	3360
16	2 1/2	1	12 7/16	8	1 1/8	3840
18	3	1	13 11/16	10	1 1/8	5400

Pipe Supports

Figure S5: Wide Clamp Hanger
(20"-60" Diameter)



Finish:

20" – 30": Hot-dipped galvanized

36" – 60": Painted

See General Note 15, page 5.

Service:

To support weight of pipe from above while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

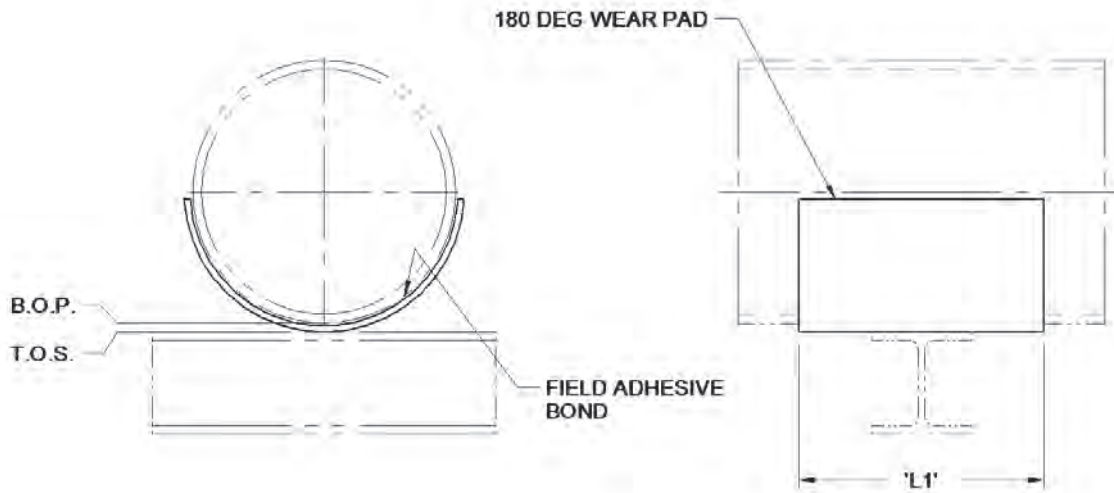
Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See page 17 for sizes 1" - 18". See General Notes, pages 5 and 6



Pipe Size [in]	C [in]	D [in]	H [in]	L1 [in]	P [in]	Allowable Loads [lb]
						Vertical
20	3	1 1/4	15 3/4	10	1 3/8	8000
24	3	1 1/2	18 3/16	12	1 5/8	10000
30	3	2	22	15	2 1/4	15000
36	4	2 1/4	26	18	2 1/2	23000
42	4	2 1/2	30 3/8	21	2 3/4	28000
48	4	2 3/4	35 1/4	24	3	36000
54	4	3	37 3/16	27	3 1/4	40000
60	4	3	40 1/4	30	3 1/4	45000

Pipe Supports

**Figure S7: FRP Wear Pad
(1"-12" Diameter)**



Finish:

Plain, painted

Service:

To provide wear protection for FRP pipe while allowing freedom of movement

Material:

Fiberglass reinforced plastic

Notes:

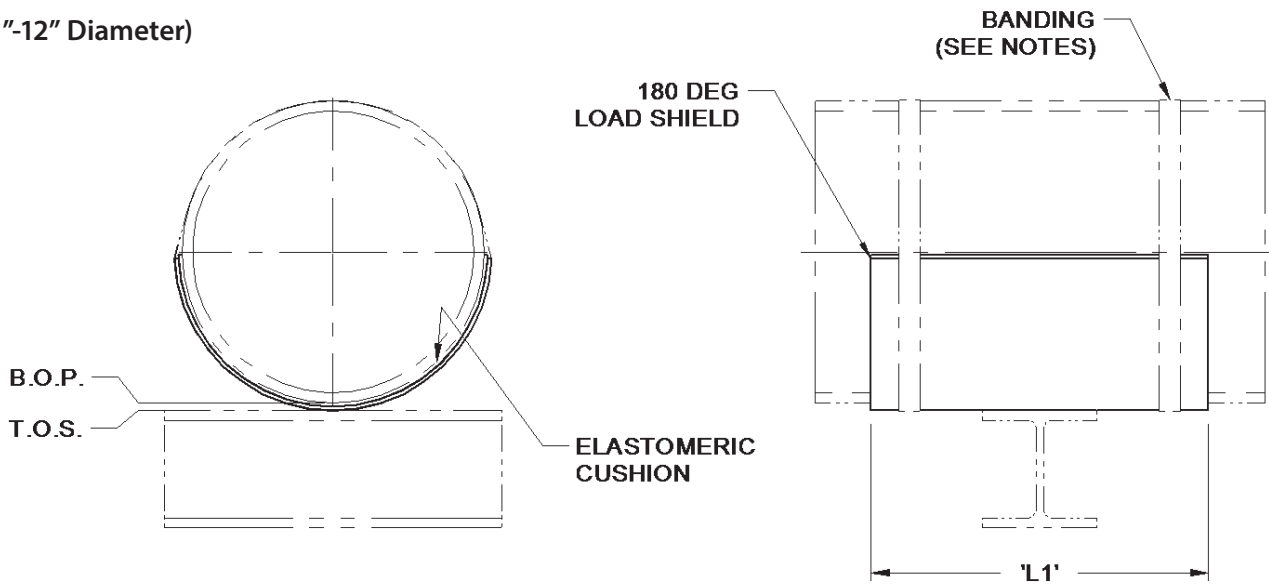
Bonded to FRP pipe. Adhesive to be ordered separately. Wear pad rests on supporting structure. See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	Allowable Loads [lb]
		Vertical
1	4	50
1 1/2	4	60
2	4	75
3	6	130
4	6	180
6	8	350
8	8	520
10	10	780
12	12	1200

Pipe Supports

Figure S8: Slide Shield
(1"-12" Diameter)

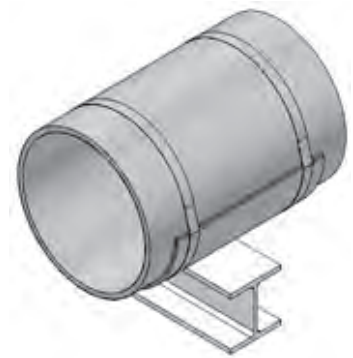


Finish:
Electroplated, hot-dipped galvanized
See General Note 15, page 5.

Service:
To provide wear protection for pipe while allowing freedom of movement

Material:
Carbon steel
See General Note 14, page 5.

Notes:
Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Load shield rests on supporting structure. Banding can be provided (in bulk) upon request. See General Note 26, page 6.

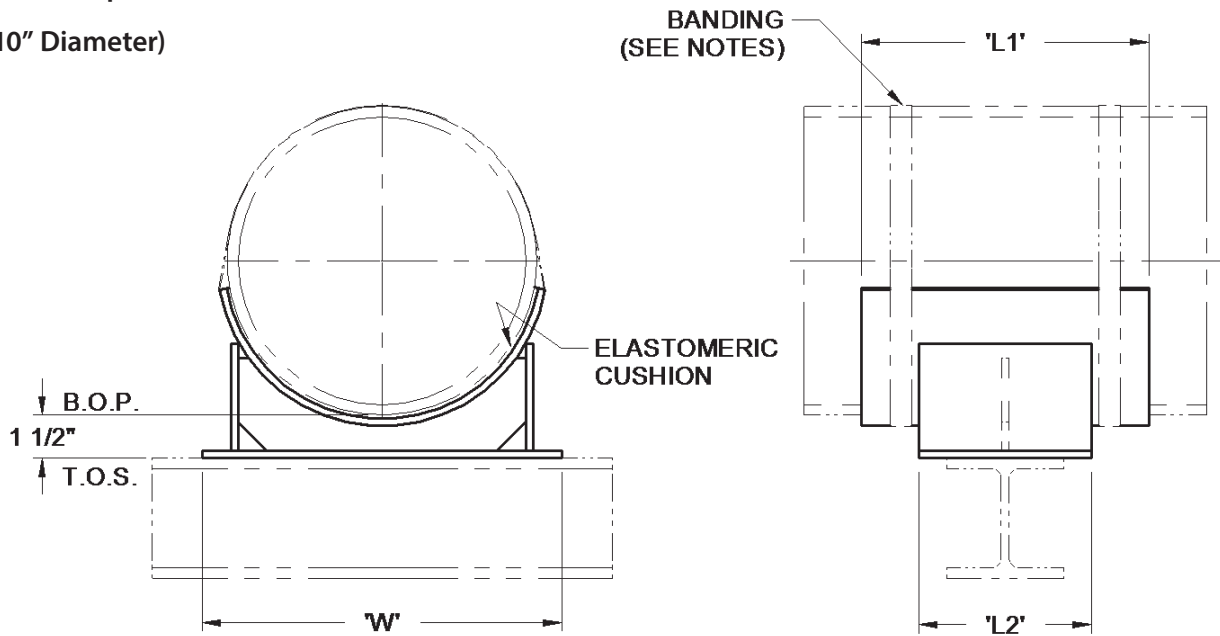


Pipe Size [in]	L1 [in]	Allowable Loads [lb]
		Vertical
1	12	80
1 1/2	12	90
2	12	110
3	12	200
4	12	280
6	12	540
8	12	800
10	12	1200
12	12	1600

Pipe Supports

Figure S9: Pipe Cradle

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of movement

Material:

Carbon steel.

See General Note 14, page 5.

Notes:

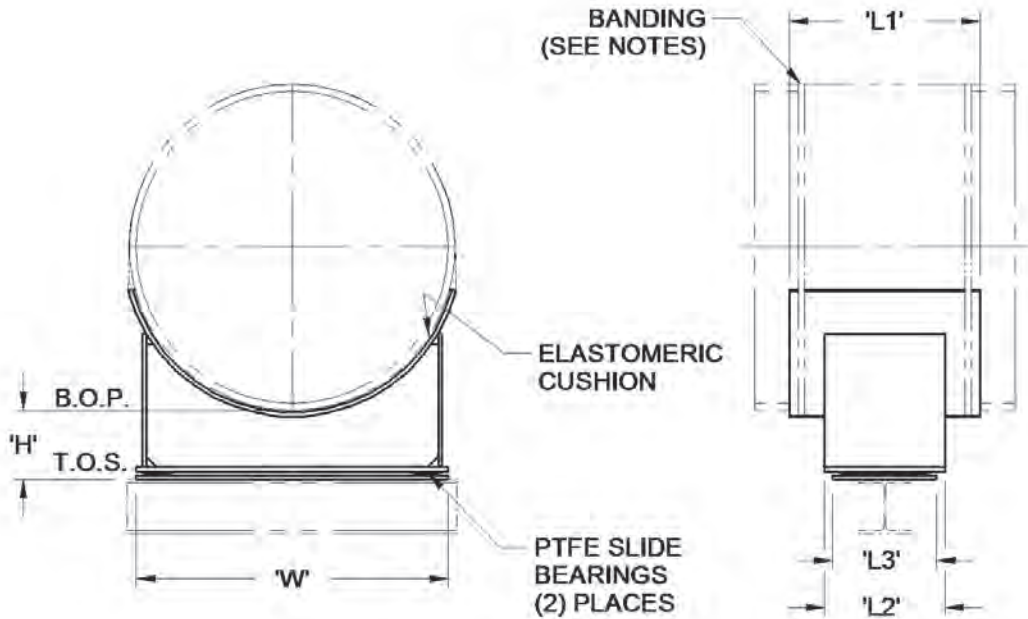
Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Banding can be provided (in bulk) upon request. See page 22 for sizes 12" – 60". See General Note 26 on page 6.



Pipe Size [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
				Vertical
1	6	4	4 1/2	120
1 1/2	6	4	5	150
2	8	4	4	170
3	8	4	4 1/2	250
4	8	4	5 1/2	320
6	10	6	7 1/2	650
8	10	6	9 1/2	1000
10	10	6	11 1/4	1500

Pipe Supports

Figure S9B: Pipe Cradle
(12"-60" Diameter)



Finish:

20" – 30": Hot-dipped galvanized

36" – 60": Painted

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

Support is provided with a base plate for welded installations. Base plates for bolted installation are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. Banding can be provided (in bulk) upon request. See page 21 for sizes 1" – 10". See General Note 26, page 6.

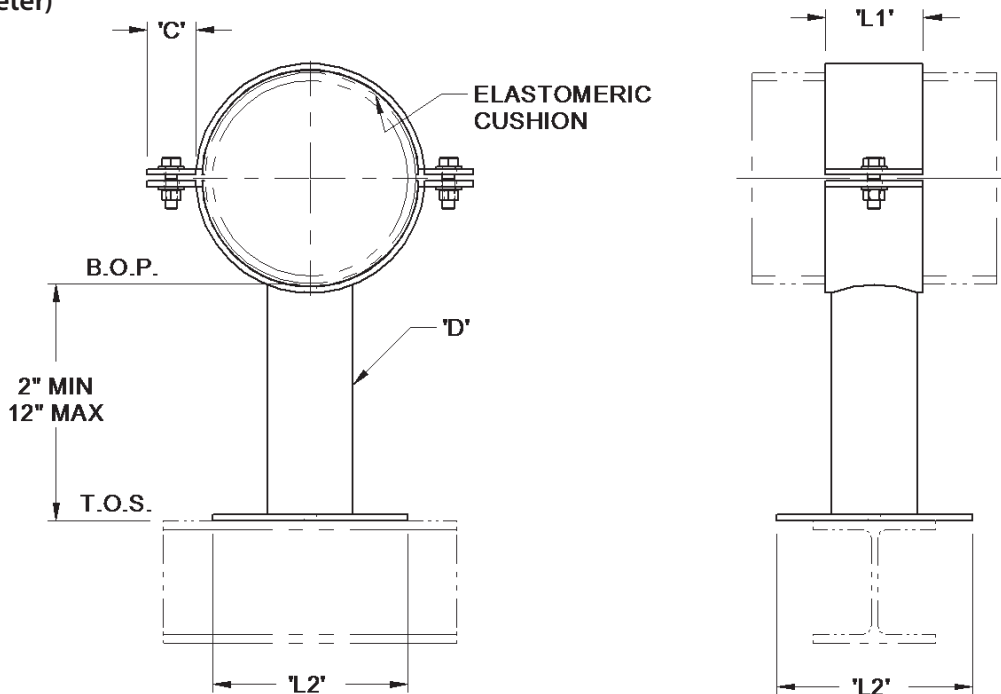


Pipe Size [in]	H [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]
						Vertical
12	3	12	8	8	13 1/8	1800
14	3	12	8	8	15	2400
16	3	12	8	8	16 1/2	3000
18	3	12	8	8	19	3700
20	3 1/4	12	8	8	21	4300
24	3 1/4	14	10	8	25	6200
30	4	16	12	10	30	9000
36	8	20	16	12	36	13000
42	8	22	18	12	42	16000
48	8	24	20	12	48	23000
54	8	26	22	12	54	28000
60	8	28	24	12	60	32000

Pipe Supports

Figure S10: Pipe Stand - Fixed Height

(1"-8" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

Fixed height pipe stand to support weight of pipe while allowing freedom of movement

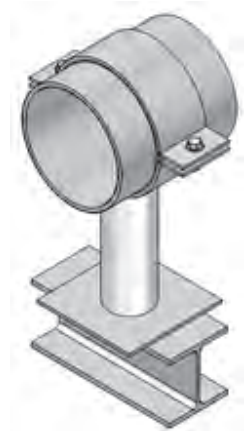
Material:

Carbon steel

See General Note 14, page 5.

Notes:

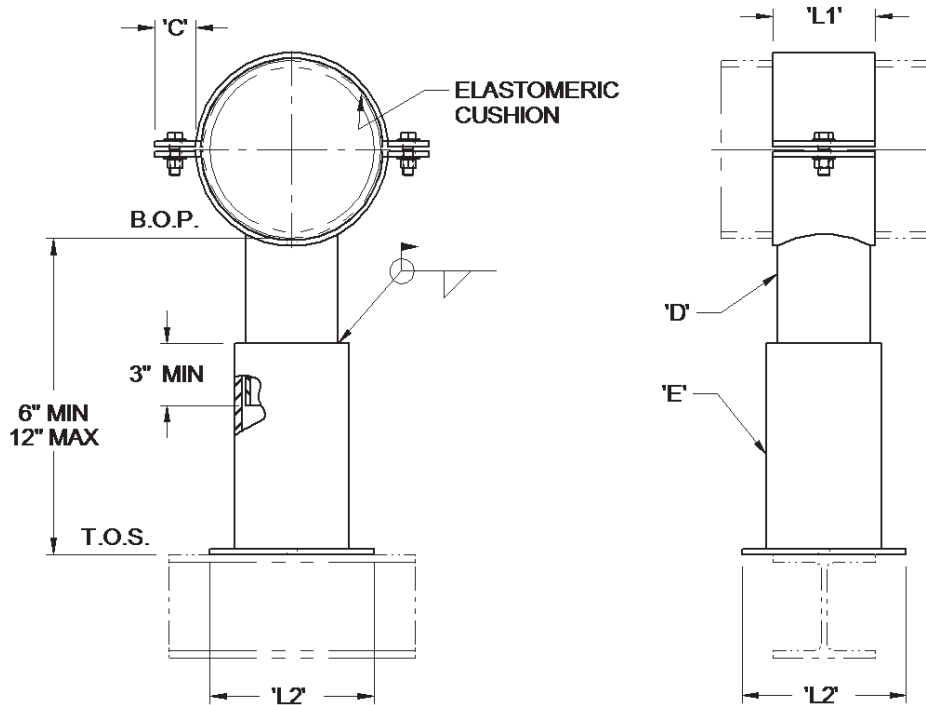
Not designed for axial or lateral loads. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Specify desired height upon placement of order. See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	D [NPS]	L1 [in]	L2 [in]	Allowable Loads [lb]
					Vertical
1	1 1/2	1 1/2	3	6	150
1 1/2	1 1/2	1 1/2	3	6	180
2	1 1/2	2	3	6	220
3	1 1/2	2	3	6	320
4	1 1/2	2	3	6	420
6	2	3	4	8	800
8	2	3	4	8	1050

Pipe Supports

Figure S11: Pipe Stand - Adjustable Height
(1"-8" Diameter)



Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
Adjustable height pipe stand to support weight of pipe while allowing freedom of movement

Material:
Carbon steel

See General Note 14, page 5.

Notes:
Not designed for axial or lateral loads. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Specify desired height upon placement of order. See General Notes, pages 5 and 6.

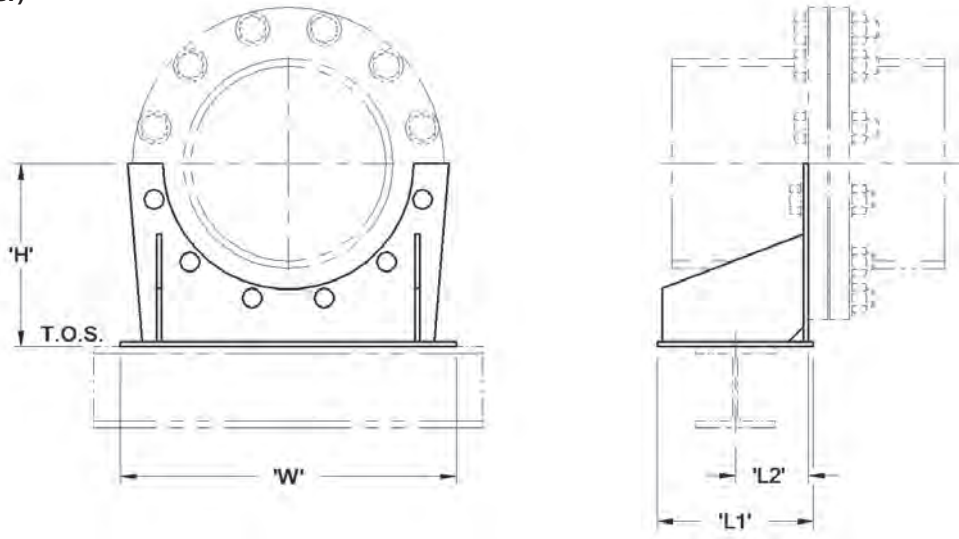


Pipe Size [in]	C [in]	D[NPS]	E [NPS]	L1 [in]	L2 [in]	Allowable Loads [lb]
						Vertical
1	1 1/2	1 1/2	2	3	6	150
1 1/2	1 1/2	1 1/2	2	3	6	180
2	1 1/2	2 1/2	3	4	6	220
3	1 1/2	2 1/2	3	4	6	320
4	1 1/2	2 1/2	3	4	6	420
6	2	4	5	5	8	800
8	2	4	5	5	8	1050

Pipe Supports

Figure S12: Flange Slide

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe, valves or equipment while allowing freedom of movement

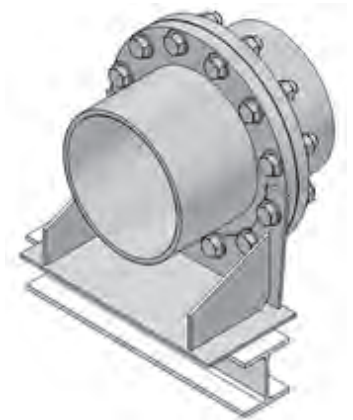
Material:

Carbon steel

See General Note 14, page 5.

Notes:

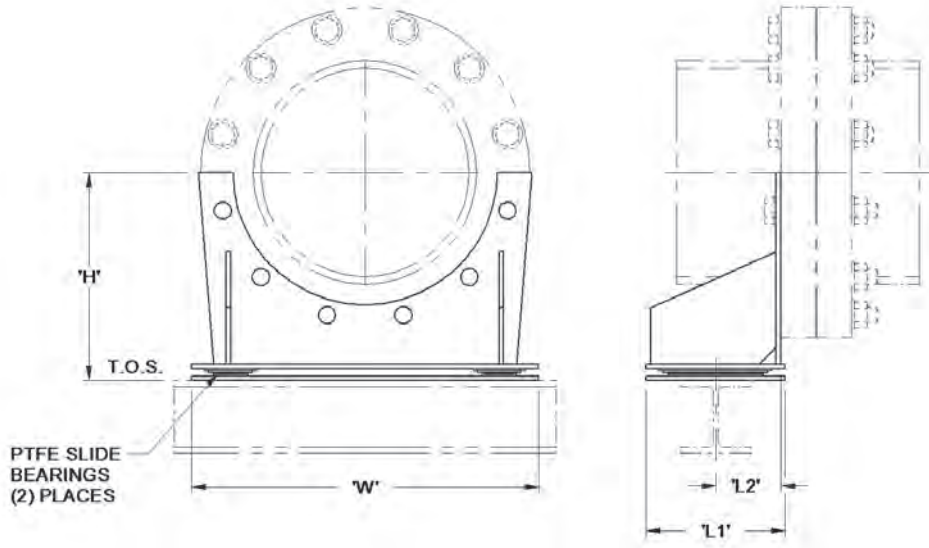
Dimensions are based on ANSI B16.5 CL150 flange drilling and may vary depending on actual drilling requirements. FRP flanges require a full back-face. See page 26 for sizes 12" – 30". See page 27 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
1	3 3/4	3	1 1/4	5 1/2	200
1 1/2	4 1/4	3	1 1/4	6	300
2	4 5/8	4	1 3/4	6	500
3	5 1/4	4	1 3/4	7 1/2	700
4	6	4	1 3/4	10 1/4	900
6	7	6	2 3/4	12 1/4	1500
8	8 1/4	6	2 3/4	14 1/4	1800
10	9 3/8	8	3 3/4	17 1/4	2200

Pipe Supports

Figure S12B: Flange Slide
(12"-30" Diameter)



Finish:

Hot-dipped galvanized
See General Note 15, page 5.

Service:

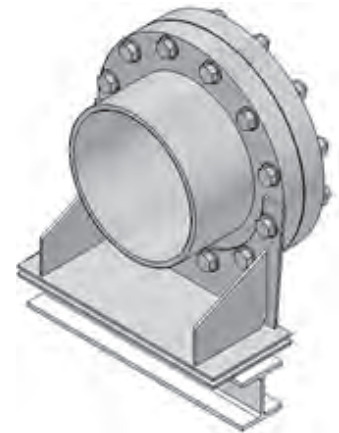
To support weight of pipe, valves or equipment, while allowing freedom of movement

Material:

Carbon steel
See General Note 14, page 5.

Notes:

Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. FRP flanges require a full back-face. See page 25 for sizes 1"-10". See page 27 for sizes 36" - 60". See General Notes, pages 5 and 6.

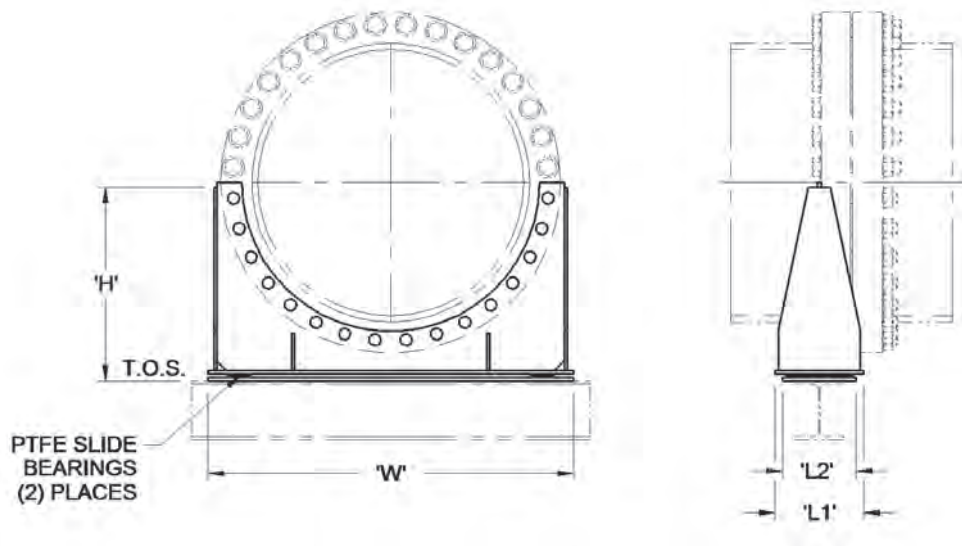


Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
12	12	8	3 3/4	20	2800
14	12 7/8	8	3 3/4	21 1/2	3200
16	14 1/8	8	3 3/4	24 1/2	4200
18	15 3/8	8	3 3/4	26	5300
20	17 1/2	10	4 5/8	29 1/8	6500
24	19 3/4	10	4 5/8	32 3/4	8900
30	23 5/8	10	4 5/8	36 3/4	11000

Pipe Supports

Figure S12B: Flange Slide

(36"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe, valve or equipment while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

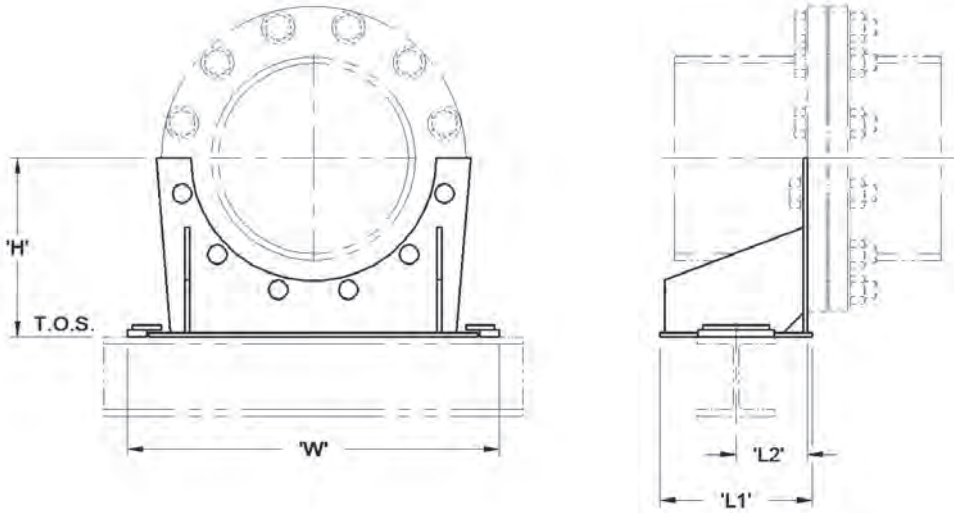
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on ASME B16.47 Series A CL 150 and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. FRP flanges require a full back-face. See page 25 for sizes 1" – 10". See page 26 for 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
36	26 3/4	12	10	49 3/4	13000
42	30 1/4	14	12	56 3/4	18000
48	33 1/2	16	14	63 3/4	24000
54	38 1/2	18	16	72	30000
60	42	20	18	78 1/2	36000

Pipe Supports

Figure S13: Flange Slide
(1"-10" Diameter)



Finish:

Hot-dipped galvanized
See General Note 15, page 5.

Service:

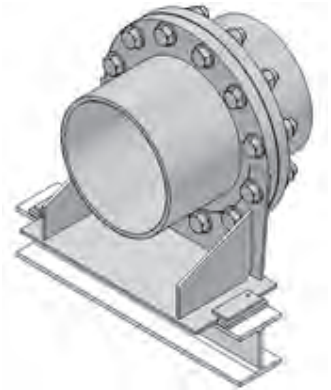
To support weight of pipe, valves or equipment, while allowing freedom of axial movement and limiting lateral movement

Material:

Carbon steel
See General Note 14, page 5.

Notes:

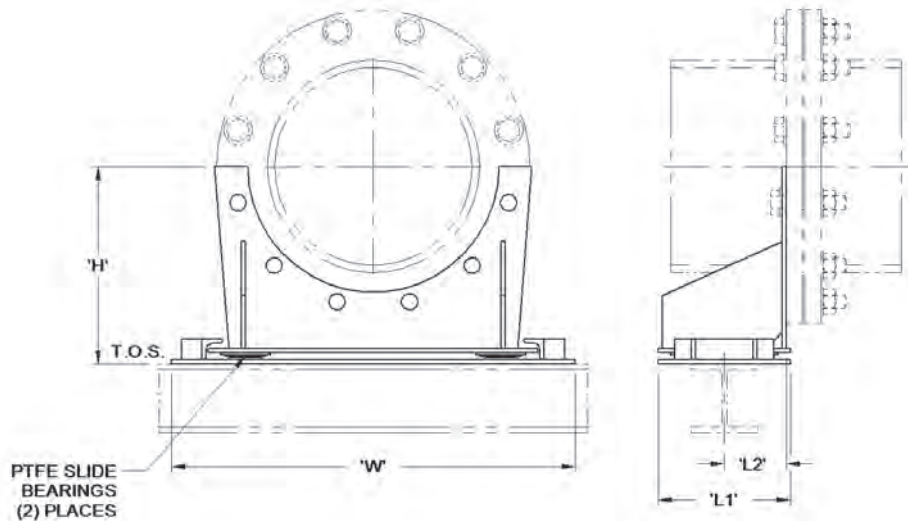
Type FB1 welded guide clips are provided with this style of support. Type FB2 bolted guide clips are available upon request. Dimensions are based on ANSI B16.5 CL 150 flange drilling and may vary depending on actual drilling requirements. Can also be used as a flange riser guide. FRP flanges require a full back-face. See page 29 for sizes 12" – 30". See page 30 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
1	3 3/4	3	1 1/4	7 3/4	100	200
1 1/2	4 1/4	3	1 1/4	8 1/4	150	300
2	4 5/8	4	1 3/4	8 1/4	200	500
3	5 1/4	4	1 3/4	9 3/4	280	700
4	6	4	1 3/4	12 1/2	360	900
6	7	6	2 3/4	14 1/2	600	1500
8	8 1/4	6	2 3/4	16 1/2	720	1800
10	9 3/8	8	3 3/4	19 1/2	880	2200

Pipe Supports

Figure S13B: Flange Slide
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe, valves or equipment, while allowing freedom of axial movement and limiting lateral movement

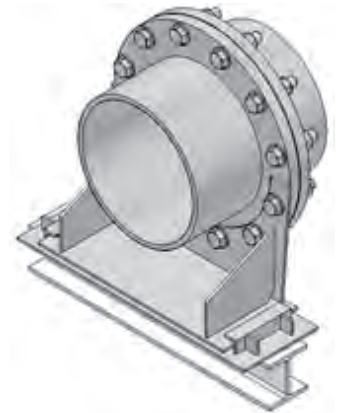
Material:

Carbon steel

See General Note 14, page 5.

Notes:

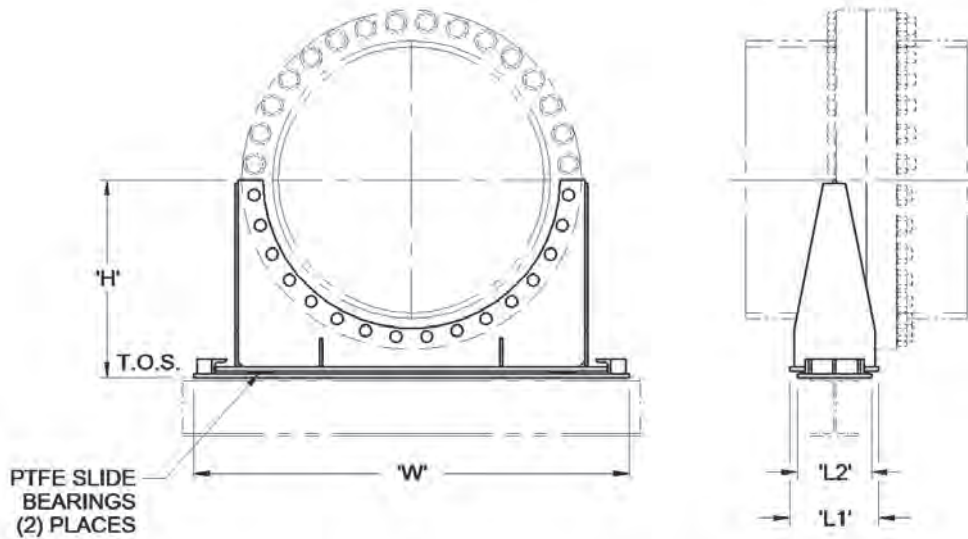
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. FRP flanges require a full back-face. See page 28 for sizes 1"-10". See page 30 for sizes 36" - 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
12	12	8	3 3/4	24 1/2	1120	2800
14	12 7/8	8	3 3/4	26	1280	3200
16	14 1/8	8	3 3/4	28	1680	4200
18	15 3/8	8	3 3/4	30 1/2	2100	5300
20	17 1/2	10	4 5/8	33 5/8	2600	6500
24	19 3/4	10	4 5/8	37 1/4	3600	8900
30	23 5/8	10	4 5/8	41 1/4	4400	11000

Pipe Supports

Figure S13B: Flange Slide
(36"-60" Diameter)

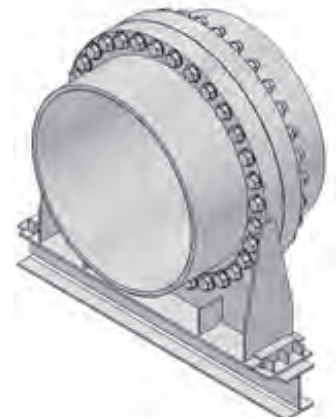


Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe, valves or equipment, while allowing freedom of axial movement and limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

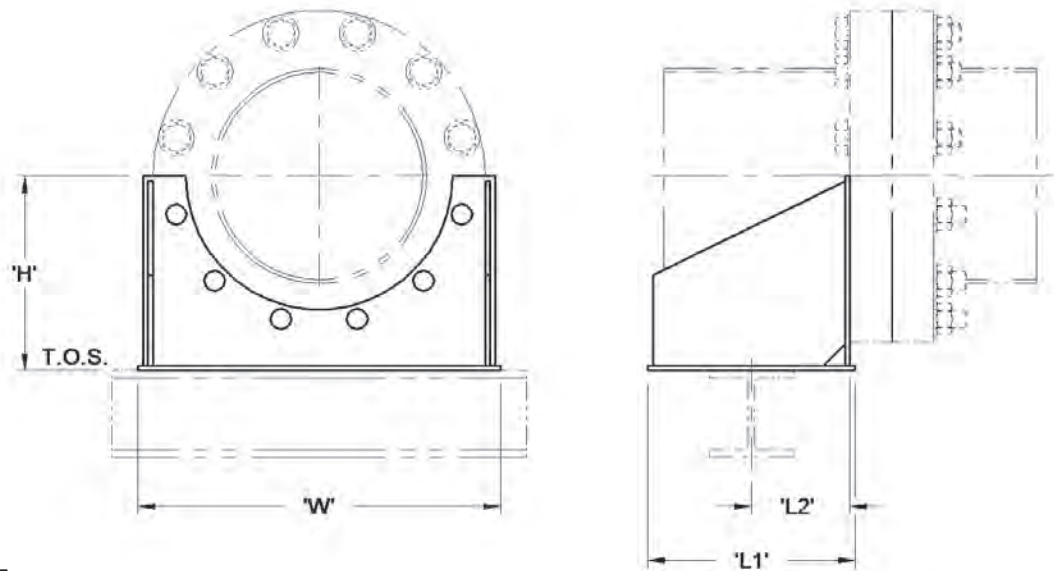
Notes:
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. FRP flanges require a full back-face. See page 28 for sizes 1"-10". See page 29 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
36	26 3/4	12	10	57 3/4	9100	13000
42	30 1/4	14	12	64 3/4	12600	18000
48	33 1/2	16	14	73 3/4	16800	24000
54	38 1/2	18	16	80 3/8	21000	30000
60	42	20	18	87	25000	36000

Pipe Supports

Figure S14: Flange Anchor
(1"-30" Diameter)

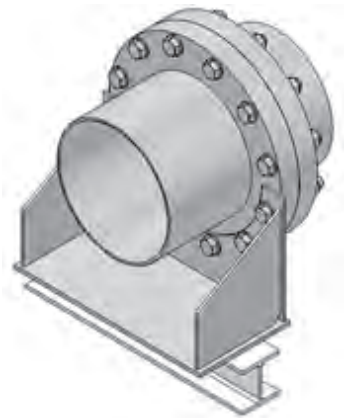


Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To support weight of pipe, valves or equipment while restricting all movement

Material:
Carbon steel
See General Note 14, page 5.

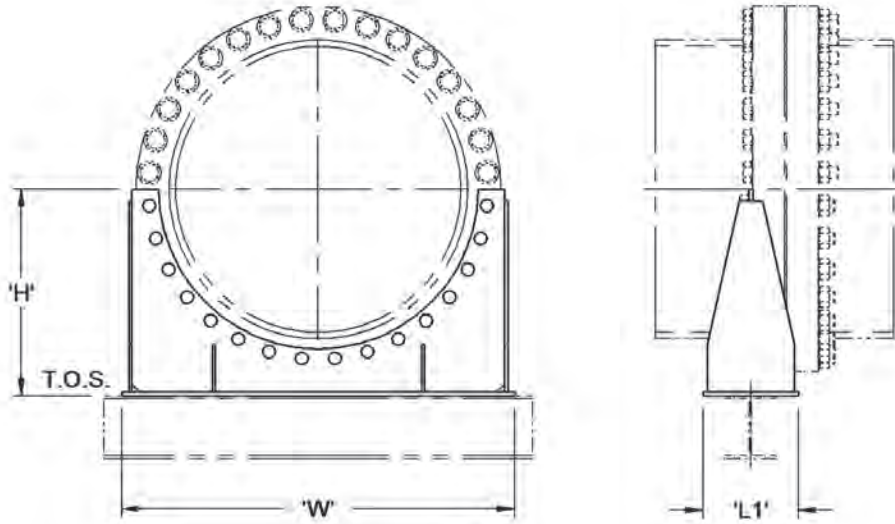
Notes:
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. FRP flanges require a full back-face. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. Can also be used as a flange riser anchor. See page 32 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]		
					Lateral	Vertical	Axial
1	3 3/4	4	1 3/4	5 1/2	100	200	300
1 1/2	4 1/4	4	1 3/4	5 7/8	150	300	320
2	4 5/8	6	2 3/4	7 1/2	200	500	350
3	5 1/4	6	2 3/4	9	280	700	490
4	6	6	2 3/4	10 1/2	360	900	630
6	7	8	3 3/4	12 1/2	600	1500	1260
8	8 1/4	8	3 3/4	15	720	1800	1800
10	9 3/8	10	4 3/4	18	880	2200	2100
12	12	10	4 3/4	20 1/2	1120	2800	2400
14	12 7/8	10	4 3/4	22 1/2	1280	3200	3000
16	14 1/8	12	5 3/4	25 1/4	1680	4200	4200
18	15 3/8	12	5 5/8	26 7/8	2100	5300	5300
20	17 1/2	12	5 5/8	30 1/4	2600	6500	6500
24	19 3/4	12	5 5/8	34	3600	8900	7000
30	23 5/8	12	5 5/8	42	4400	11000	7500

Pipe Supports

Figure S14: Flange Anchor
(36"-60" Diameter)

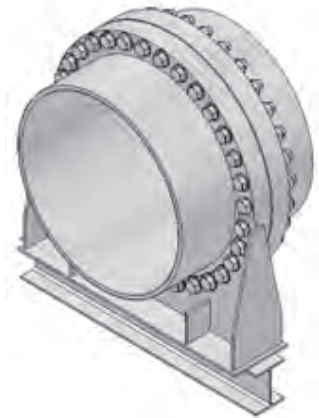


Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe, valves or equipment while restricting all movement

Material:
Carbon steel
See General Note 14, page 5.

Notes:
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. FRP flanges require a back-face. Dimensions are based on ASME B16.47 Series a CL 150 and may vary depending on actual drilling requirements. See page 31 for sizes 1" – 30". See General Notes, pages 5 and 6.

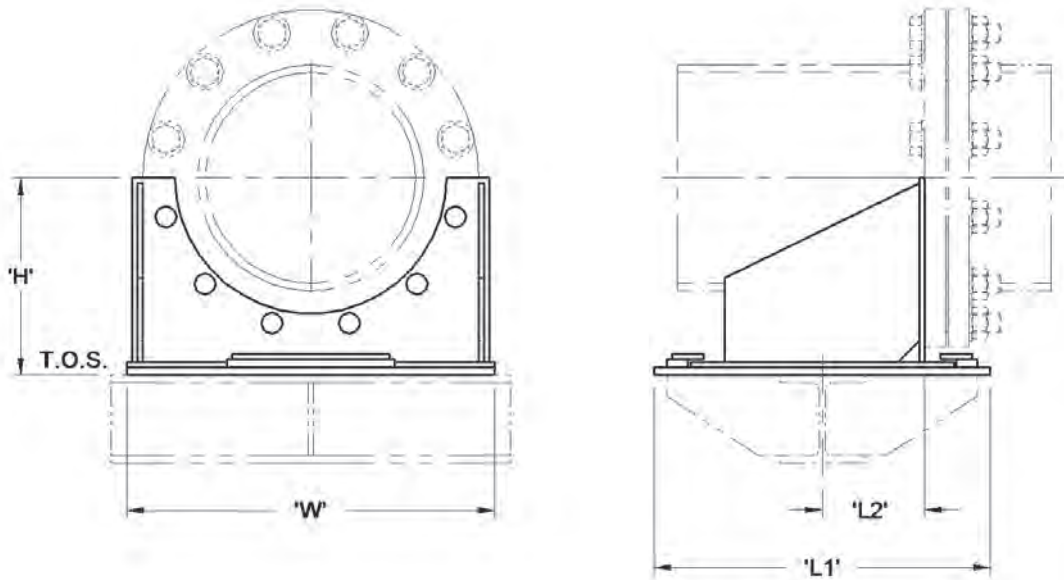


Pipe Size [in]	H [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
36	26 3/4	12	49 3/4	9100	13000	8000
42	30 1/4	14	56 3/4	12600	18000	9100
48	33 1/2	16	63 3/4	16800	24000	12000
54	38 1/2	18	72	21000	30000	15000
60	42	20	78 1/2	25000	36000	18000

Pipe Supports

Figure S15: Flange Linestop

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe, valves or equipment, while allowing freedom of lateral movement and limiting axial movement

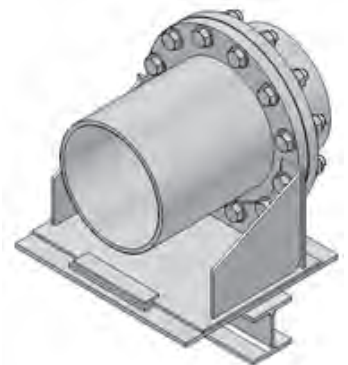
Material:

Carbon steel

See General Note 14, page 5.

Notes:

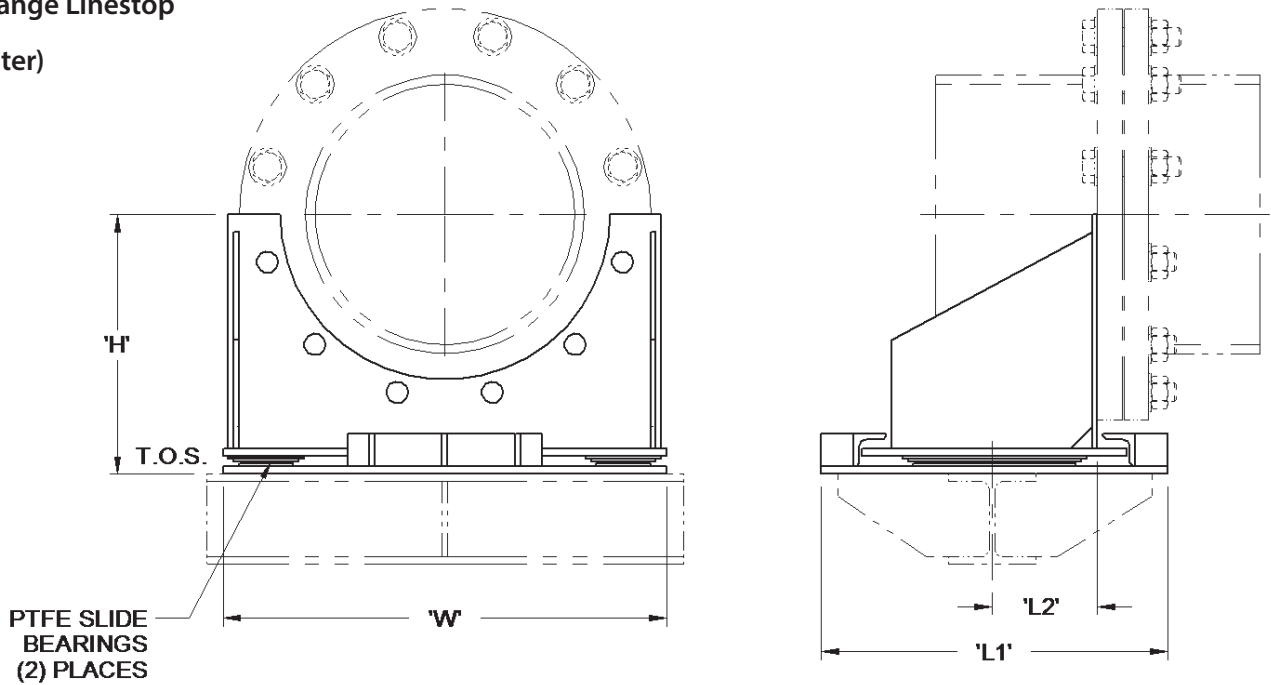
If axial and lateral displacements are to be limited, request optional base plate type BP4, page 86. Base width (W) and length (L1) must be fully supported. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. FRP flanges require a full back-face. Dimensions are based on ANSI B16.5 CL 150 flange drilling and may vary depending on actual drilling requirements. See page 34 for sizes 12" – 30". See page 35 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
1	3 3/4	8 1/4	1 3/4	5 1/2	200	300
1 1/2	4 1/4	8 1/4	1 3/4	5 7/8	300	320
2	4 5/8	10 1/2	2 3/4	7 1/2	500	350
3	5 1/4	10 1/2	2 3/4	9	700	490
4	6	10 1/2	2 3/4	10 1/2	900	630
6	7	14	3 3/4	12 1/2	1500	1260
8	8 1/4	14	3 3/4	15	1800	1800
10	9 3/8	16	4 3/4	18	2200	2100

Pipe Supports

Figure S15B: Flange Linestop
(12"-30" Diameter)

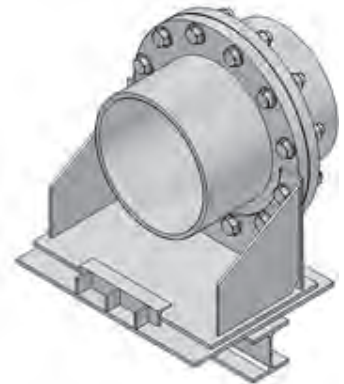


Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To support weight of pipe, valves or equipment, while allowing freedom of lateral movement and limiting axial movement

Material:
Carbon steel
See General Note 14, page 5.

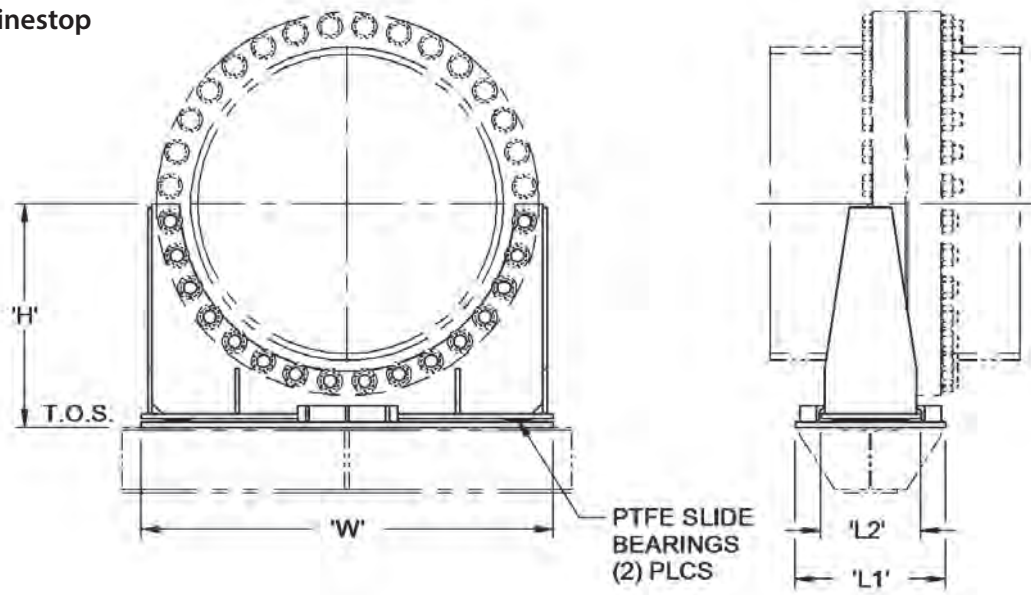
Notes:
If axial and lateral displacements are to be limited, request optional base plate type BP4, page 86. Base width (W) and length (L1) must be fully supported. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. FRP flanges require a full back-face. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 33 for sizes 1" – 10". See page 35 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
12	12	16	4 3/4	20 1/2	2800	2400
14	12 7/8	16	4 3/4	22 1/2	3200	3000
16	14 1/8	18	5 3/4	25 1/4	4200	4200
18	15 3/8	18	5 5/8	26 7/8	5300	5300
20	17 1/2	18	5 5/8	30 1/4	6500	6500
24	19 3/4	18	5 5/8	34	8900	7000
30	23 5/8	18	5 5/8	42	11000	7500

Pipe Supports

Figure S15B: Flange Linestop
(36"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe, valves or equipment, while allowing freedom of lateral movement and limiting axial movement

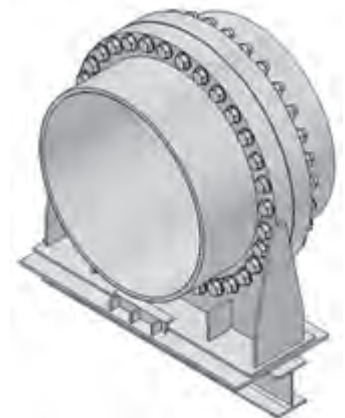
Material:

Carbon steel

See General Note 14, page 5.

Notes:

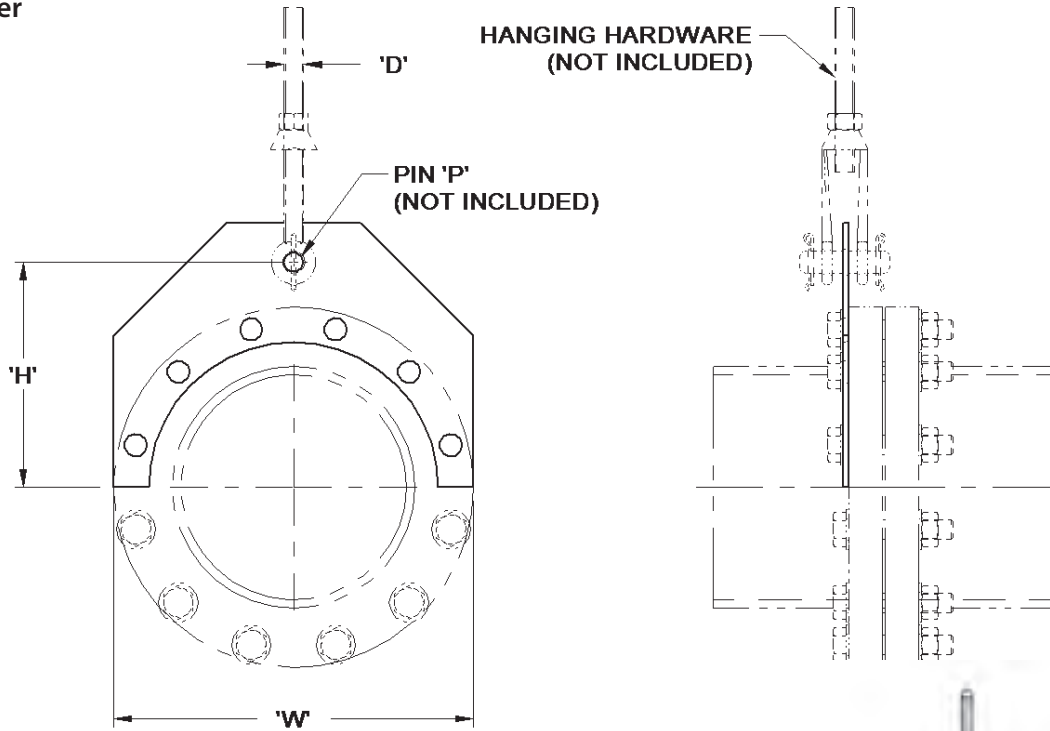
If axial and lateral displacements are to be limited, request optional base plate type BP4, page 86. Base width (W) and length (L1) must be fully supported. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. FRP flanges require a full back-face. Dimensions are based on ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 33 for sizes 1" – 10". See page 34 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
36	26 3/4	21	15	49 3/4	13000	8000
42	30 1/4	23	17	56 3/4	18000	9100
48	33 1/2	25	19	63 3/4	24000	12000
54	38 1/2	27	21	72	30000	15000
60	42	29	23	78 1/2	36000	18000

Pipe Supports

Figure S16: Flange Hanger
(1"-18" Diameter)



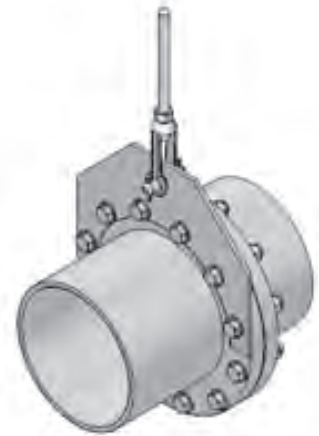
Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To support weight of pipe, valves or equipment from above while allowing freedom of movement

Material:
Carbon steel

See General Note 14, page 5.

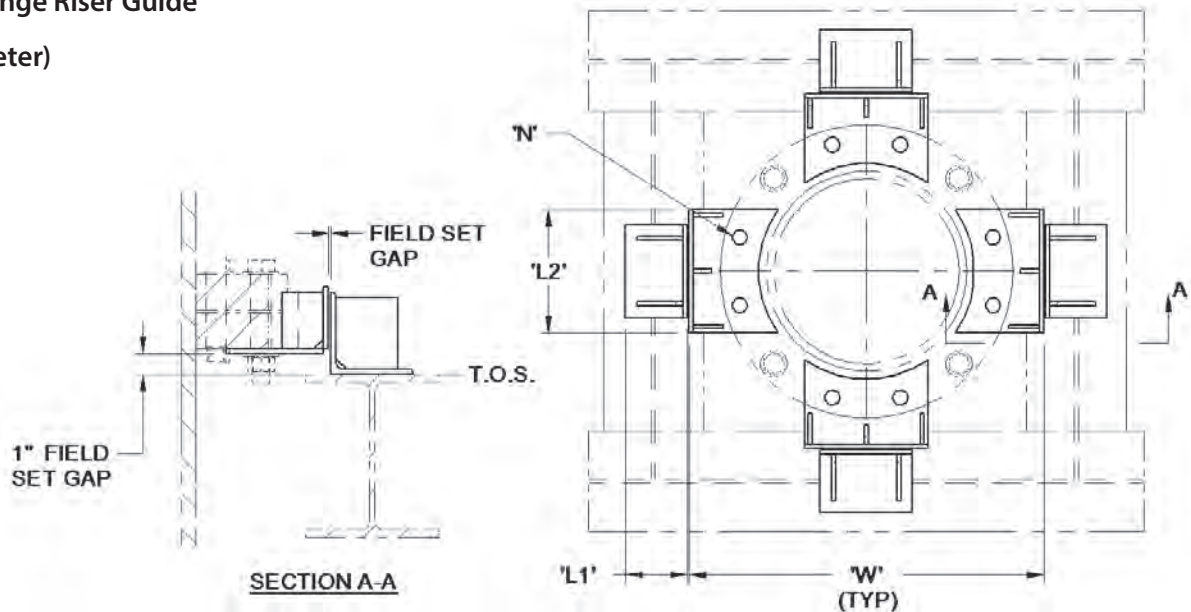
Notes:
Dimensions are based on ANSI B16.5 CL 150 flange drilling and may vary depending on actual drilling requirements. FRP flanges require full back-face. Hanging hardware is available upon request. See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	D [in]	P [in]	W [in]	Allowable Loads [lb]
					Vertical
1	4 1/8	3/8	1/2	4 1/4	250
1 1/2	4 1/2	3/8	1/2	5	450
2	5	3/8	1/2	6	600
3	6	1/2	5/8	7 1/2	1100
4	6 1/2	5/8	3/4	9	1600
6	7 1/2	3/4	7/8	11	2200
8	9	3/4	7/8	14	2800
10	10	7/8	1	16	3200
12	12	7/8	1	19	3600
14	13	1	1 1/8	21	4000
16	14	1	1 1/8	24	4500
18	15	1	1 1/8	25	5300

Pipe Supports

Figure S17: Flange Riser Guide
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To allow axial movement while limiting lateral movement

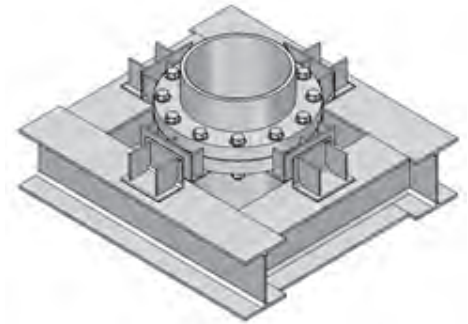
Material:

Carbon steel

See General Note 14, page 5.

Notes:

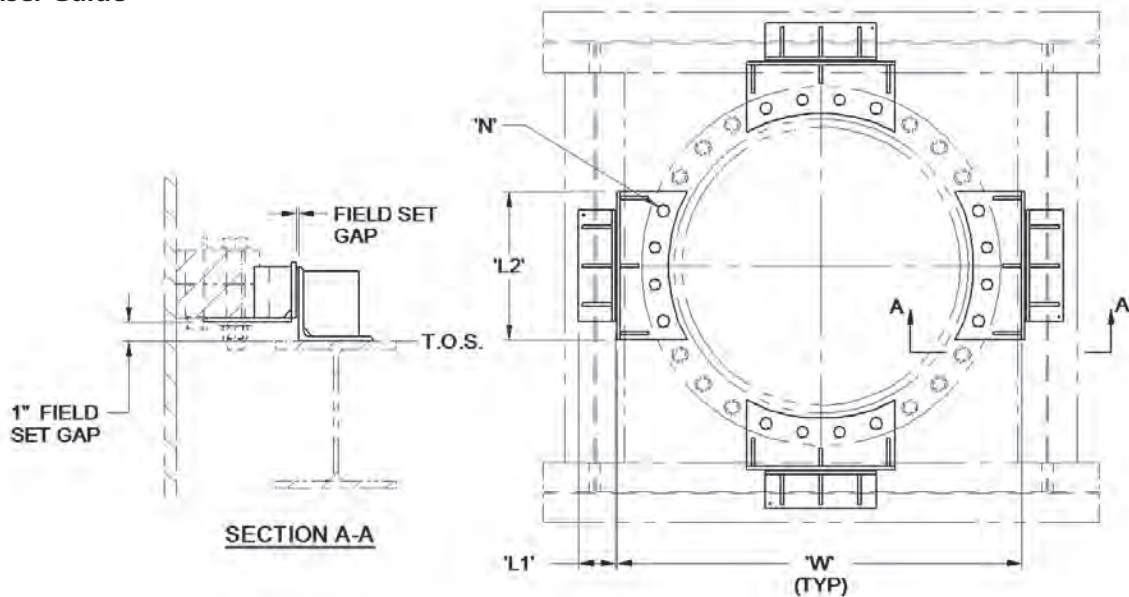
Not designed for vertical loading. Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded riser guide clips are provided with this style of support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. FRP flanges require full back-face. See page 38 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	N # Of Holes	W [in]	Allowable Loads [lb]
					Lateral
12	4	8	8	23	3300
14	4	8 1/2	8	25	3600
16	4	15	16	27 1/2	4000
18	4	16	16	29	4400
20	4	15	16	31 1/2	5800
24	4	18	16	36	6600
30	4	16	16	44	8000

Pipe Supports

Figure S17: Flange Riser Guide
(36"-60" Diameter)

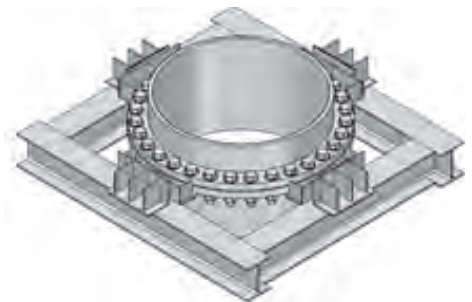


Finish:
Painted
See General Note 15, page 5.

Service:
To allow axial movement while limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

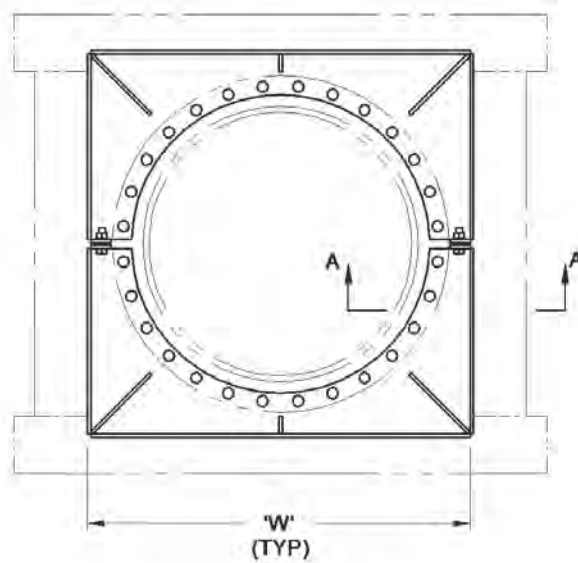
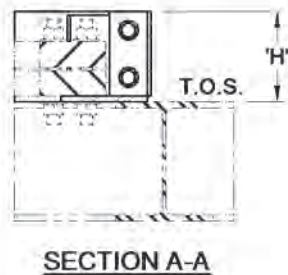
Notes:
Not designed for vertical loading. Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded riser guide clips are provided with this style of support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions are based on ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. FRP flanges require full back-face. See page 37 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	N # Of Holes	W [in]	Allowable Loads [lb]
					Lateral
36	6	17 1/2	16	53	9100
42	6	26 3/4	24	60	10500
48	6	24 1/2	24	66 1/2	12000
54	8	27 3/4	24	73 1/4	13500
60	8	34	32	80	15000

Pipe Supports

Figure S18: Flange Riser Support
(12"-60" Diameter)



Finish:

12" – 30": Hot-dipped galvanized

36" – 60": Painted

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of lateral movement. May also be configured to restrict all movement

Material:

Carbon steel

See General Note 14, page 4.

Notes:

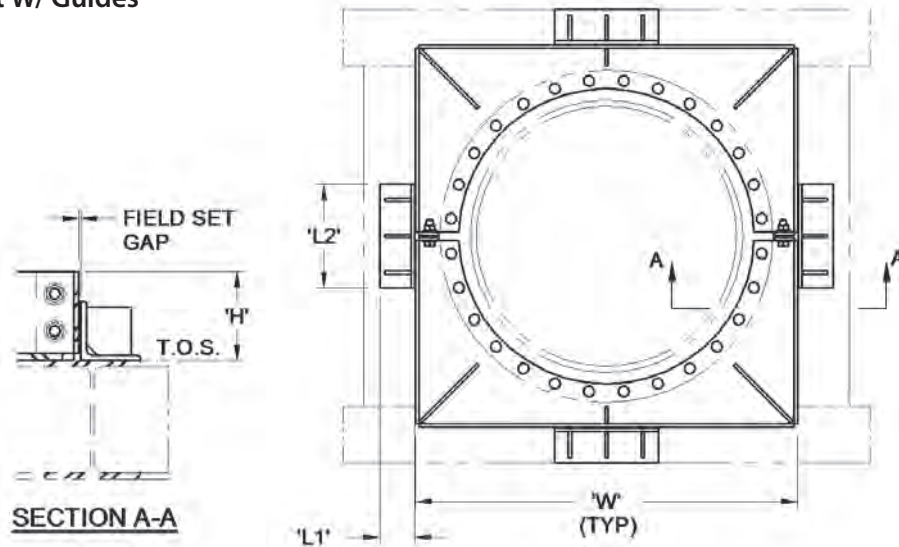
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. If a fixed anchor type support is required, provide loads for evaluation. FRP flanges require a full back-face. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	W [in]	Allowable Loads [lb]
			Vertical
12	4	25	5800
14	4	27	6300
16	4	29 1/2	6900
18	4	31	7600
20	6	33 1/2	12000
24	6	38	15000
30	6	46 3/4	18000
36	6	54	24000
42	6	61	30000
48	8	67 1/2	36000
54	8	74 1/4	48000
60	8	81	60000

Pipe Supports

Figure S19: Flange Riser Support W/ Guides
(12"-60" Diameter)

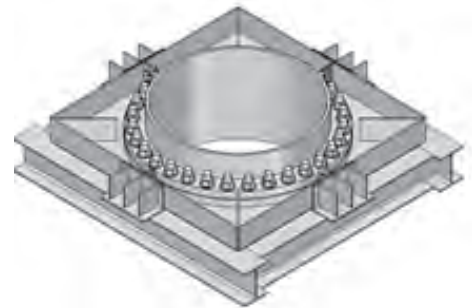


Finish:
12" – 30": Hot-dipped galvanized
36" – 60": Painted
See General Note 15, page 5.

Service:
To support weight of pipe while limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

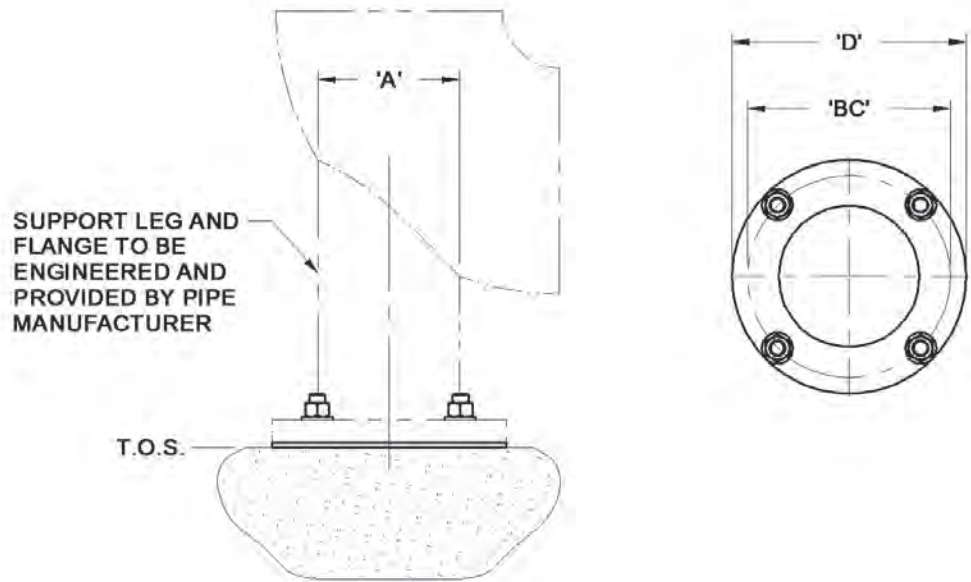
Notes:
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RC1 welded riser guide clips are provided with this style support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions are based on ANSI B16.5 or ASME B16.47 Series A CL 150 flange drilling and may vary depending on actual drilling requirements. FRP flanges require a full back-face. See General Notes, pages 5 and 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
12	4	4	4	25	3300	5800
14	4	4	4	27	3600	6300
16	4	4	6	29 1/2	4000	6900
18	4	4	6	31	4400	7600
20	6	4	8	33 1/2	5800	12000
24	6	4	8	38	6600	15000
30	6	4	12	46 3/4	8000	18000
36	6	6	12	54	9100	24000
42	6	6	12	61	12600	30000
48	8	8	12	67 1/2	16800	36000
54	8	8	18	74 1/4	21000	48000
60	8	8	18	81	25000	60000

Pipe Supports

Figure P7: Elbow Support Slide Plate
(2"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To carry pipe weight while allowing freedom of movement

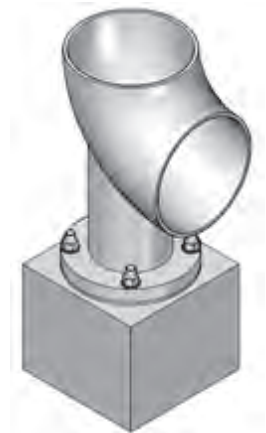
Material:

Carbon steel

See General Note 14, page 5.

Notes:

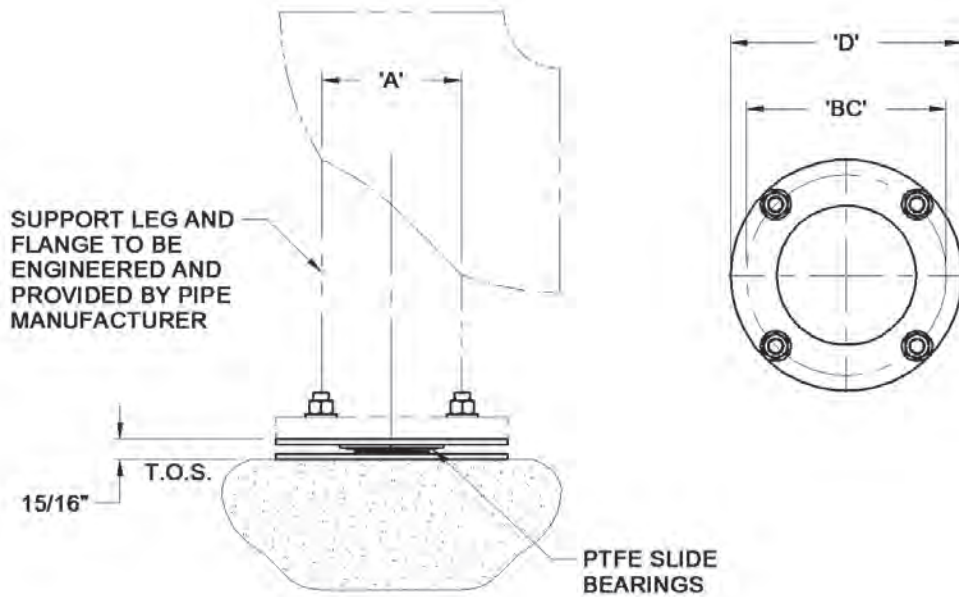
Bending moments should be evaluated at the connection to elbow. Provide support leg flange thickness when ordering. See General Notes, pages 5 and 6.



Elbow Size [in]	A [in]	BC [in]	D [in]
2	2	4 3/4	6
3	3	6	7 1/2
4	3	6	7 1/2
6	4	7 1/2	9
8	6	9 1/2	11
10	6	9 1/2	11

Pipe Supports

Figure P7B: Elbow Support Slide Plate
(12"-24" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To carry pipe weight while allowing freedom of movement

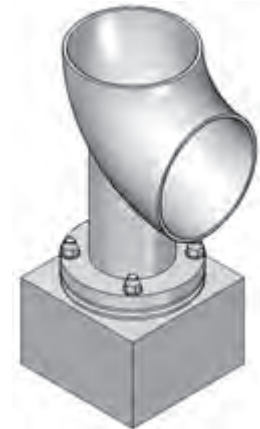
Material:

Carbon steel

See General Note 14, page 5.

Notes:

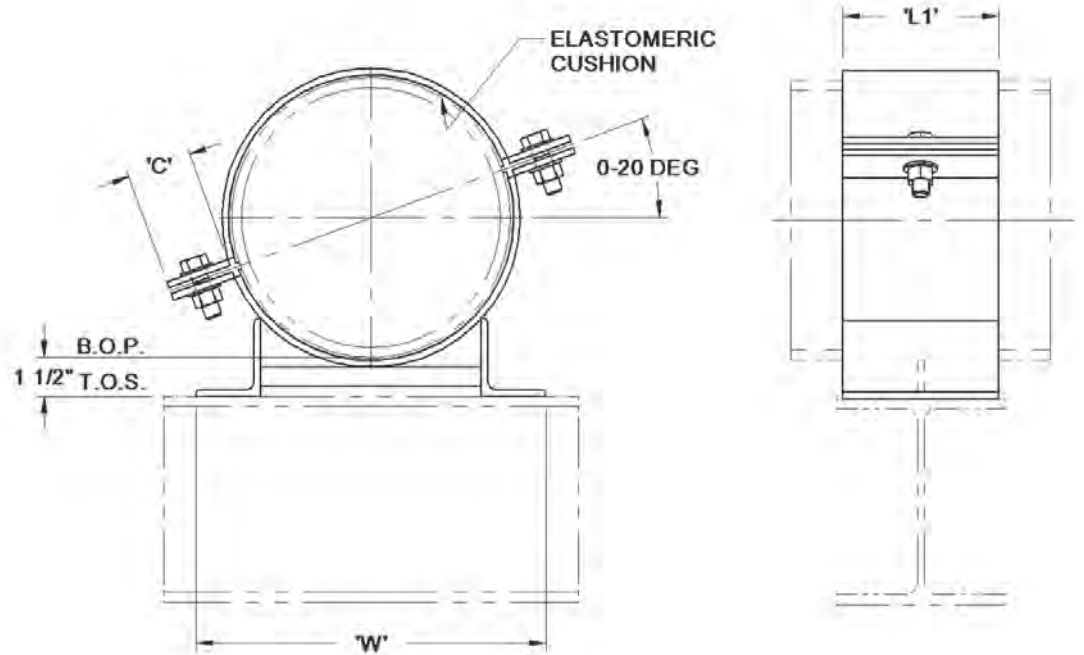
Bending moments should be evaluated at the connection to elbow. Provide support leg flange thickness when ordering. PTFE slide bearings are recommended for pipe sizes above 10" NPS. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. See General Notes, pages 5 and 6.



Elbow Size [in]	A [in]	BC [in]	D [in]
12	8	11 3/4	13 1/2
14	10	14 1/4	16
16	10	14 1/4	16
18	12	17	19
20	14	18 3/4	21
24	16	21 1/4	23 1/2

Pipe Supports

Figure P8: Base Slide
(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

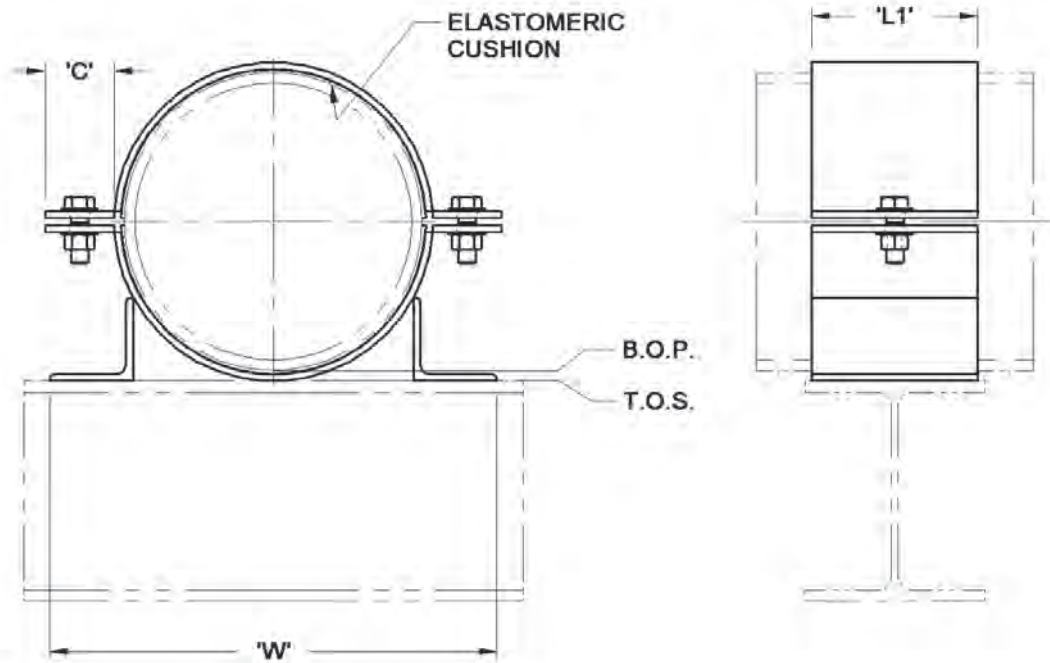
Dimensions are estimated based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]
				Vertical
1	1 1/2	3	4 3/8	150
1 1/2	1 1/2	3	4 1/2	200
2	1 1/2	3	4 3/4	300
3	1 1/2	3	6 1/4	430
4	1 1/2	3	6 1/2	550
6	2	4	8 7/8	1090
8	2	4	10 3/4	1440
10	2 1/2	5	13 1/2	2000

Pipe Supports

Figure P8L: Base Slide - Low Profile
(1"-10" Diameter)

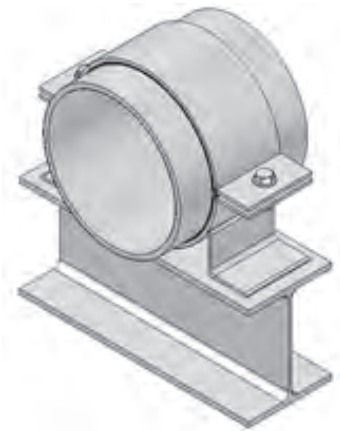


Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To support weight of pipe while allowing freedom of movement

Material:
Carbon steel
See General Note 14, page 5.

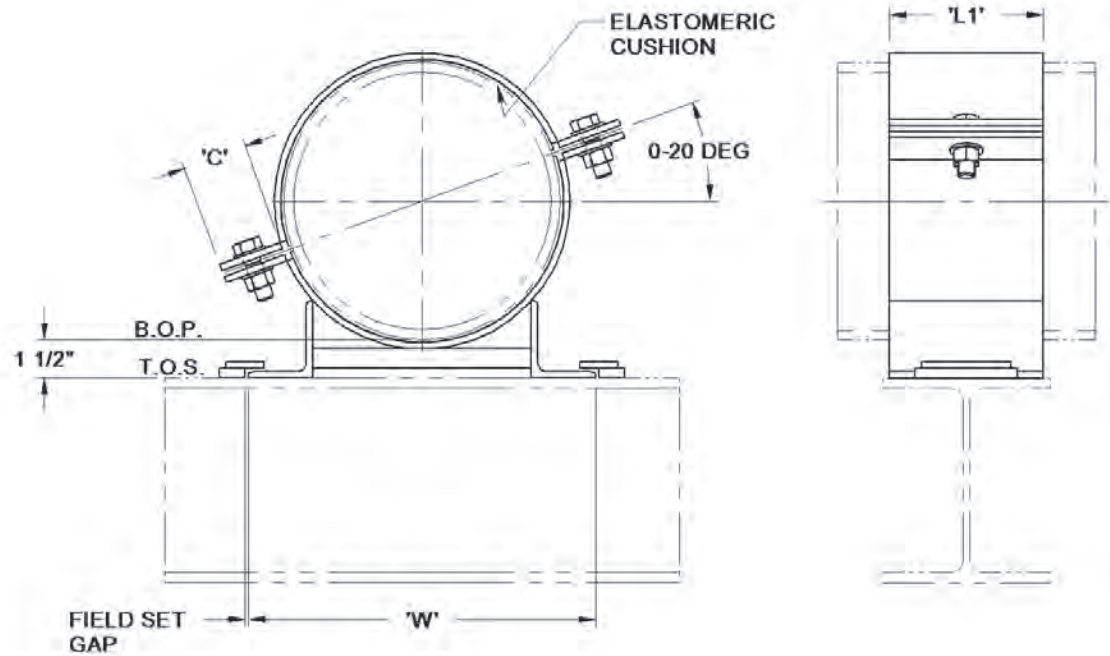
Notes:
Base width (W) must be fully supported as shown. Lower saddle rests on supporting structure. Dimensions are estimated based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]
				Vertical
1	1 1/2	3	4 3/8	150
1 1/2	1 1/2	3	4 1/2	200
2	1 1/2	3	5 3/4	300
3	1 1/2	3	6 1/4	430
4	1 1/2	3	7 5/8	530
6	2	4	10 5/8	1090
8	2	4	11 3/4	1440
10	2 1/2	5	16 1/8	2000

Pipe Supports

Figure P9: Base Guide
(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of axial movement and limiting lateral movement

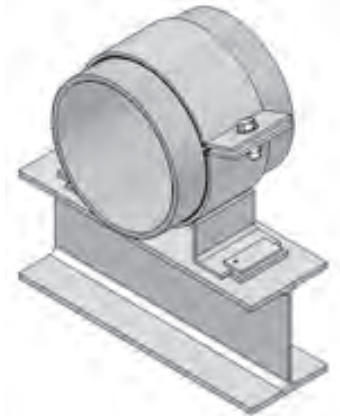
Material:

Carbon steel

See General Note 14, page 5.

Notes:

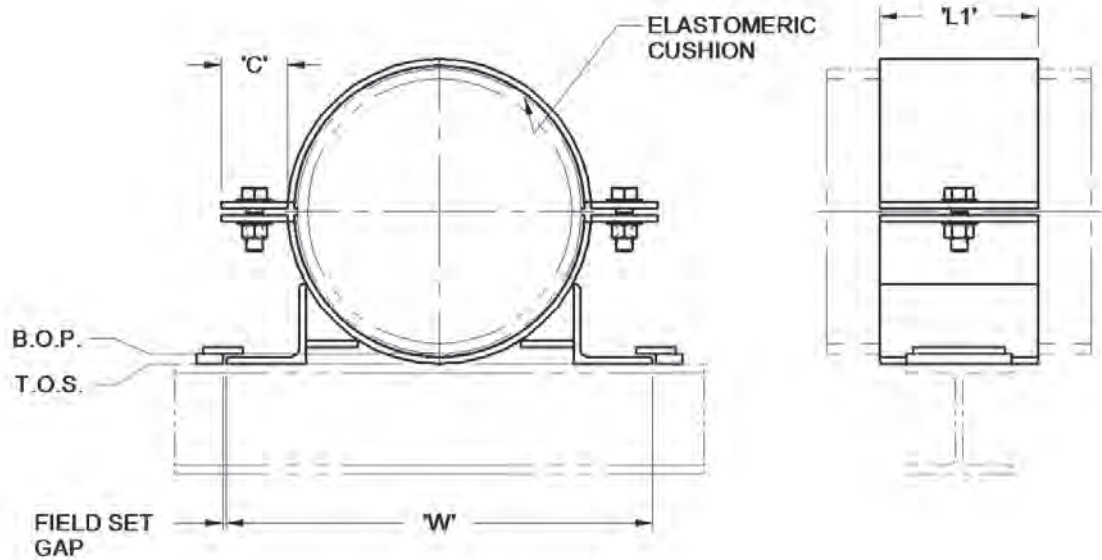
Type FB1 welded guide clips are provided with this style of support. Type FB2 bolted guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]	
				Lateral	Vertical
1	1 1/2	3	4 3/8	80	150
1 1/2	1 1/2	3	4 1/2	100	200
2	1 1/2	3	4 3/4	130	270
3	1 1/2	3	6 1/4	190	380
4	1 1/2	3	6 1/2	240	500
6	2	4	8 7/8	480	980
8	2	4	10 3/4	650	1280
10	2 1/2	5	13 1/2	800	2000

Pipe Supports

Figure P9L: Base Guide - Low Profile
(1"-10" Diameter)

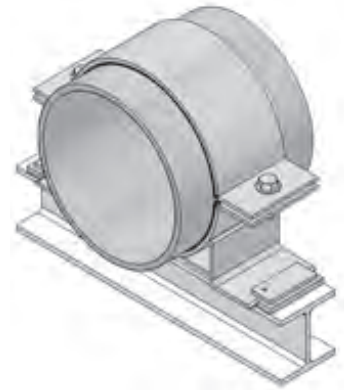


Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To support weight of pipe while allowing freedom of axial movement and limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

Notes:
Base width (W) must be fully supported as shown. Lower saddle rests on supporting structure. Type FB1 welded guide clips are provided with this style of support. Type FB2 bolted guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.

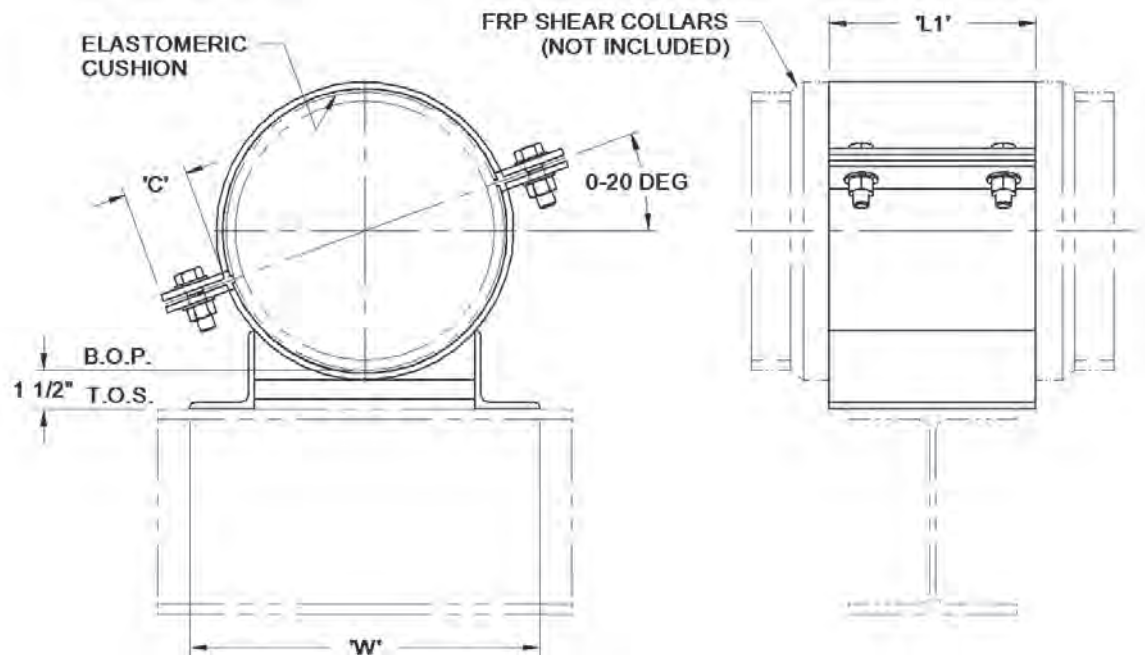


Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]	
				Lateral	Vertical
1	1 1/2	3	5 3/8	80	150
1 1/2	1 1/2	3	4 1/2	100	200
2	1 1/2	3	6 3/4	130	270
3	1 1/2	3	6 1/4	190	380
4	1 1/2	3	7 5/8	240	500
6	2	4	10 5/8	480	980
8	2	4	11 3/4	650	1280
10	2 1/2	5	16 1/8	800	2000

Pipe Supports

Figure P10: Base Anchor

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while restricting all movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

Support is provided with a base sized for a welded installation. A bolted installation is available upon request. Provide bolting arrangement with placement of order. If limiting axial displacement is required, request linstop clips type LS1 or LS2 with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.

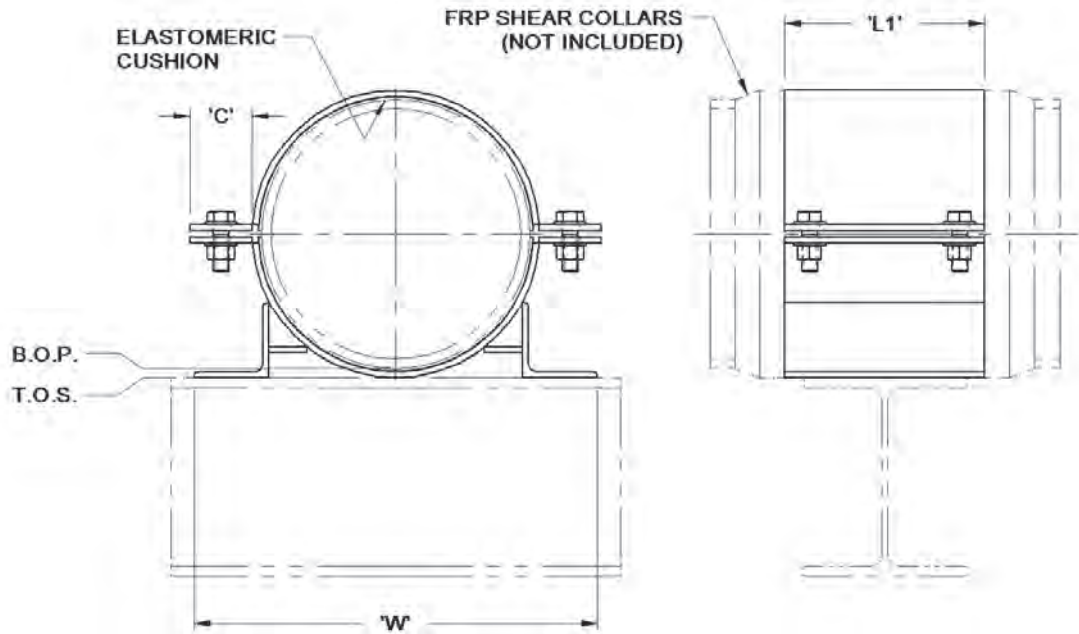


Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
1	1 1/2	3	4 3/8	80	150	350
1 1/2	1 1/2	3	4 1/2	100	200	450
2	1 1/2	3	4 3/4	130	270	650
3	1 1/2	3	6 1/4	190	380	800
4	1 1/2	4	6 1/2	340	660	1200
6	2	6	8 7/8	800	1400	2700
8	2	8	10 3/4	1100	2600	4200
10	2 1/2	8	13 1/2	1200	3300	5000

Pipe Supports

Figure P10L: Base Anchor - Low Profile

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while restricting all movement

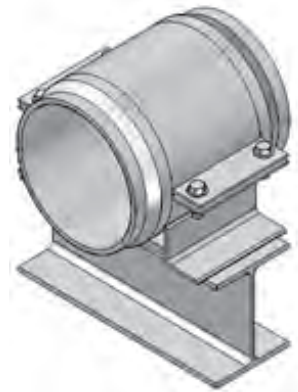
Material:

Carbon steel

See General Note 14, page 5.

Notes:

Base width (W) must be fully supported as shown. Lower saddle rests on supporting structure. Support is provided with a base sized for a welded installation. A bolted installation is available upon request. Provide bolting arrangement with placement of order. If limiting axial displacement is required, request linestop clips type LS1 or LS2 with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See General Notes, pages 5 and 6.

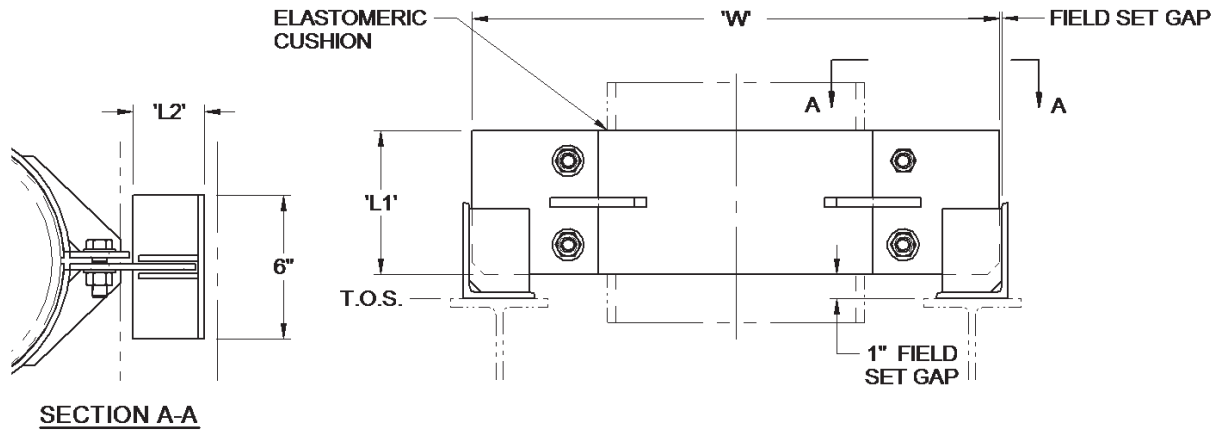


Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
1	1 1/2	3	4 3/8	80	150	350
1 1/2	1 1/2	3	4 1/2	100	200	450
2	1 1/2	3	5 3/4	130	270	650
3	1 1/2	3	6 1/4	190	380	800
4	1 1/2	4	7 5/8	340	660	1200
6	2	6	10 5/8	800	1400	2700
8	2	8	11 3/4	1100	2600	4200
10	2 1/2	8	16 1/8	1200	3300	5000

Pipe Supports

Figure P13: Riser Guide

(1"-20" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To allow axial movement while limiting lateral movement

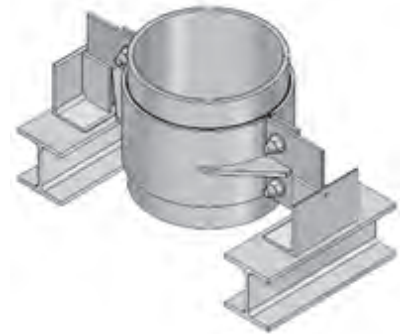
Material:

Carbon steel

See General Note 14, page 5.

Notes:

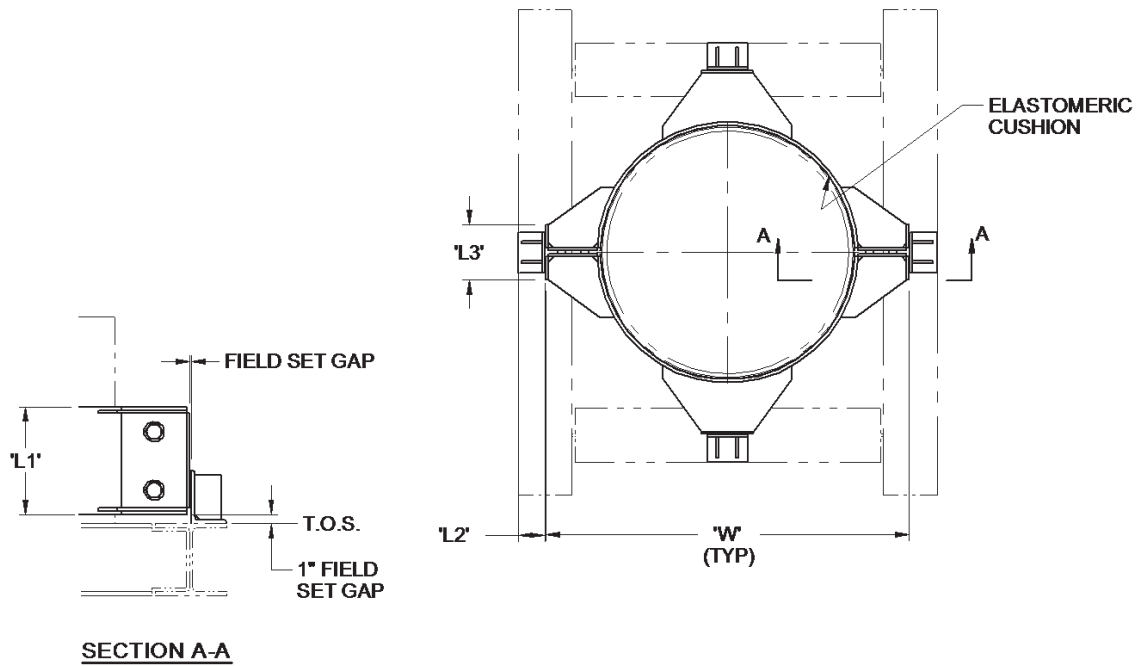
Not designed for vertical loads. Type RGC1 welded riser guide clips are provided with this style of support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 50 for sizes 24" – 60". See General Notes, page 3 and 4.



Pipe Size [in]	L1[in]	L2 [in]	W [in]	Allowable Loads [lb]
				Lateral
1	3	2	10 1/4	80
1 1/2	3	2	10 3/4	100
2	3	2	11 1/4	130
3	3	2	12 1/4	190
4	3	2	13 1/4	240
6	4	2	15 3/4	360
8	4	2	17 3/4	480
10	6	3	22	650
12	6	3	24 3/4	900
14	8	4	27	1500
16	8	4	29 1/2	1700
18	10	4	31 1/2	2300
20	10	4	34	2700

Pipe Supports

Figure P13: Riser Guide
(24"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To allow axial movement while limiting lateral movement

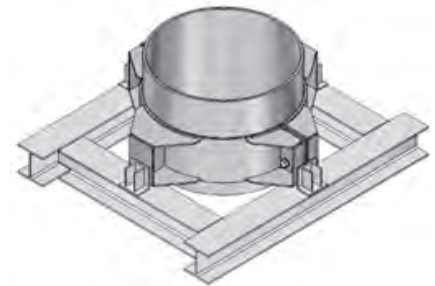
Material:

Carbon steel

See General Note 14, page 5.

Notes:

Not designed for vertical loads. Type RGC1 welded riser clips are provided with this style support. Type RGC2 bolted riser clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 49 for sizes 1" – 20". See General Notes, pages 5 and 6.

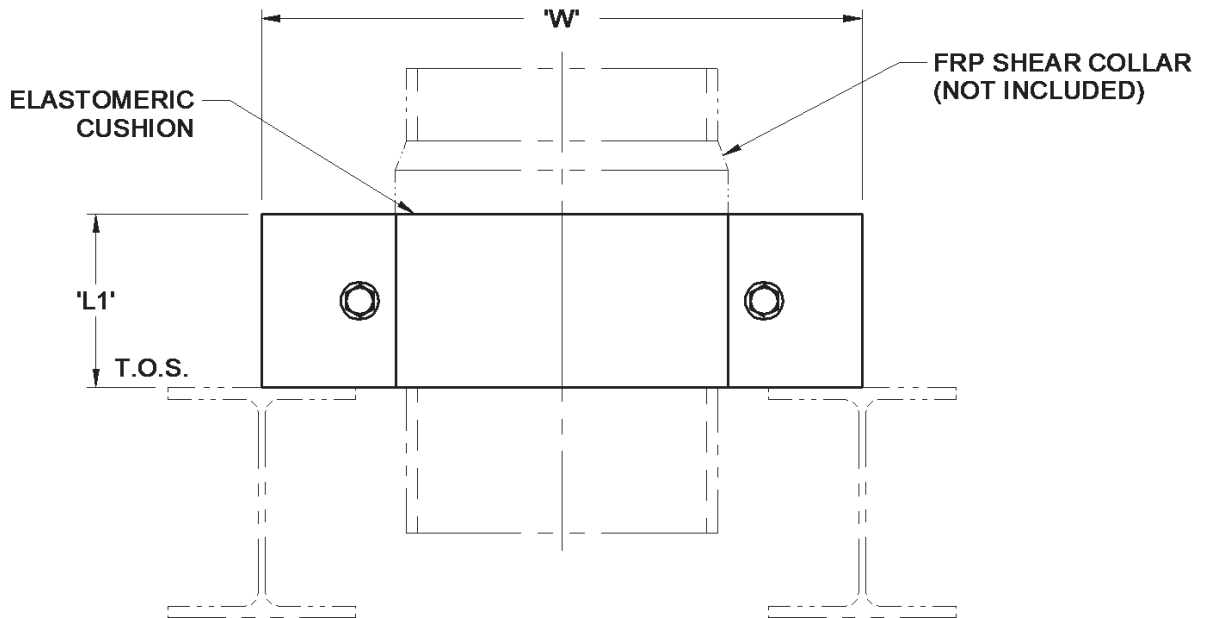


Pipe Size [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]
					Lateral
24	8	4	6	38	6000
30	10	6	6	44 1/2	9100
36	12	6	8	54 1/2	13000
42	14	6	10	61 3/8	17000
48	16	6	10	67 7/8	23000
54	18	8	12	73 3/4	29000
60	20	8	12	80	35000

Pipe Supports

Figure P14: Riser Support

(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of lateral movement

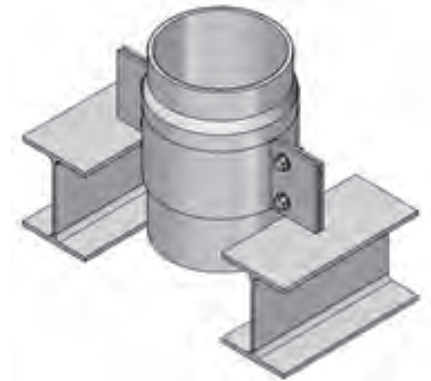
Material:

Carbon steel

See General Note 14, page 5.

Notes:

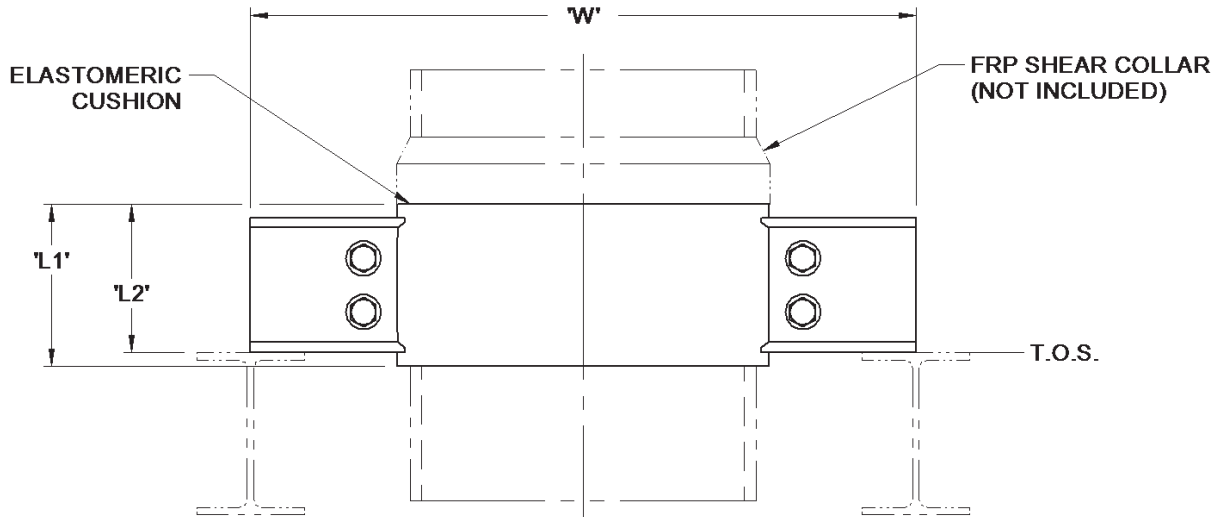
Not designed for lateral loading. Support width (W) is based on listed available loads. For a greater width, the support configuration may need to be adjusted to suit listed available loads. If a fixed anchor type support is required, provide loads for evaluation. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 52 for sizes 12" – 30". See page 53 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	W [in]	Allowable Loads [lb]
			Vertical
1	3	10 1/4	400
1 1/2	3	10 3/4	550
2	3	11 1/4	700
3	3	12 1/4	850
4	3	13 1/4	1200
6	4	15 3/4	1600
8	4	17 3/4	2000
10	6	20 3/4	2800

Pipe Supports

Figure P14: Riser Support
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of lateral movement

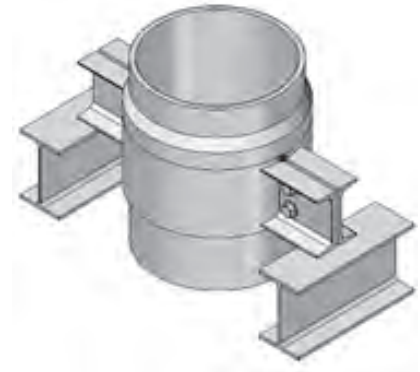
Material:

Carbon steel

See General Note 14, page 5.

Notes:

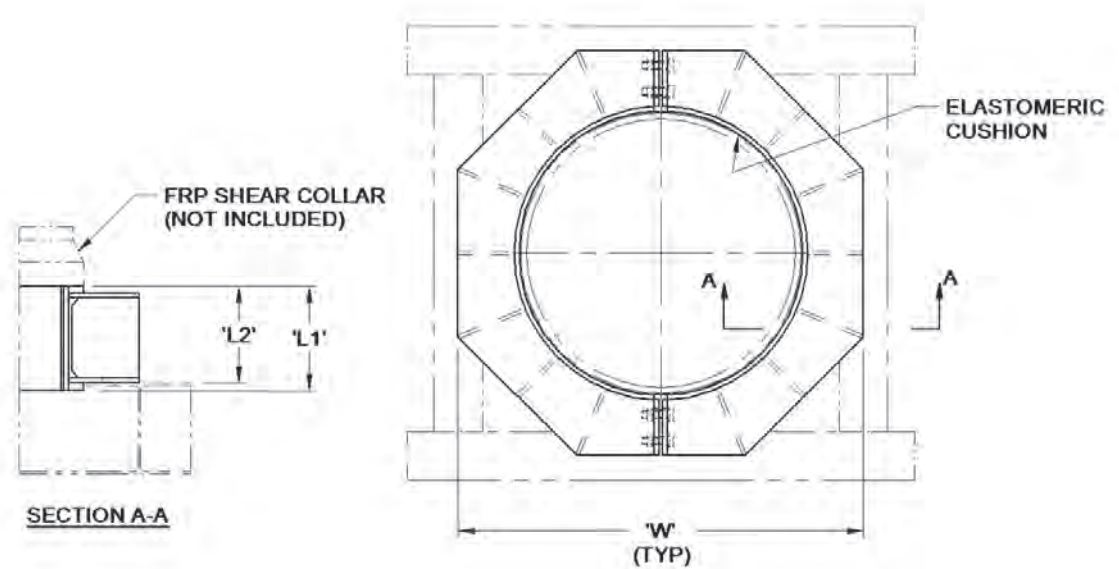
Not designed for lateral loading. Support width (W) is based on listed available loads. For a greater width, the support configuration may need to be adjusted to suit listed available loads. If a fixed anchor type support is required, provide loads for evaluation. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 51 for sizes 1" – 10". See page 53 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
				Vertical
12	6	5 1/2	24 3/4	3200
14	8	7 1/2	27	4000
16	9	8 1/2	29 1/2	4800
18	10	9 1/2	31 1/2	5900
20	12	11	34	7700
24	12	11	38	9500
30	12	11	44 1/2	13500

Pipe Supports

Figure P14: Riser Support
(36"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of lateral movement

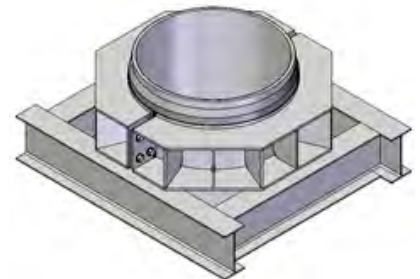
Material:

Carbon steel

See General Note 14, page 5.

Notes:

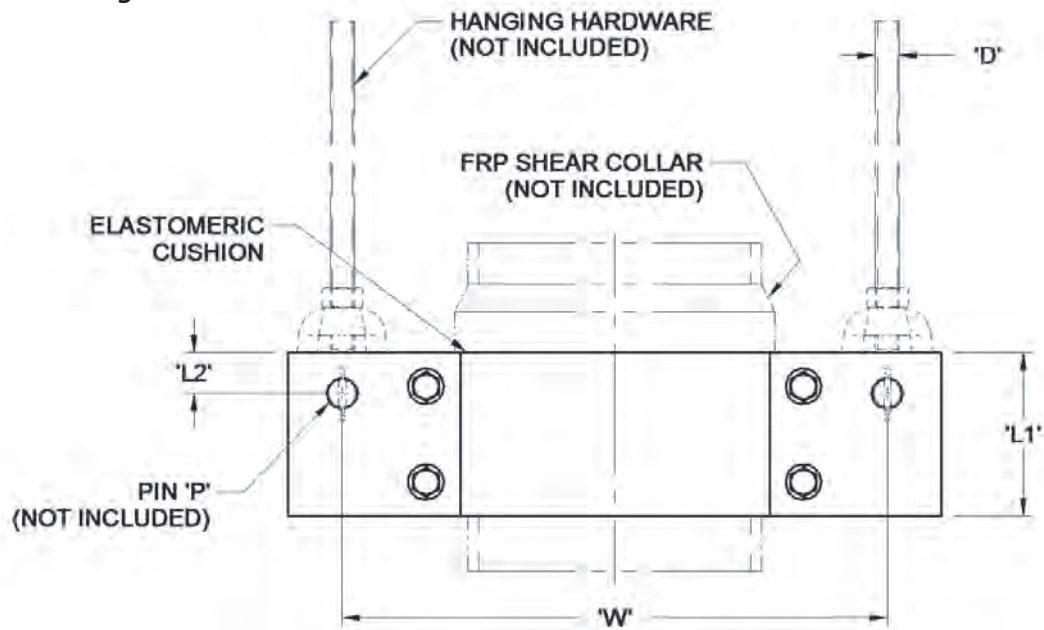
Not designed for lateral loading. Support width (W) is based on listed available loads. For a greater width, the support configuration may need to be adjusted to suit listed available loads. If a fixed anchor type support is required, provide loads for evaluation. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 51 for sizes 1" – 10". See page 52 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
				Lateral	Vertical
36	12	11	53	13000	32000
42	14	13	60	17000	45000
48	16	15	66 1/2	23000	58000
54	18	17	73 3/4	29000	72000
60	20	19	80	35000	85000

Pipe Supports

Figure P15: Double Rod Riser Hanger
(1"-10" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe from above while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

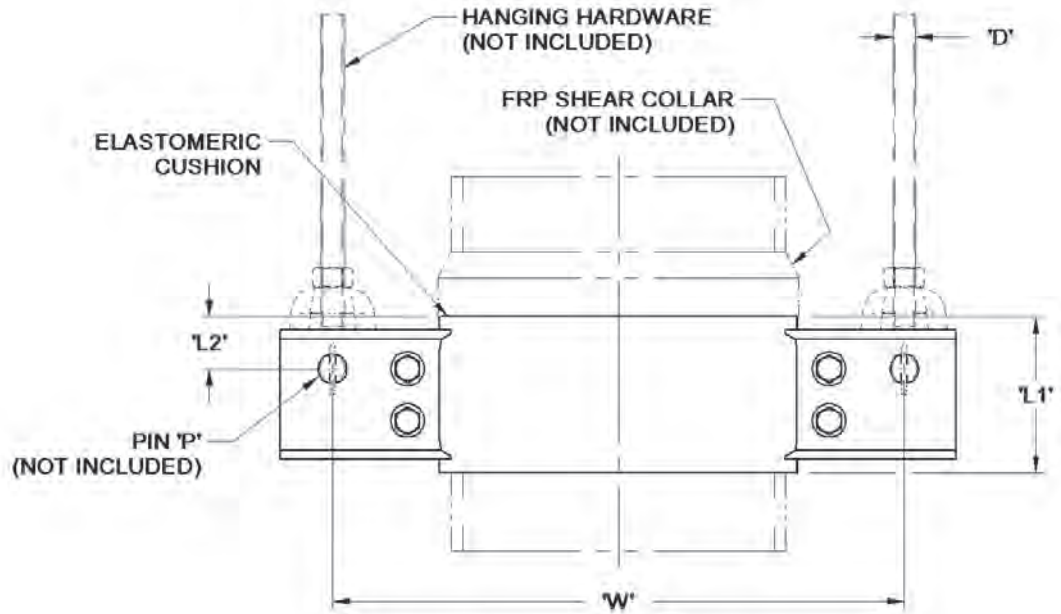
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See page 55 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	D [in]	L1 [in]	L2 [in]	P [in]	W [in]	Allowable Loads [lb]
						Vertical
1	3/8	3	1 1/2	1/2	9 1/2	400
1 1/2	3/8	3	1 1/2	1/2	10	550
2	3/8	3	1 1/2	1/2	10 1/2	700
3	1/2	3	1 1/2	5/8	11 1/2	850
4	5/8	3	1 1/2	3/4	12 1/2	1200
6	3/4	4	1 1/8	7/8	15	1600
8	3/4	4	1 1/8	7/8	17	2000
10	7/8	6	1 1/2	1	20	2800

Pipe Supports

Figure P15: Double Rod Riser Hanger
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe from above while allowing freedom of movement

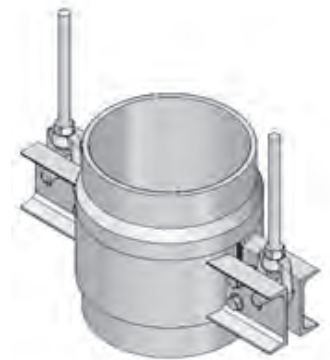
Material:

Carbon steel

See General Note 14, page 5.

Notes:

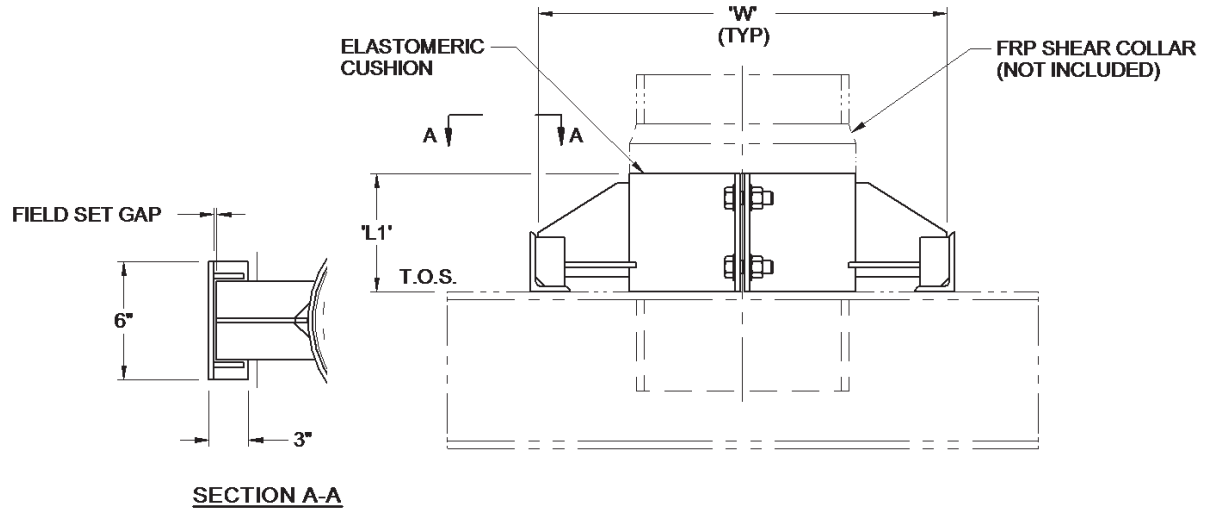
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See page 54 for sizes 1" – 10". See General Notes, pages 5 and 6.



Pipe Size [in]	D [in]	L1 [in]	L2 [in]	P [in]	W [in]	Allowable Loads [lb]
						Vertical
12	7/8	6	2	1	22	3200
14	1	8	2 1/4	1 1/8	24 1/2	4000
16	1	9	2 1/4	1 1/8	26 3/4	4800
18	1	10	2 1/4	1 1/8	28 3/4	5900
20	1 1/4	12	3	1 3/8	32 1/2	7700
24	1 1/4	12	3	1 3/8	36 1/2	9500
30	1 1/2	12	3	1 5/8	43	13500

Pipe Supports

Figure P16: Riser Support W/ Guides
(1"-10" Diameter)



Finish:

Hot-dipped galvanized
See General Note 15, page 5.

Service:

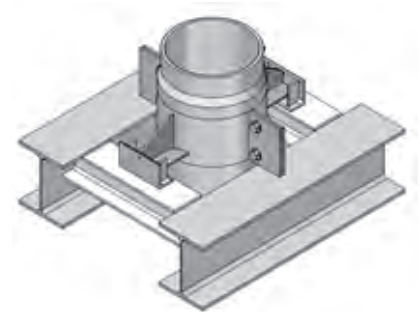
To support weight of pipe while limiting lateral movement

Material:

Carbon steel
See General Note 14, page 5.

Notes:

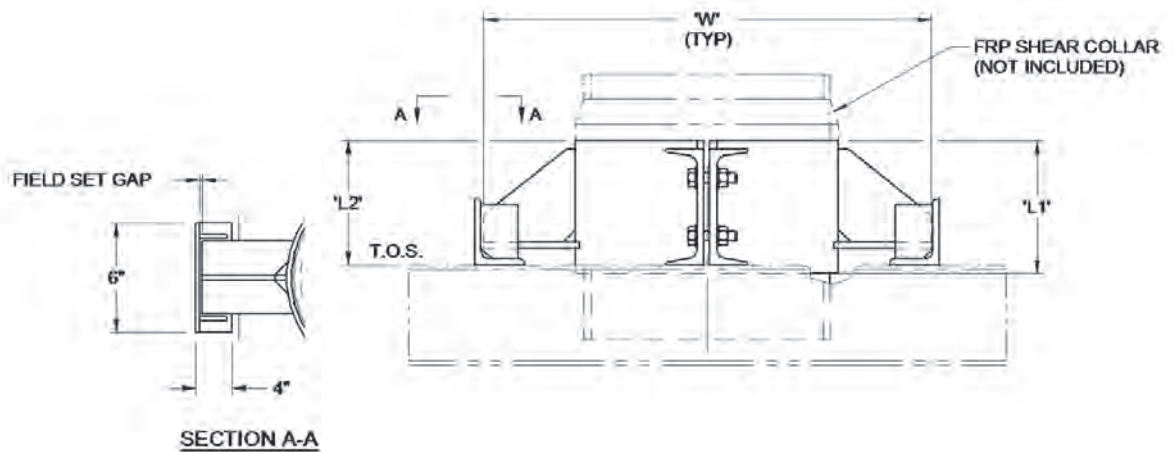
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded guide clips are provided with this style support. Type RGC2 bolted guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 57 for sizes 12" – 30". See page 58 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	W [in]	Allowable Loads [lb]	
			Lateral	Vertical
1	3	10 1/4	80	400
1 1/2	3	10 3/4	100	550
2	3	11 1/4	130	700
3	3	12 1/4	190	850
4	3	13 1/4	240	1200
6	4	15 3/4	360	1600
8	4	17 3/4	480	2000
10	6	20 3/4	650	2800

Pipe Supports

Figure P16: Riser Support W/ Guides
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while limiting lateral movement

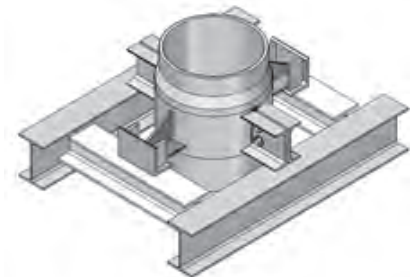
Material:

Carbon steel

See General Note 14, page 5.

Notes:

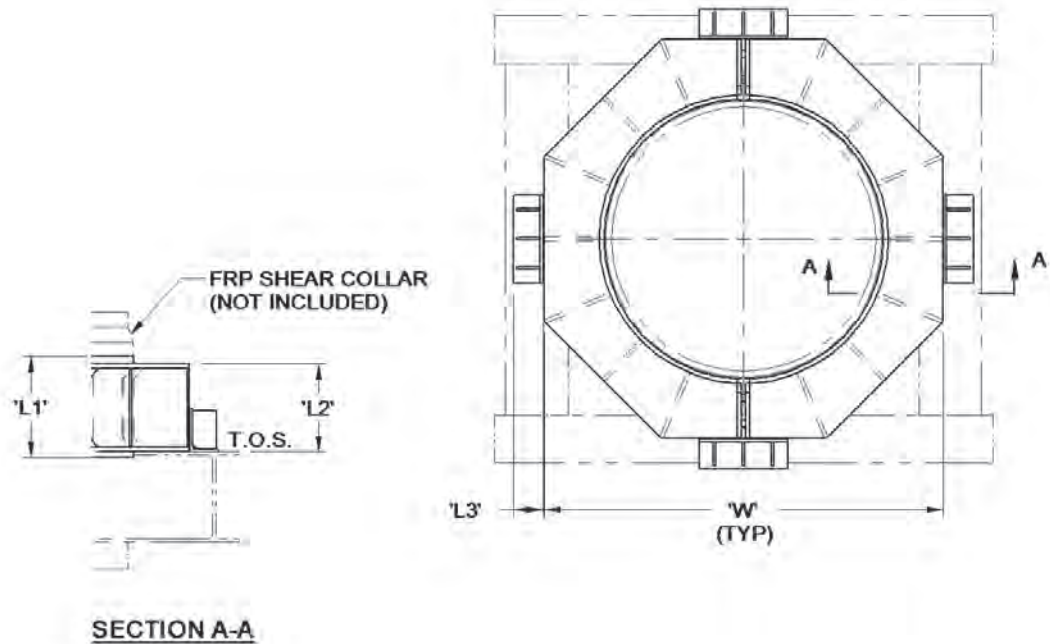
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded guide clips are provided with this style support. Type RGC2 bolted guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 56 for sizes 1" – 10". See page 58 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
				Lateral	Vertical
12	6	5 1/2	24 3/4	900	3200
14	8	7 1/2	27	1500	4000
16	9	8 1/2	29 1/2	1700	4800
18	10	9 1/2	31 1/2	2300	5900
20	12	11	34	2700	7700
24	12	11	38	3300	9500
30	12	11	44 1/2	4000	13500

Pipe Supports

Figure P16: Riser Support W/ Guides
(36"-60" Diameter)



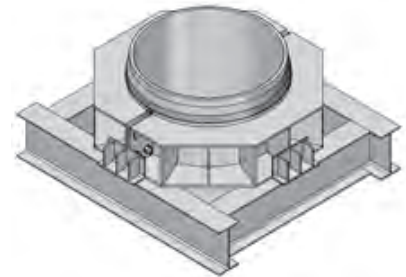
Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe while limiting lateral movement

Material:
Carbon steel

See General Note 14, page 5.

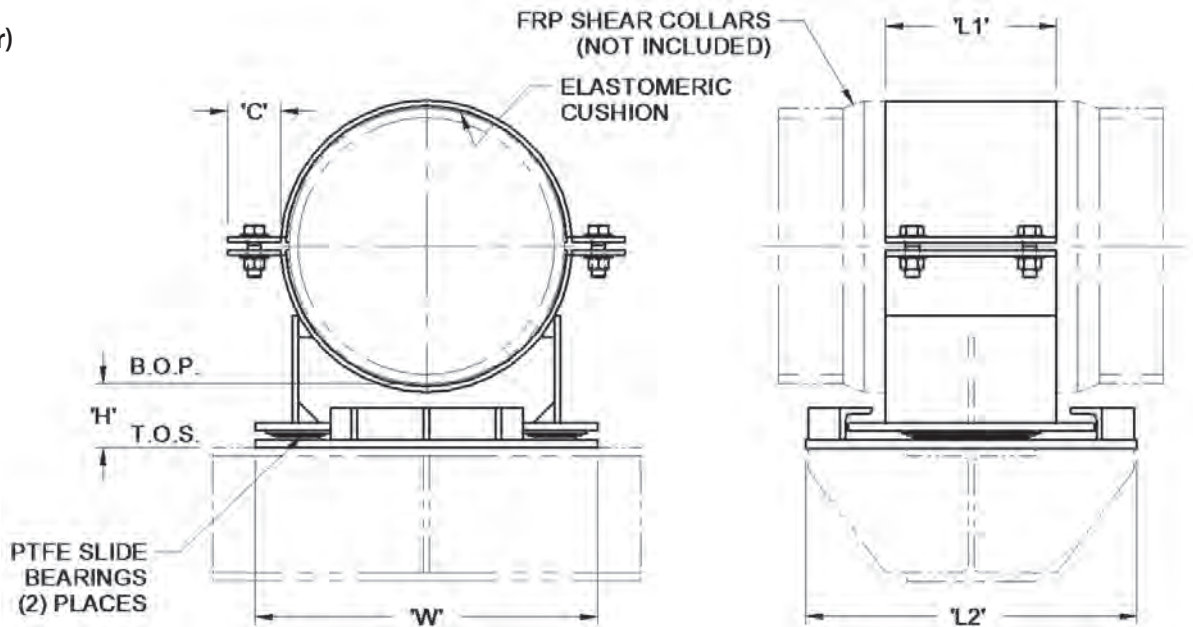
Notes:
Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded guide clips are provided with this style support. Type RGC2 bolted guide clips are available upon request, page 87. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 56 for sizes 1" – 10". See page 57 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
36	12	11	6	53	13000	32000
42	14	13	6	60	17000	45000
48	16	15	6	66 1/2	23000	58000
54	18	18	8	77 3/4	29000	72000
60	20	19	8	80	35000	85000

Pipe Supports

Figure P17: Base Linestop
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of lateral movement and limiting axial movement

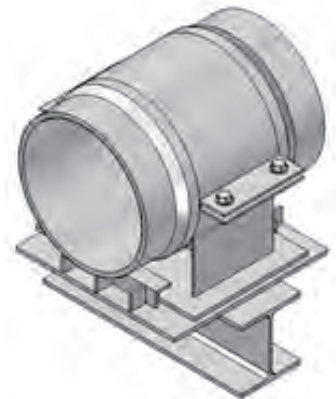
Material:

Carbon steel

See General Note 14, page 5.

Notes:

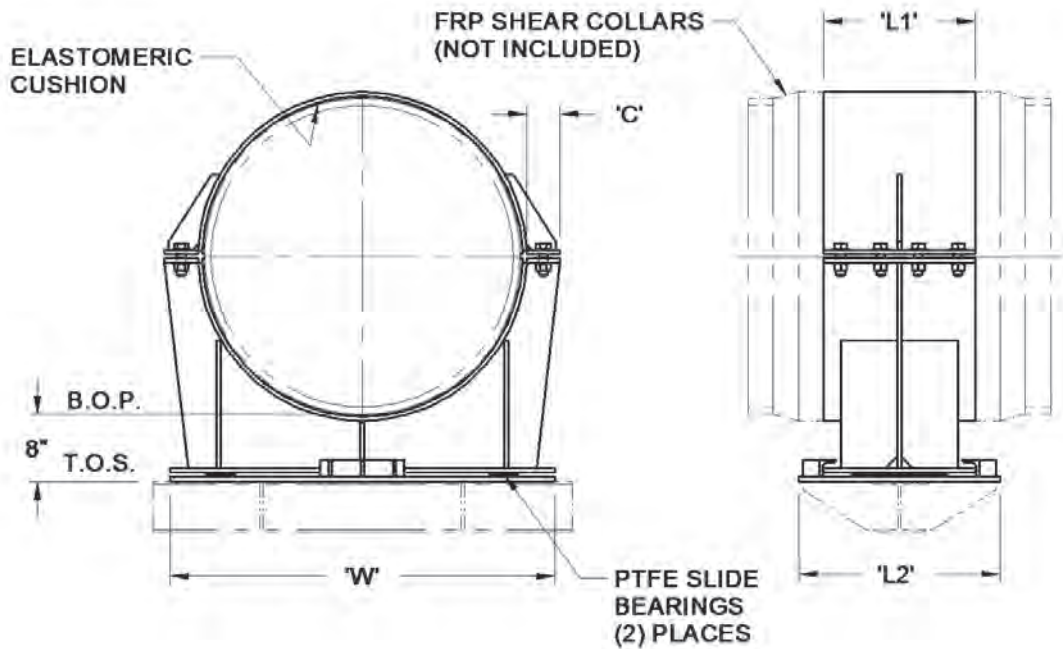
Base width (W) and length (L2) must be fully supported as shown. If axial and lateral displacements are to be limited, request optional base plate type BP4, page 86. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 60 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
						Vertical	Axial
12	2 1/2	3	8	15 1/2	16	3900	3500
14	2 1/2	3	10	17 1/2	18	5700	4000
16	2 1/2	3	12	19 1/2	20	7500	6000
18	3	3	14	21 1/2	21 3/4	10000	7000
20	3	3 1/4	14	21 1/2	24	11000	11000
24	3	3 1/4	18	25 1/2	27 3/8	16000	15000
30	3	4	20	30	32 3/4	18000	16000

Pipe Supports

Figure P17: Base Linestop
(36"-60" Diameter)



Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe while allowing freedom of lateral movement and limiting axial movement

Material:
Carbon steel
See General Note 14, page 5.

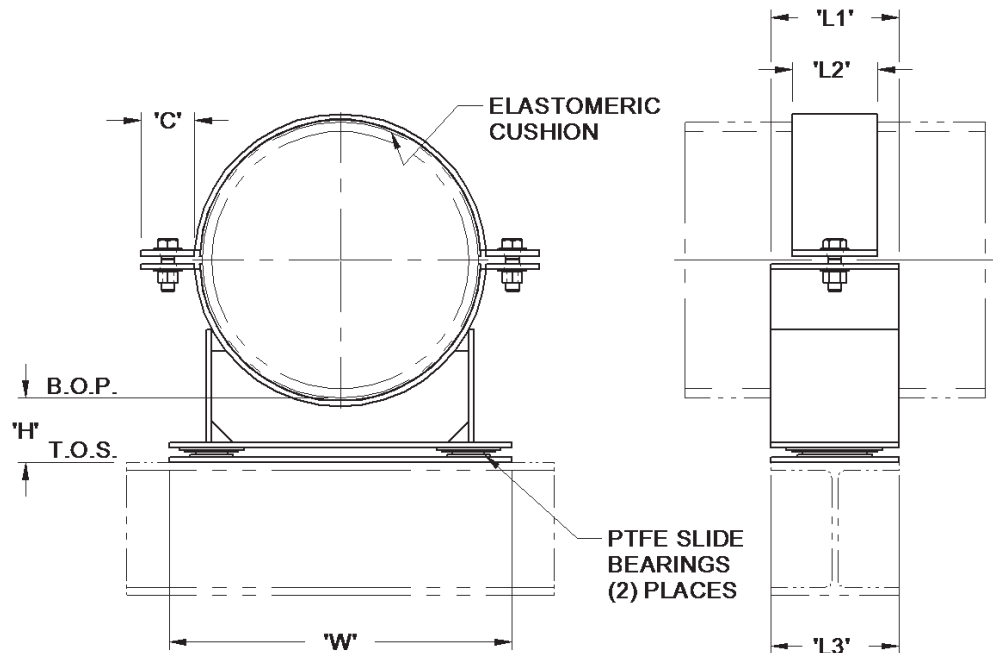
Notes:
Base width (W) and length (L2) must be fully supported as shown. If lateral displacements are to be limited, request optional base plate type BP4, page 86 and provide load requirements. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 59 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
36	4	24	30 1/2	40	21000	18000
42	4	26	32 1/2	47	30000	24000
48	4	28	34 1/2	53 1/4	39000	30000
54	4	30	37 1/4	57 3/4	48000	36000
60	4	32	39 1/4	63 1/4	56000	40000

Pipe Supports

Figure P18: Base Slide
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while allowing freedom of movement

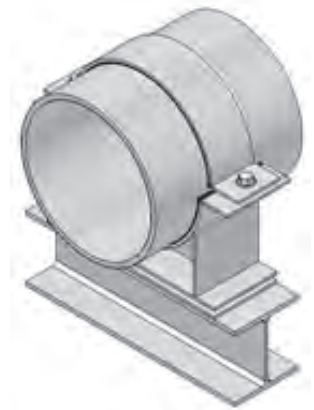
Material:

Carbon steel

See General Note 14, page 5.

Notes:

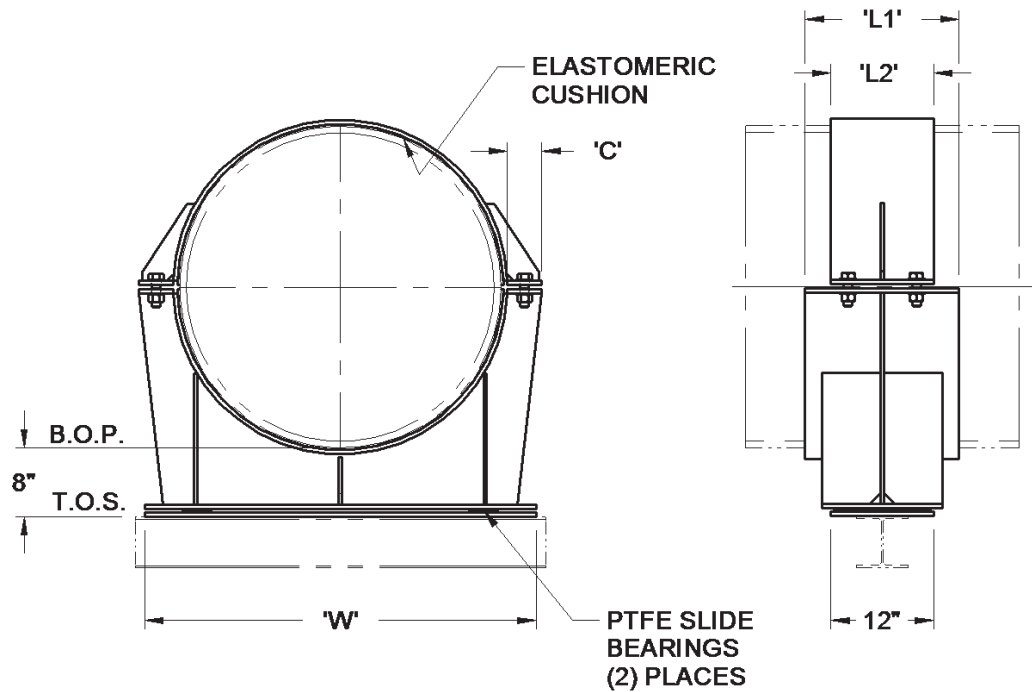
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 62 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	H [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]
							Vertical
12	2 1/2	3	6	4	6	16	3200
14	2 1/2	3	8	6	8	18	4950
16	2 1/2	3	8	6	8	20	5700
18	3	3	10	6	8	21 3/4	8000
20	3	3 1/4	10	6	8	24	8900
24	3	3 1/4	12	8	10	27 3/8	12600
30	3	4	15	10	12	32 3/4	15000

Pipe Supports

Figure P18: Base Slide
(36"-60" Diameter)



Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe while allowing freedom of movement

Material:
Carbon steel
See General Note 14, page 5.

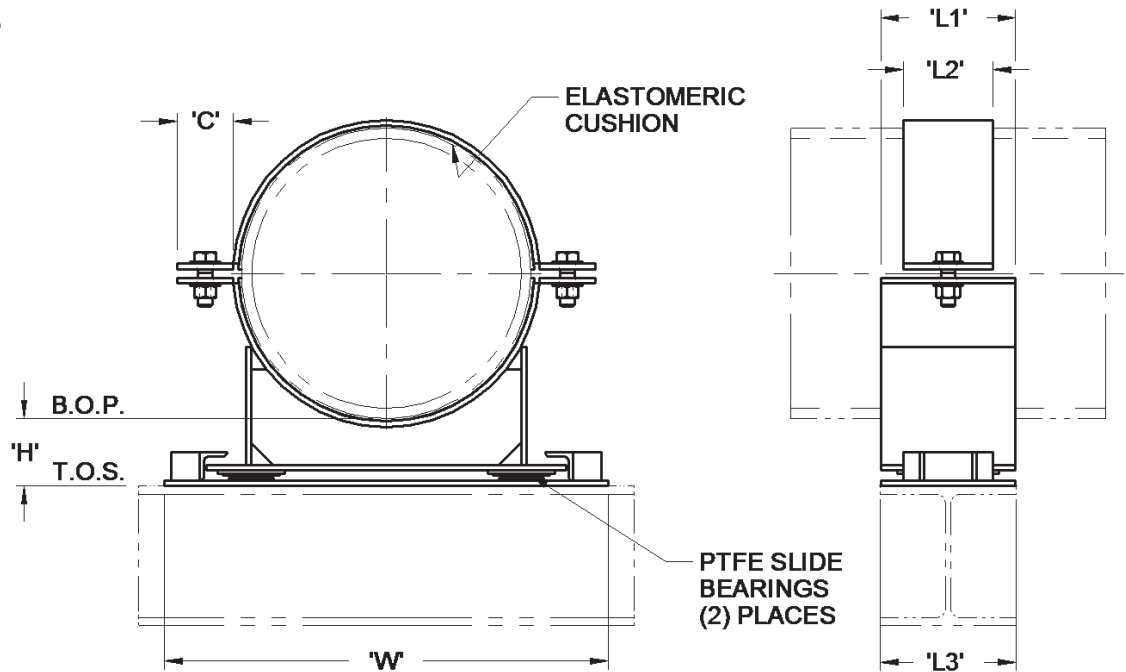
Notes:
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 61 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
36	4	18	12	40	21000
42	4	21	14	47	30000
48	4	24	16	53 1/4	39000
54	4	27	18	57 3/4	48000
60	4	30	20	63 1/4	56000

Pipe Supports

Figure P19: Base Guide
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while limiting lateral movement

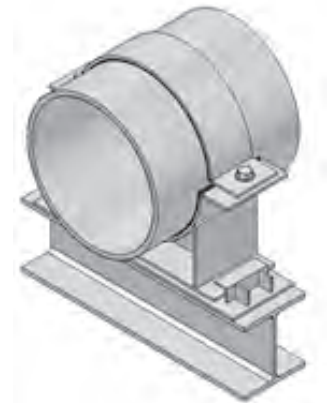
Material:

Carbon steel

See General Note 14, page 5.

Notes:

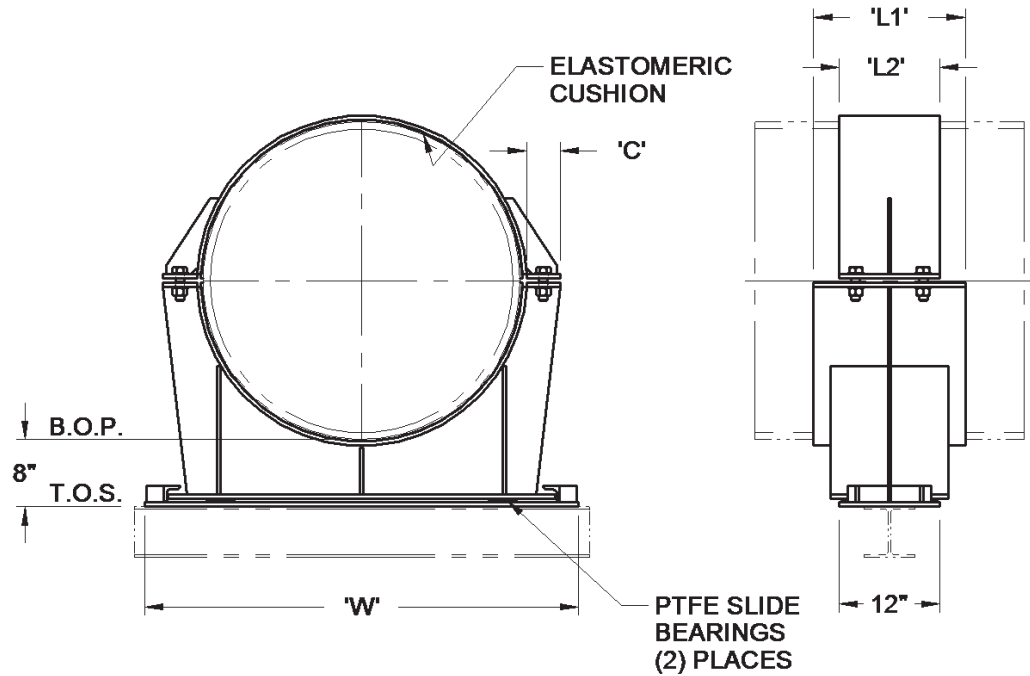
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 64 for sizes 36" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	H [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]	
							Lateral	Vertical
12	2 1/2	3	6	4	6	19 3/4	900	3000
14	2 1/2	3	8	6	8	21 3/4	1500	4600
16	2 1/2	3	8	6	8	23 3/4	1700	5400
18	3	3	10	6	8	25 1/2	2300	7500
20	3	3 1/4	10	6	8	27 3/4	2700	8200
24	3	3 1/4	12	8	10	31 1/8	5200	11000
30	3	4	15	10	12	38	7500	15000

Pipe Supports

Figure P19: Base Guide
(36"-60" Diameter)



Finish:
Painted
See General Note 15, page 5.

Service:
To support weight of pipe while limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

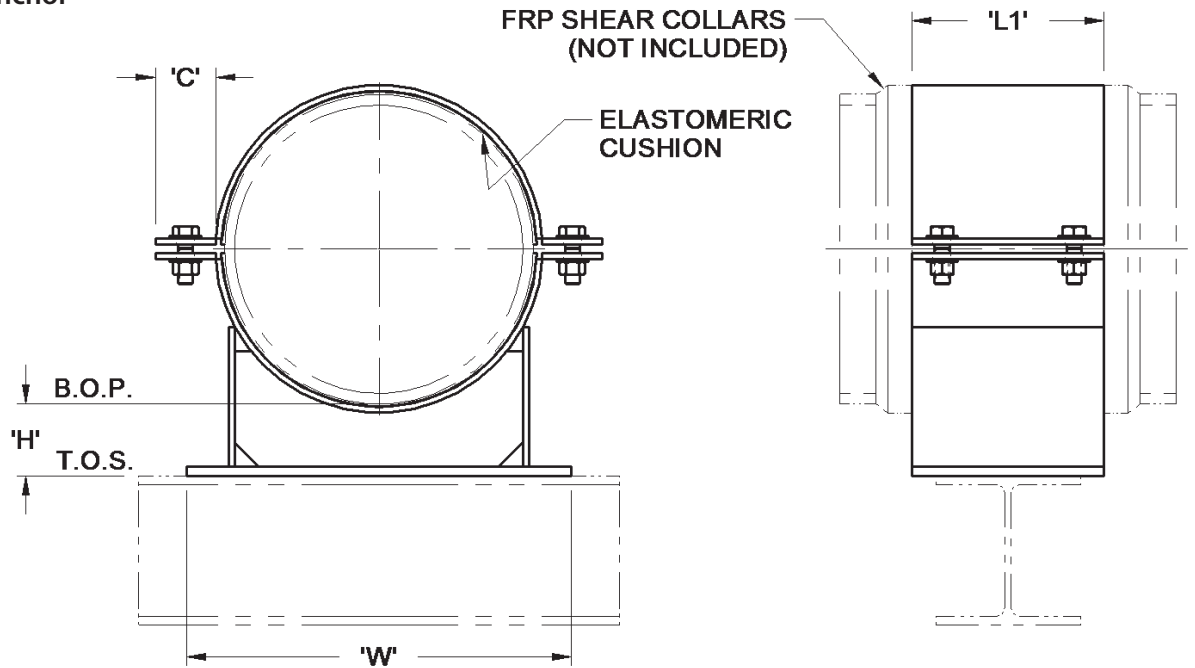
Notes:
Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended for pipe sizes above 10" NPS. See page 63 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
36	4	18	12	47	14000	21000
42	4	21	14	53 1/2	19000	30000
48	4	24	16	60	25000	39000
54	4	27	18	66	31000	48000
60	4	30	20	71 1/2	37000	56000

Pipe Supports

Figure P20: Base Anchor
(12"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe while restricting all movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

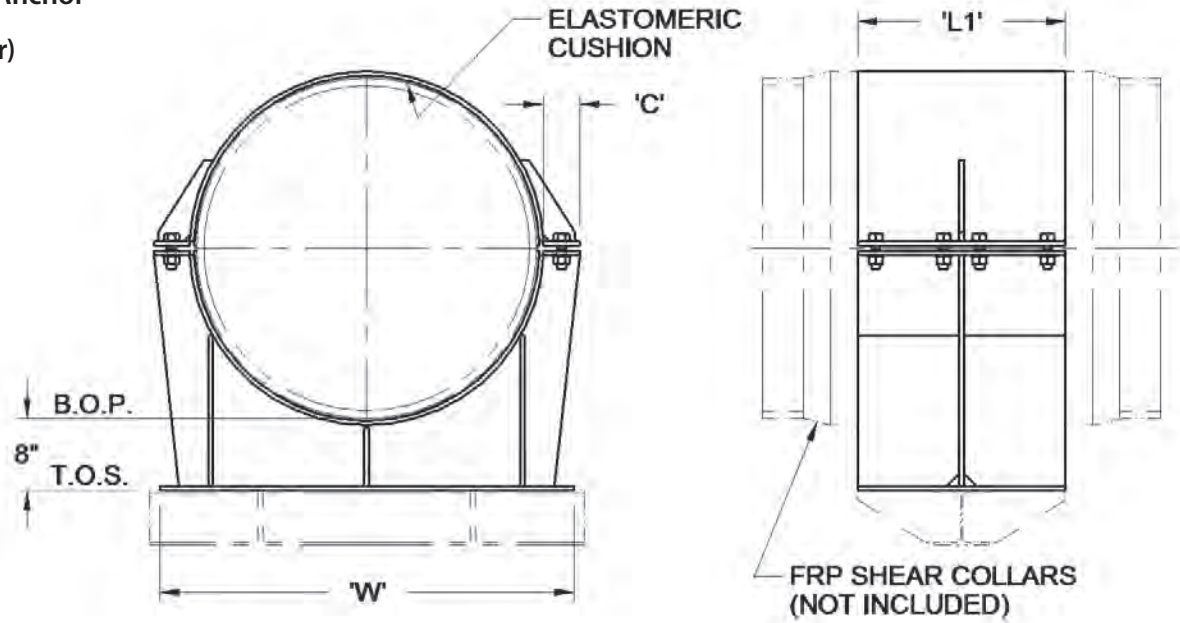
Base width (W) must be fully supported as shown. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 66 for sizes 36" – 60". See General Notes, page 5 and 6.



Pipe Size [in]	C [in]	H [in]	L1 [in]	W [in]	Allowable Loads [lb]		
					Lateral	Vertical	Axial
12	2 1/2	3	8	16	1600	3900	3500
14	2 1/2	3	10	18	2300	5700	4000
16	2 1/2	3	12	20	3500	7500	6000
18	3	3	14	21 3/4	4500	10000	7000
20	3	3 1/4	14	24	5500	11000	11000
24	3	3 1/4	18	27 3/8	8000	16000	15000
30	3	4	20	32 3/4	9000	18000	16000

Pipe Supports

Figure P20: Base Anchor
(36"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe while restricting all movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

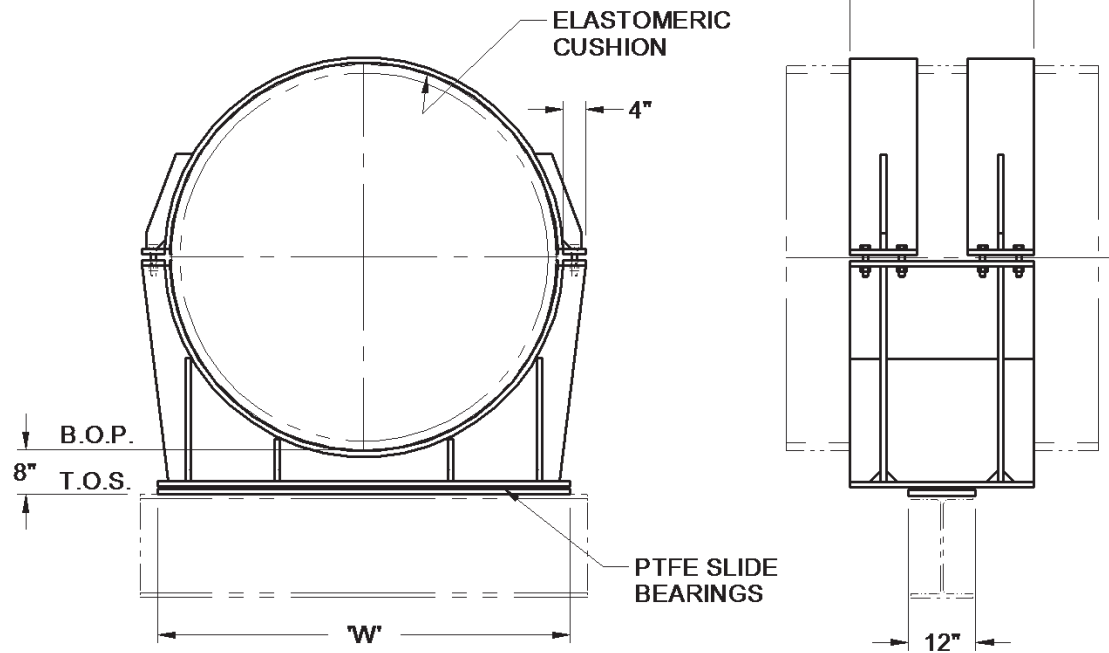
Base width (W) must be fully supported as shown. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions are based on typical 150 PSI rated pipe and may vary depending on the actual O.D. and load requirements. See page 65 for sizes 12" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
36	4	24	40	10000	21000	21000
42	4	26	47	15000	30000	30000
48	4	28	53 1/4	19000	39000	39000
54	4	30	57 3/4	24000	48000	45000
60	4	32	63 1/4	32000	56000	50000

Pipe Supports

Figure XL12: Extra Large Slide
(66"-108" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe or duct while allowing freedom of movement

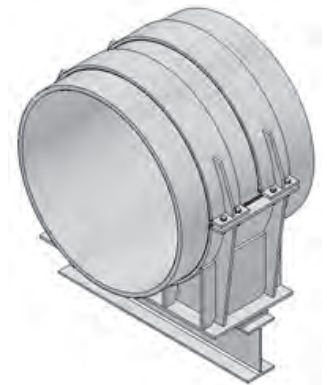
Material:

Carbon steel

See General Note 14, page 5.

Notes:

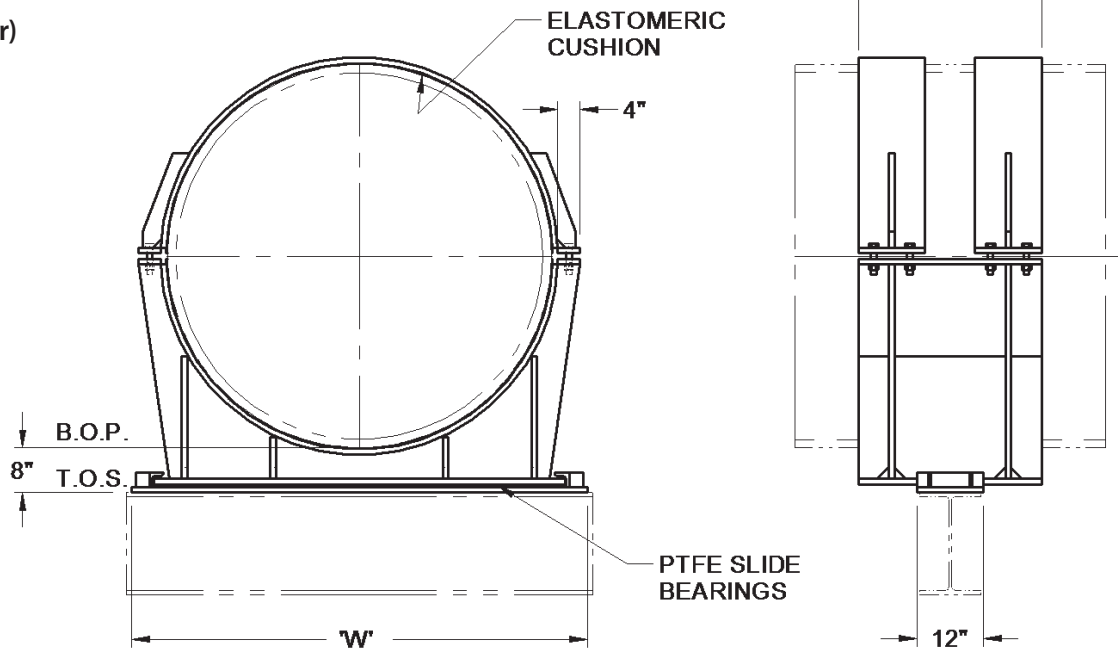
Large diameter pipe supports are engineered to suit project requirements. Contact us for further information and how to order. Base width (W) must be fully supported as shown. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. PTFE slide bearings are recommended. Where increase friction is desirable, the base plate and bearing(s) may be eliminated. Dimensions may vary depending on actual pipe O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	W [in]
66	33	74
72	36	80
78	39	90
84	42	92
90	45	98
96	48	104
102	48	110
108	48	116

Pipe Supports

Figure XL13: Extra Large Slide
(66"-108" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe or duct while allowing freedom of axial movement and limiting lateral movement

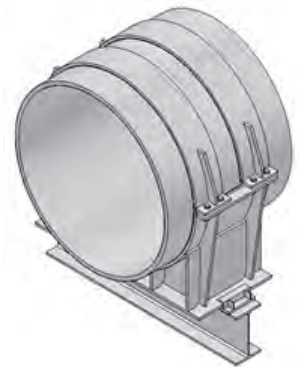
Material:

Carbon steel

See General Note 14, page 5.

Notes:

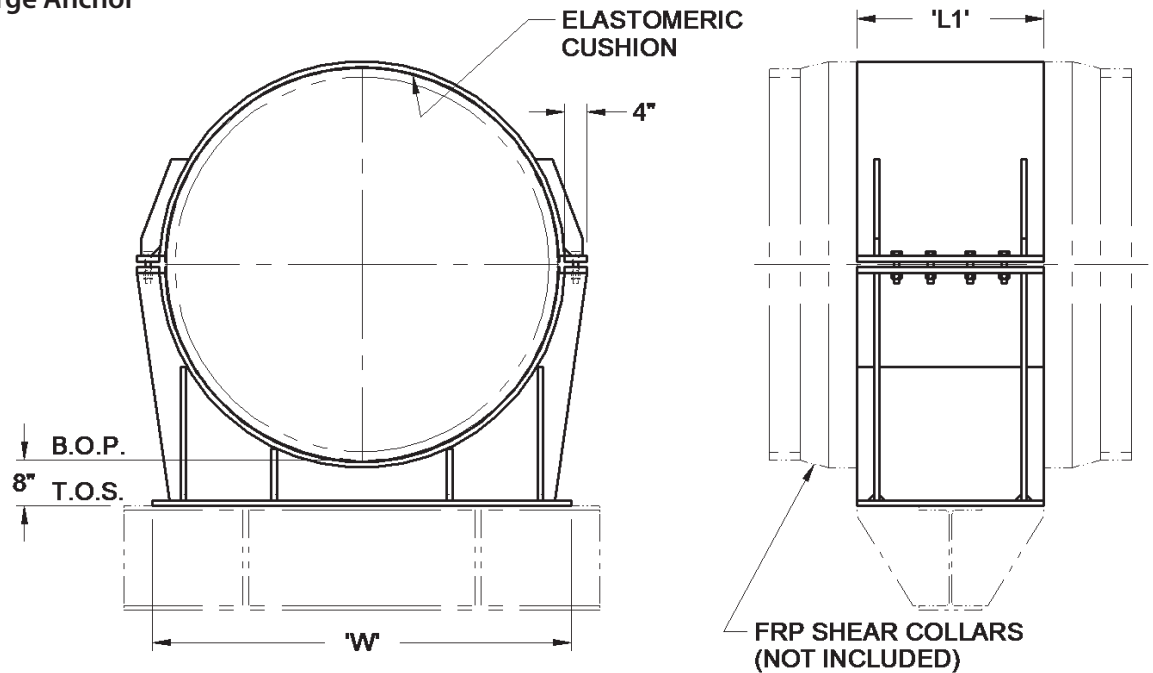
Large diameter pipe supports are engineered to suit project requirements. Contact us for further information and how to order. Base width (W) must be fully supported as shown. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. PTFE slide bearings are recommended. Where increase friction is desirable, the base plate and bearing(s) may be eliminated. Dimensions may vary depending on actual pipe O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	W [in]
66	33	80
72	36	86
78	39	96
84	42	98
90	45	104
96	48	110
102	48	116
108	48	122

Pipe Supports

Figure XL14: Extra Large Anchor
(66"-108" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of pipe or duct while restricting all movement

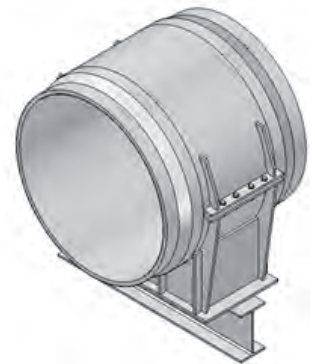
Material:

Carbon steel

See General Note 14, page 5.

Notes:

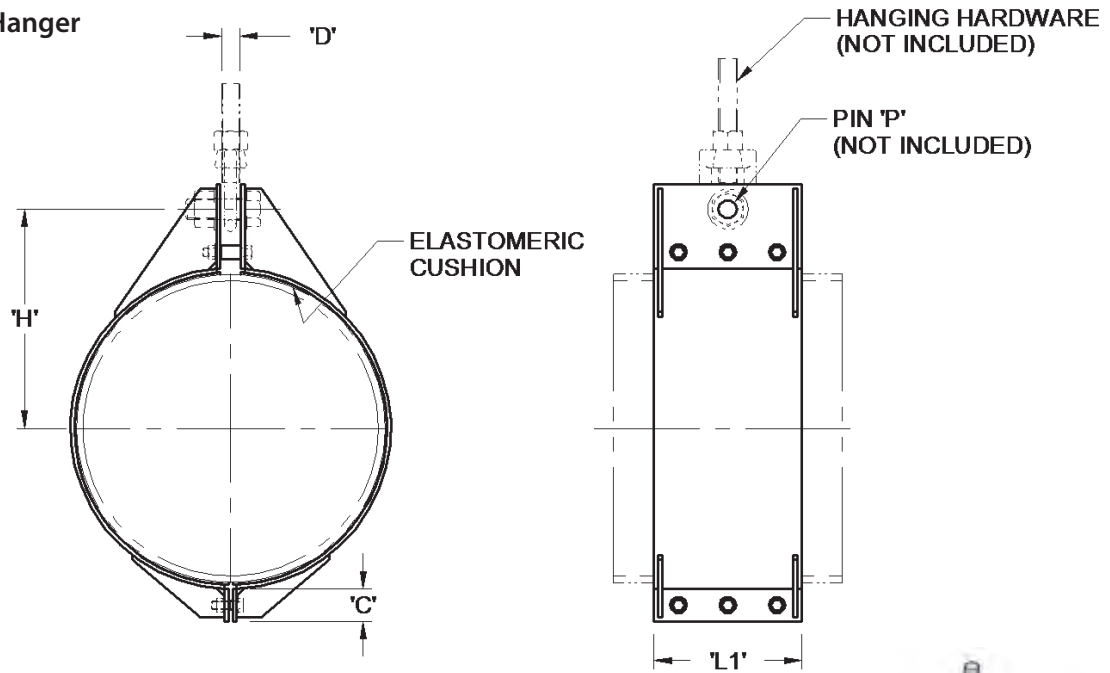
Large diameter pipe supports are engineered to suit project requirements. Contact us for further information and how to order. Base width (W) must be fully supported as shown. Support is provided with a base plate for welded installations. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on actual pipe O.D. and load requirements. See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	W [in]
66	33	74
72	36	80
78	39	90
84	42	92
90	45	98
96	48	104
102	48	110
108	48	116

Duct Supports

Figure D1: Duct Clamp Hanger
(20"-60" Diameter)



Finish:

20" – 30": Hot-dipped galvanized

36" – 60": Painted

See General Note 15, page 5.

Service:

To support weight of duct from above while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

Dimensions may vary depending on the actual O.D. and load requirements. Hanging hardware is available upon request. See General Notes, pages 5 and 6.

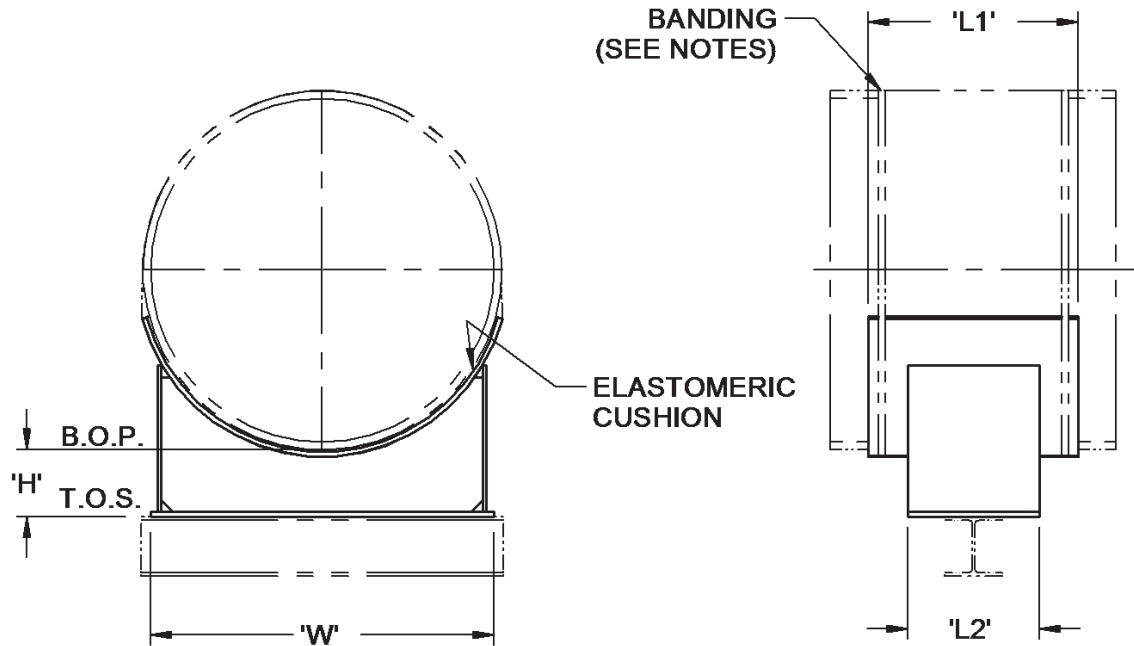


Pipe Size [in]	C [in]	D [in]	H [in]	L1 [in]	P [in]	Allowable Loads [lb]
						Vertical
20	2 1/2	1/2	15 3/4	6	5/8	900
24	2 1/2	1/2	18 3/16	6	5/8	1200
30	2 1/2	5/8	22	8	3/4	1750
36	2 1/2	3/4	26	10	7/8	2400
42	3	7/8	30 3/8	10	1	3750
48	3	1	35 1/4	12	1 1/8	4750
54	3	1 1/4	37 3/16	16	1 3/8	6000
60	3	1 1/4	40 1/4	16	1 3/8	7500

Pipe Supports

Figure D3: Duct Cradle Base Slide

(20"-60" Diameter)



Finish:

20" – 30": Hot-dipped galvanized

36" – 60": Painted

See General Note 15, page 5.

Service:

To support weight of duct while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

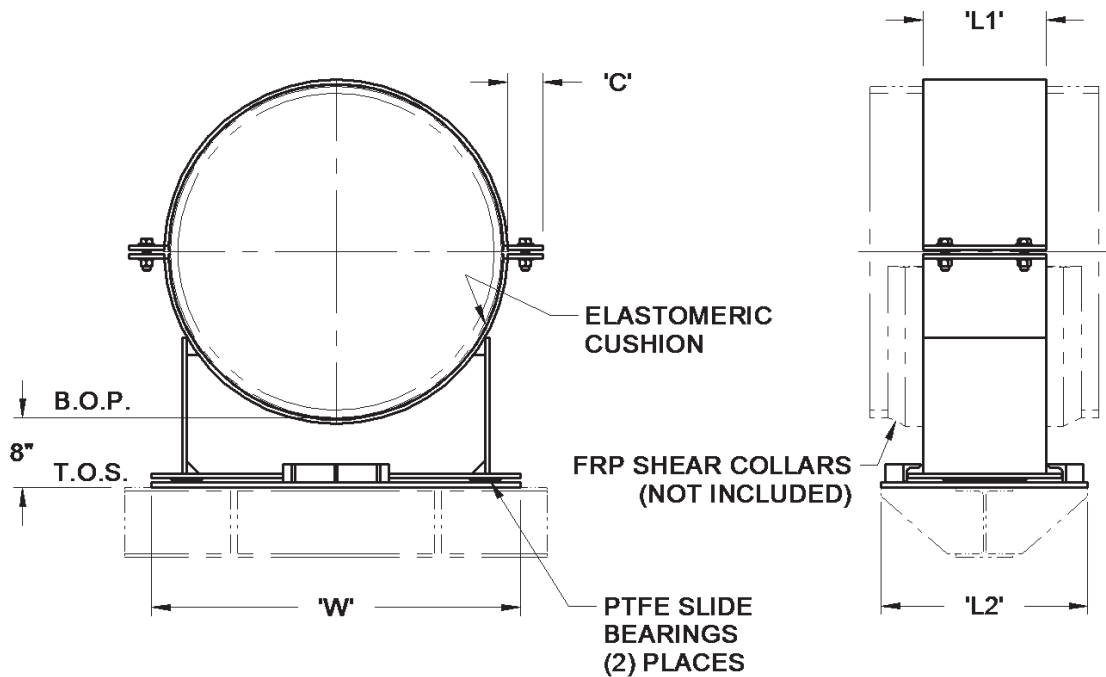
Not designed for lateral or axial loads. Base width (W) must be fully supported as shown. Dimensions may vary depending on the actual O.D. and load requirements. Banding can be provided (in bulk) upon request. See General Note 26, page 6.



Pipe Size [in]	H [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
20	7	10	6	21	450
24	7	10	6	25	600
30	8	10	6	30	875
36	8	10	6	36	1200
42	8	12	8	42	1875
48	8	12	8	48	2375
54	8	16	12	54	3000
60	8	16	12	60	3750

Pipe Supports

Figure D4: Duct Base Linestop
(20"-36" Diameter)



Finish:

20" – 30": Hot-dipped galvanized

36": Painted

See General Note 15, page 5.

Service:

To support weight of duct while allowing freedom of lateral movement and limiting axial movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

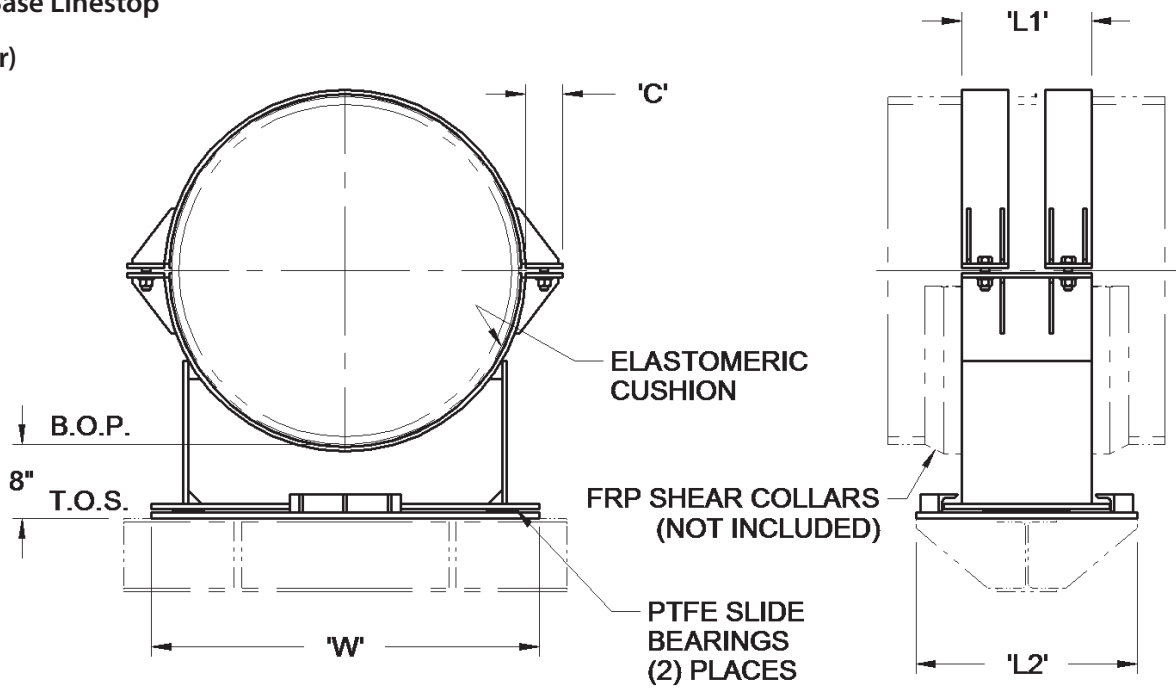
Base width (W) and length (L2) must be fully supported as shown. If lateral displacements are to be limited, request optional base plate type BP4, page 86 and provide loads for evaluation. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 73 for sizes 42" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
20	2 1/2	8	15 1/2	24	900	1800
24	2 1/2	8	15 1/2	27 3/8	1200	2100
30	2 1/2	10	20	31 3/4	1750	3000
36	2 1/2	12	22	36	2400	4200

Pipe Supports

Figure D4: Duct Base Linestop
(42"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of duct while allowing freedom of lateral movement and limiting axial movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

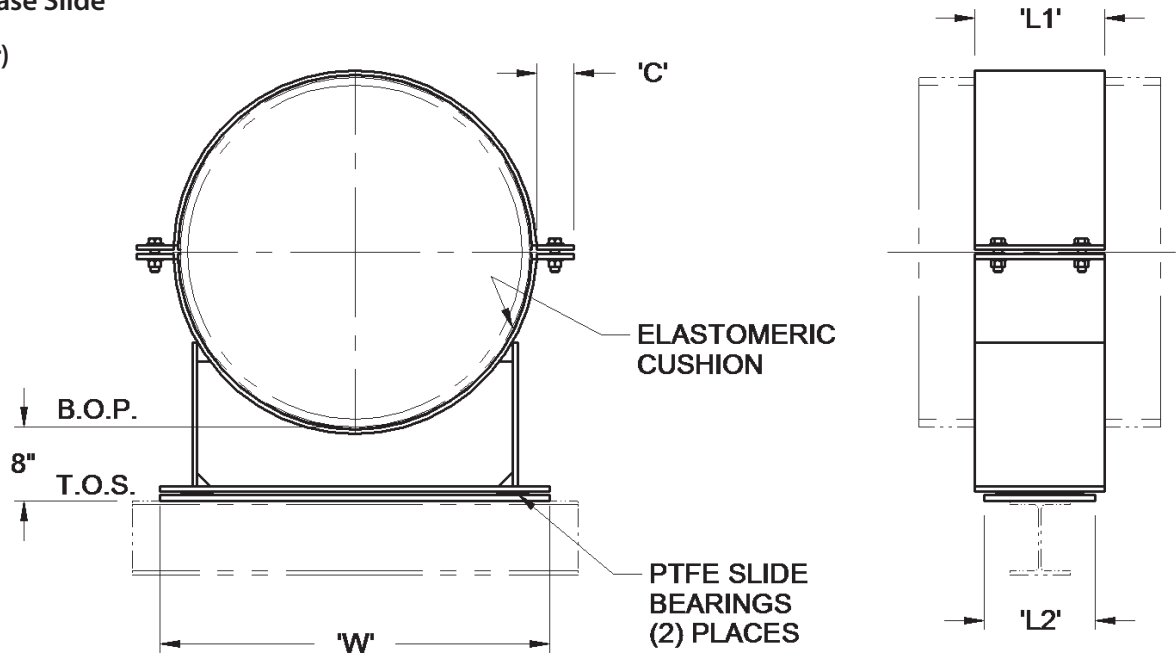
Base width (W) and length (L2) must be fully supported as shown. If lateral displacements are to be limited, request optional base plate type BP4, page 86 and provide loads for evaluation. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 72 for sizes 20" – 36". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Vertical	Axial
42	3	14	24 1/2	43	3750	6000
48	3	16	26 1/2	49 1/4	4750	7500
54	3	18	29 1/4	53 3/4	6000	9000
60	3	20	31 1/4	59 1/4	7500	12000

Pipe Supports

Figure D5: Duct Base Slide
(20"-36" Diameter)



Finish:
20" – 30": Hot-dipped galvanized
36": Painted
See General Note 15, page 5.

Service:
To support weight of duct while allowing freedom of movement

Material:
Carbon steel
See General Note 14, page 5.

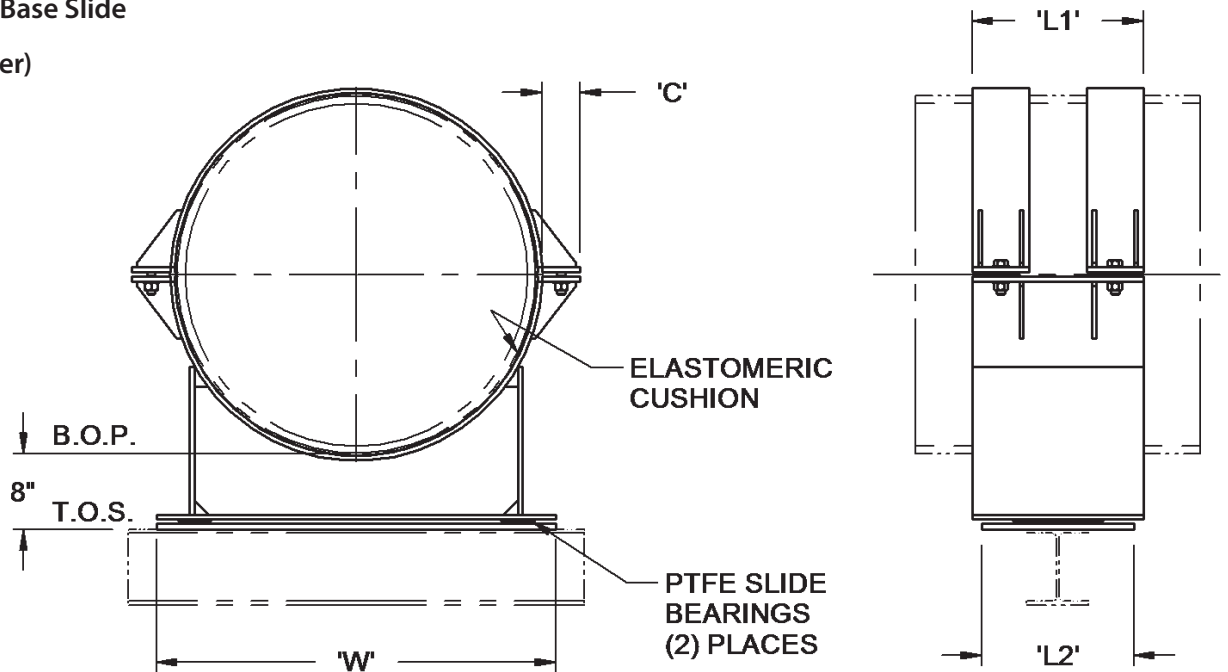
Notes:
Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 75 for sizes 42" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
20	2 1/2	6	6	24	900
24	2 1/2	6	6	27 3/4	1200
30	2 1/2	8	6	31 3/4	1750
36	2 1/2	10	8	36	2400

Pipe Supports

Figure D5: Duct Base Slide
(42"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of duct while allowing freedom of movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

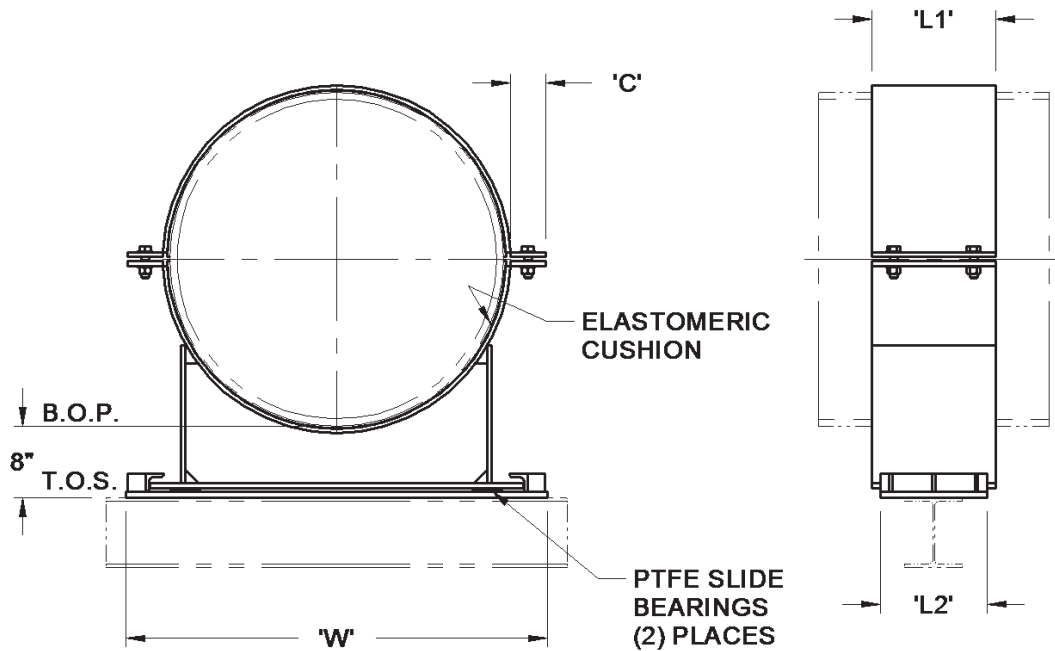
Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 74 for sizes 20" – 36". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]
					Vertical
42	3	10	8	43	3750
48	3	12	10	49 1/4	4750
54	3	16	12	53 3/4	6000
60	3	16	12	59 1/4	7500

Pipe Supports

Figure D6: Duct Base Guide
(20"-36" Diameter)



Finish:
20" – 30": Hot-dipped galvanized
36": Painted
See General Note 15, page 5.

Service:
To support weight of duct while allowing freedom of axial movement and limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

Notes:
Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 77 for sizes 42" – 60". See General Notes, pages 5 and 6.

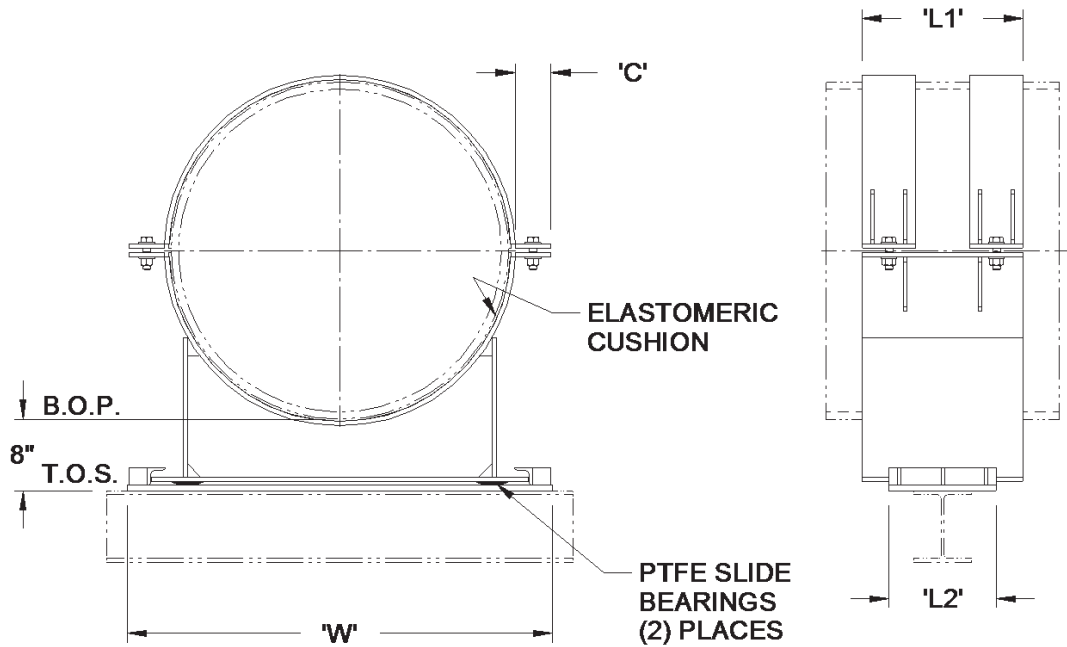


Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
20	2 1/2	6	6	28	1800	900
24	2 1/2	6	6	33	2100	1200
30	2 1/2	8	6	38	3000	1750
36	2 1/2	10	8	43	4200	2400

Pipe Supports

Figure D6: Duct Base Guide

(42"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of duct while allowing freedom of axial movement and limiting lateral movement

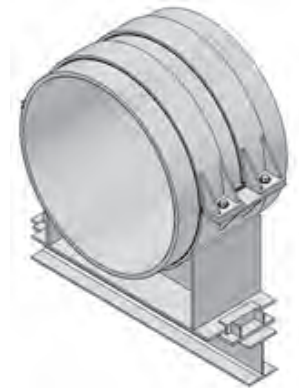
Material:

Carbon steel

See General Note 14, page 5.

Notes:

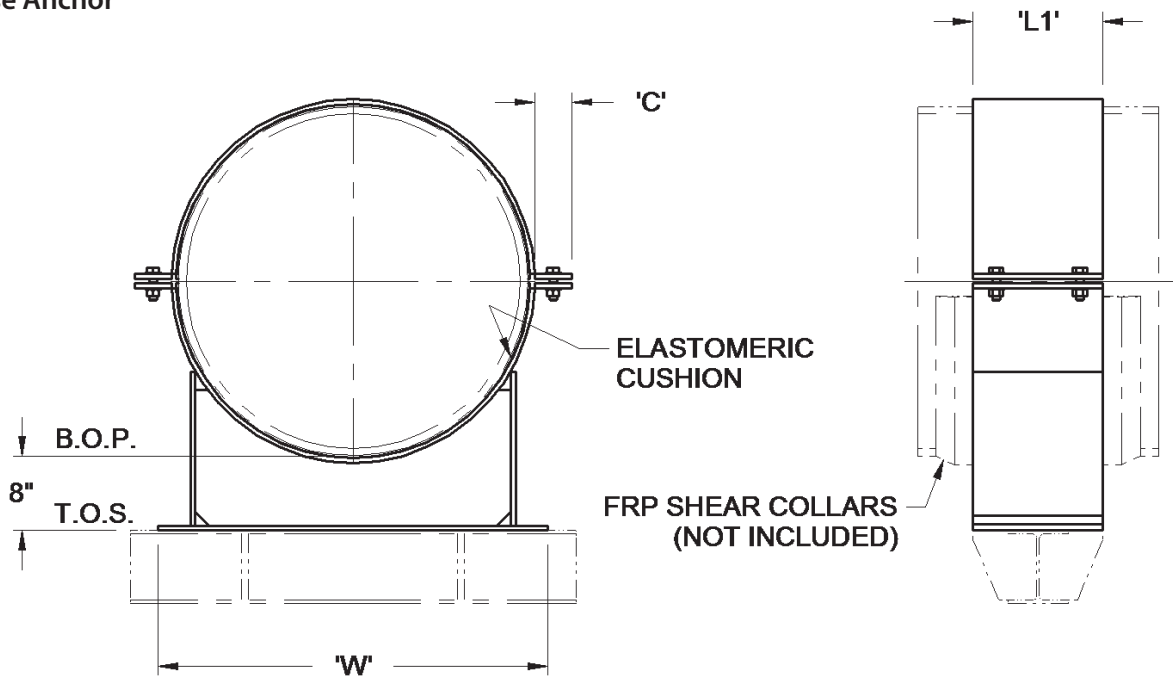
Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. PTFE slide bearings are recommended. See page 76 for sizes 20" – 36". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	L2 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
42	3	10	8	49 1/2	6000	3750
48	3	12	10	56	7500	4750
54	3	16	12	62	9000	6000
60	3	16	12	67 1/2	12000	7500

Pipe Supports

Figure D7: Duct Base Anchor
(20"-36" Diameter)



Finish:
20" – 30": Hot-dipped galvanized
36": Painted
See General Note 15, page 5.

Service:
To support weight of duct while restricting all movement

Material:
Carbon steel
See General Note 14, page 5.

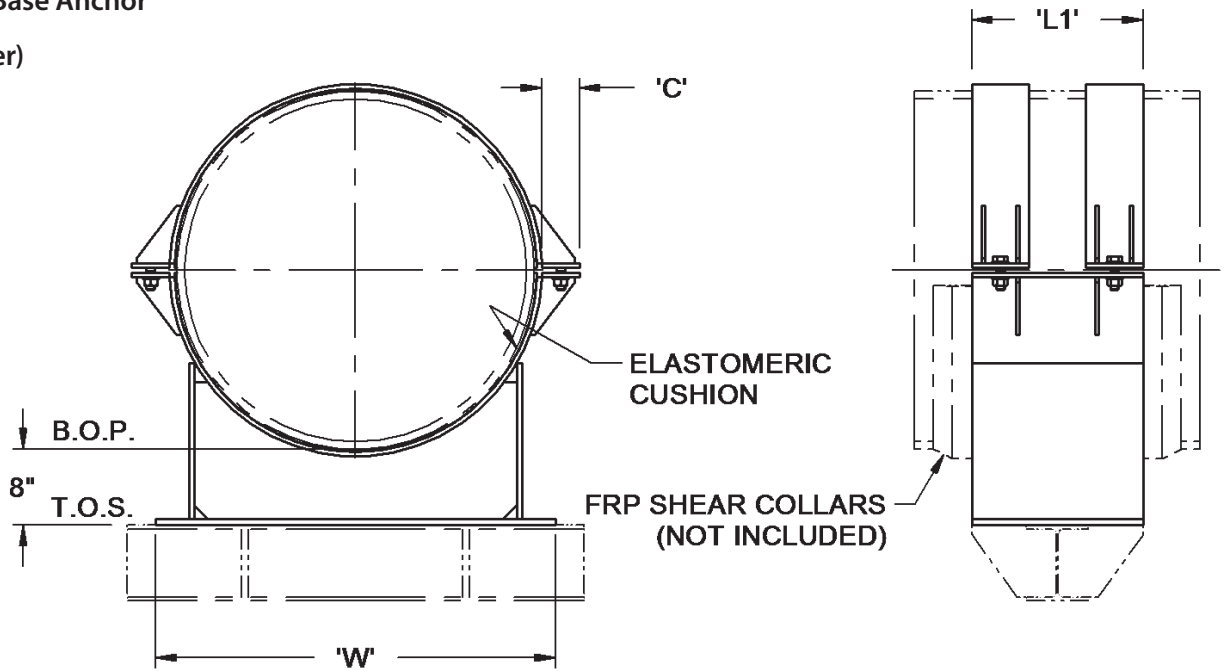
Notes:
Base width (W) and length (L1) must be fully supported as shown. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. See page 79 for sizes 42" – 60". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
20	2 1/2	8	24	1800	900	1800
24	2 1/2	8	27 3/8	2100	1200	2100
30	2 1/2	10	31 3/4	3000	1750	3000
36	2 1/2	12	36	4200	2400	4200

Pipe Supports

Figure D7: Duct Base Anchor
(42"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of duct while restricting all movement

Material:

Carbon steel

See General Note 14, page 5.

Notes:

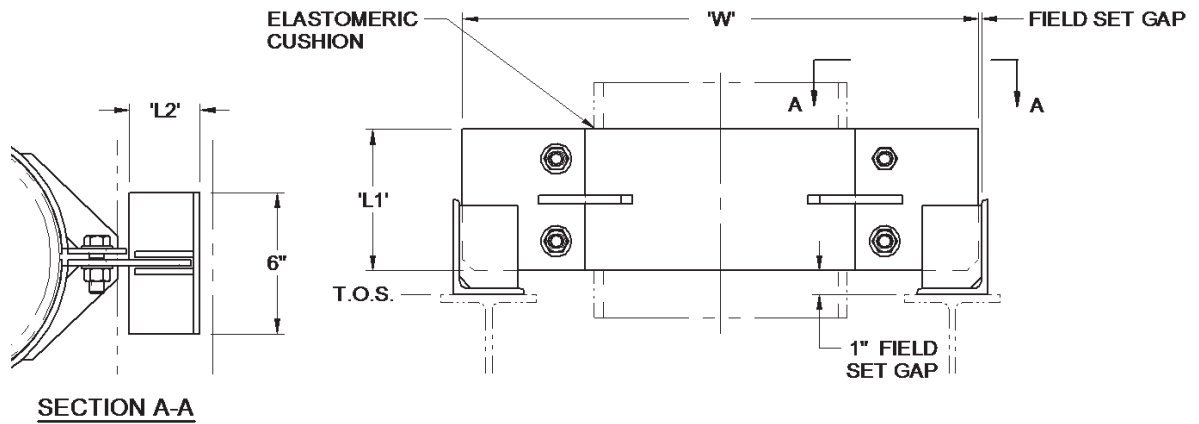
Base width (W) and length (L1) must be fully supported as shown. Support is provided with a base plate for welded installation. Base plates for bolted installations are available upon request. Provide bolting arrangement with placement of order. Dimensions may vary depending on the actual O.D. and load requirements. See page 78 for sizes 20" – 36". See General Notes, pages 5 and 6.



Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]		
				Lateral	Vertical	Axial
42	3	14	43	6000	3750	6000
48	3	16	49 1/4	7500	4750	7500
54	3	18	53 3/4	9000	6000	9000
60	3	20	59 1/4	12000	7500	12000

Pipe Supports

Figure D16: Duct Riser Guide
(20"-30" Diameter)

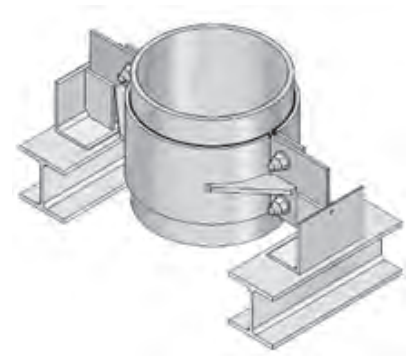


Finish:
Hot-dipped galvanized
See General Note 15, page 5.

Service:
To allow axial movement while limiting lateral movement

Material:
Carbon steel
See General Note 14, page 5.

Notes:
Not designed for vertical loads. Type RGC1 welded riser guide clips are provided with this style of support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions may vary depending on the actual O.D. and load requirements. See page 81 for sizes 36" – 60". See General Notes, page 5 and 6.

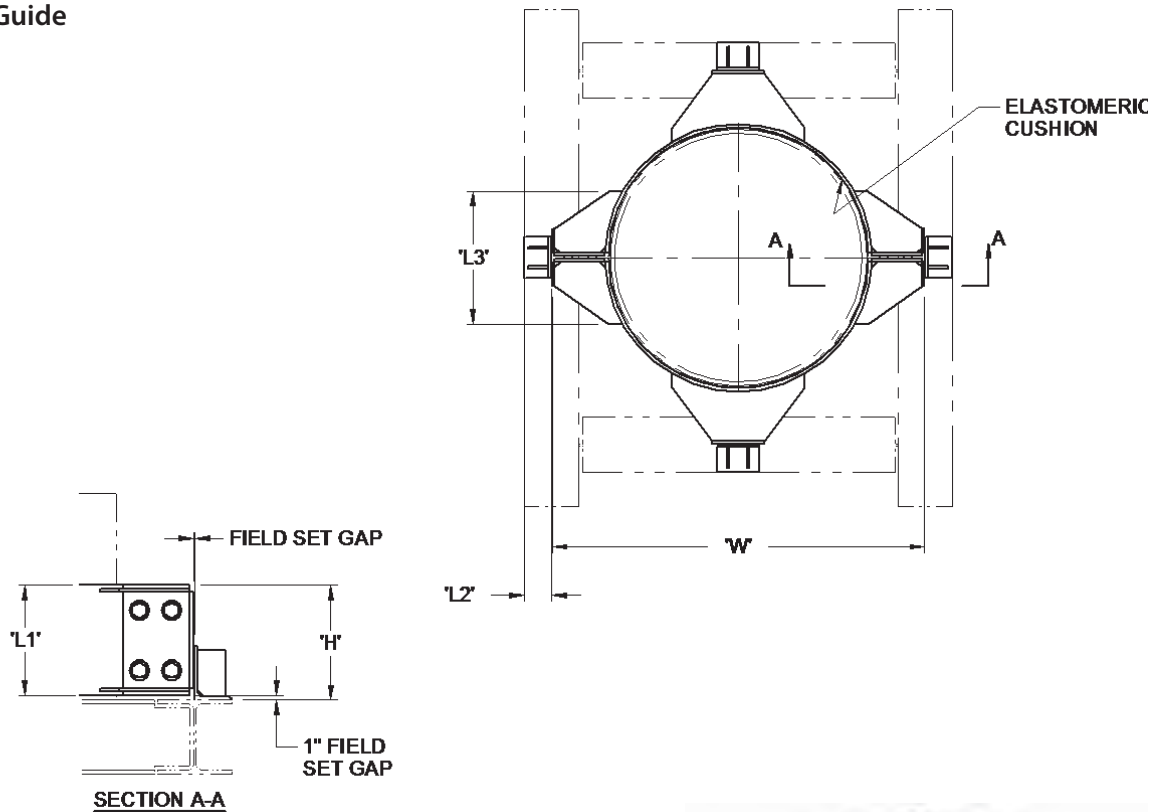


Pipe Size [in]	C [in]	L1 [in]	W [in]	Allowable Loads [lb]
				Lateral
20	6	4	34	1800
24	6	4	38	2100
30	8	4	44 1/2	3000

Pipe Supports

Figure D16: Duct Riser Guide

(36"-60" Diameter)



Finish:
Painted

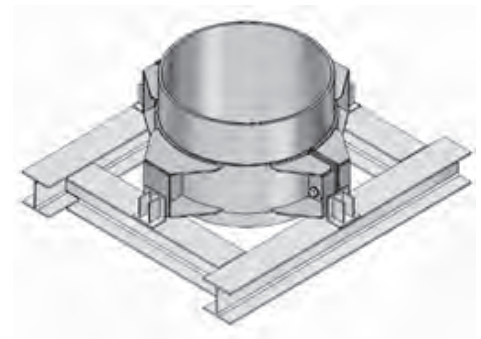
See General Note 15, page 5.

Service:
To allow axial movement while limiting lateral movement

Material:
Carbon steel

See General Note 14, page 5.

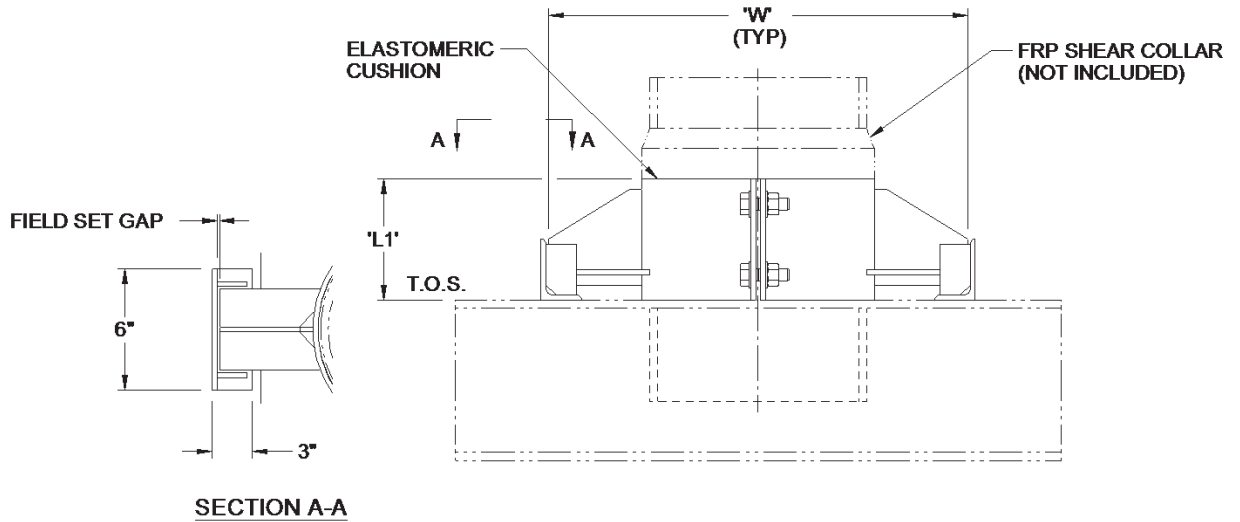
Notes:
Not designed for vertical loads. Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded guide clips are provided with this style support. Type RGC2 bolted riser guide clips are available upon request, page 87. Dimensions may vary depending on the actual duct O.D. and load requirements. See page 80 for sizes 20" – 30". See General Notes, pages 5 and 6.



Pipe Size [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]
					Lateral
36	10	4	8	48	4200
42	10	4	10	56	6000
48	12	6	10	64	7500
54	16	6	12	70	9000
60	16	6	12	72	12000

Pipe Supports

Figure D17: Duct Riser Support W/ Guides
(20"-30" Diameter)



Finish:

Hot-dipped galvanized

See General Note 15, page 5.

Service:

To support weight of pipe or duct while limiting lateral movement

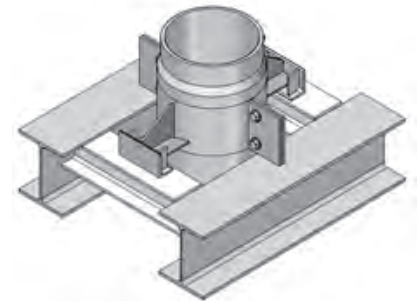
Material:

Carbon steel

See General Note 14, page 5.

Notes:

Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RGC1 welded guide clips are provided with this style support. Type RGC2 bolted guide clips are available upon request, page 87. Dimensions may vary depending on the actual O.D. and load requirements. See page 83 for sizes 36" – 60". See General Notes, pages 5 and 6.

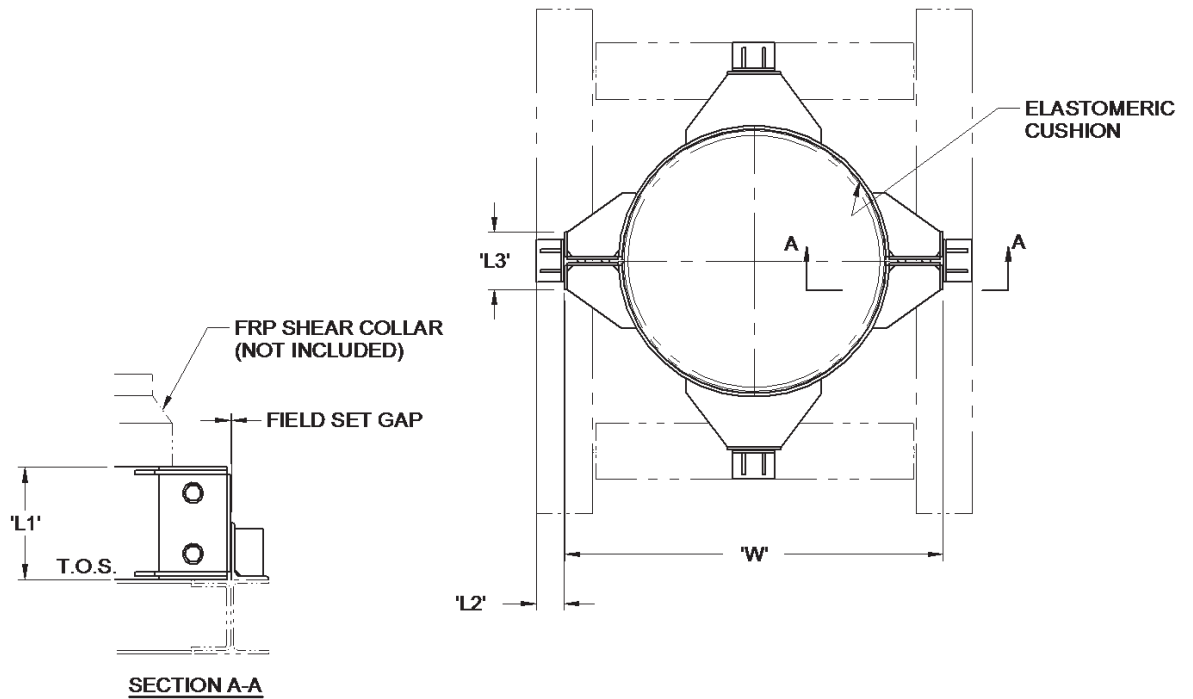


Pipe Size [in]	L1 [in]	W [in]	Allowable Loads [lb]	
			Lateral	Vertical
20	8	34	1800	900
24	8	38	2100	1200
30	10	44 1/2	3000	1750

Pipe Supports

Figure D17: Duct Riser Support W/ Guides

(36"-60" Diameter)



Finish:

Painted

See General Note 15, page 5.

Service:

To support weight of duct while limiting lateral movement

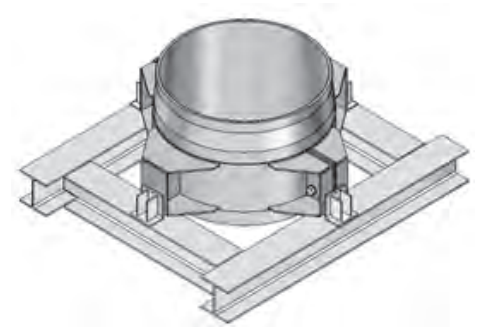
Material:

Carbon steel

See General Note 14, page 5.

Notes:

Support width (W) is based on listed allowable loads. For a greater width, the support configuration may need to be adjusted to suit listed allowable loads. Type RCG1 welded riser guide clips are provided with this style support. Type RCG2 bolted riser guide clips are available upon request, page 87. Dimensions may vary depending on the actual duct O.D. and load requirements. See page 82 for sizes 20" – 30". See General Notes, pages 5 and 6.



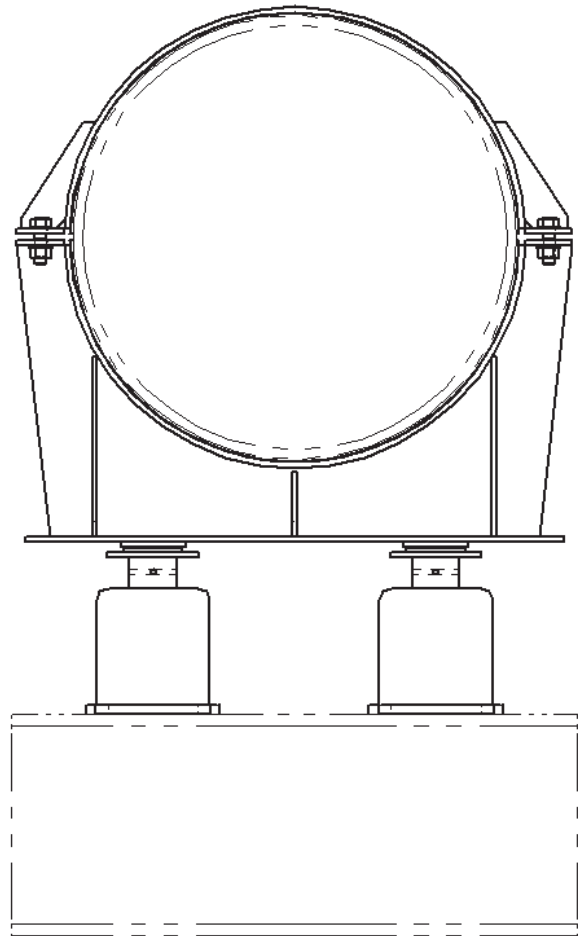
Pipe Size [in]	L1 [in]	L2 [in]	L3 [in]	W [in]	Allowable Loads [lb]	
					Lateral	Vertical
36	12	4	8	48	4200	2400
42	14	4	10	56	6000	3750
48	16	6	10	64	7500	4750
54	18	6	12	70	9000	6000
60	20	6	12	72	12000	7500

Support Options

Figure O1: Variable Spring Hanger Supports

Variable spring hanger supports are used at locations that are subjected to vertical thermal displacements. The size and type of variable spring hangers to be used depends on the load requirements and the method of installation. The actual load for which the spring is to support (hot condition), and the amount and direction of the pipe line movement from the cold to the hot position is required to properly determine sizes.

This illustration above depicts a large diameter base mount type support with slide bearings and variable spring hangers. Other configurations are available such as single and / or double rod type suspended from above.



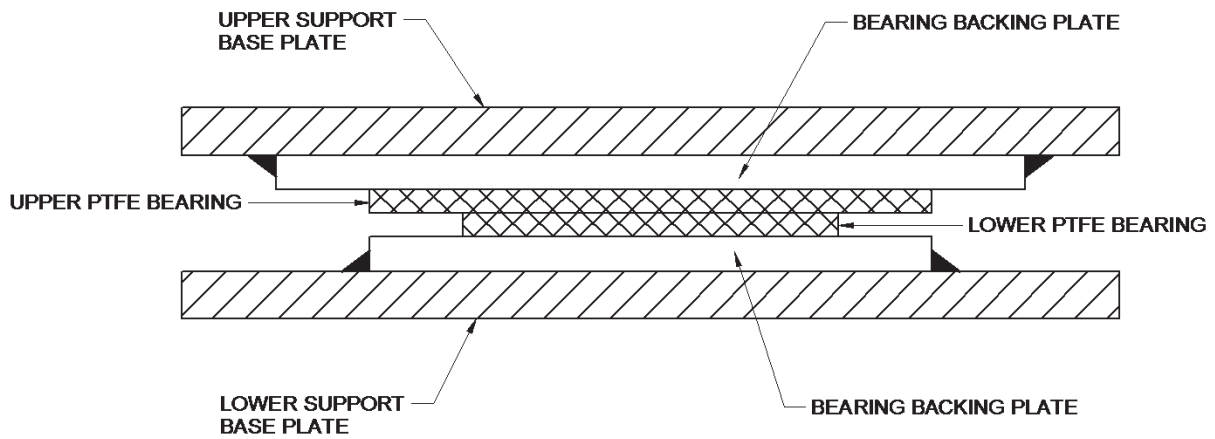
BASE MOUNTED DOUBLE CAN

Pipe Supports

Figure O2: Slide Bearings

Slide bearings minimize the frictional resistance of pipe supports as much as 40% thus reducing the chance of the pipe supports binding and creating localized stresses in the pipe. Slide bearings also reduce the loads transferred to a supporting structure. As pipe sizes and dead weights increase, slide bearings become more critical with the increased frictional loads. Slide bearings are recommended for all pipe sizes 12" diameter and above and systems having large temperature gradients and displacements.

PTFE slide bearings are bonded to steel backing plates, which are then welded to upper and lower support base plates. For pipe supports without a lower base plate, the lower bearing can be welded directly to the supporting structure.



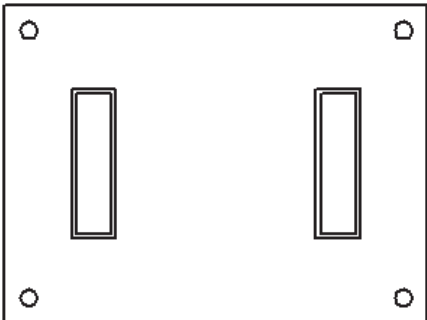
Pipe Supports

Figure O3: Base Plates

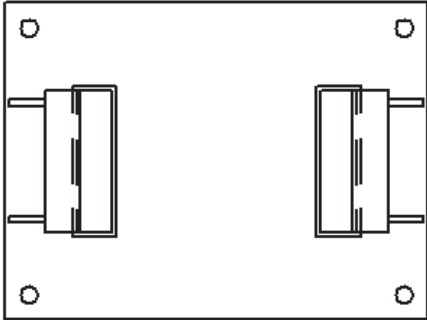
If base plates are desired to accompany pipe supports, base plates may be supplied as part of a total assembly. Base plates are available in standard dimensions or to customer specifications. The standard base plate provided with our base mounted supports is for welded installations. All base mounted supports with slide bearings are provided with both an upper and a lower base plate that includes the slide bearing assemblies. Base plates can be provided for bolted

installations upon request. Please provide bolting configuration requirements with placement of order.

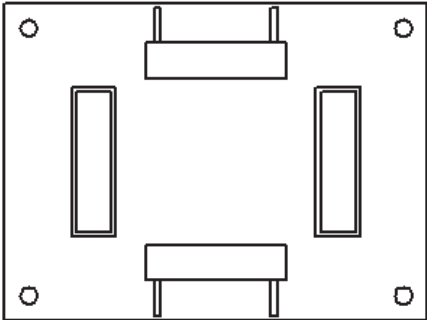
Note:
The type of guide and linestop clips depends on the style of the support and may vary from what is indicated here.



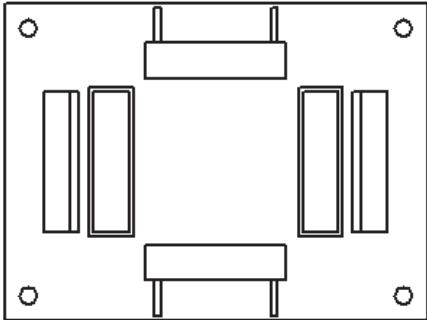
BP1
Slide Baseplate



BP2
Guide Baseplate
(See Note)



BP3
Linestop Baseplate
(See Note)

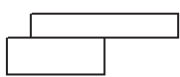
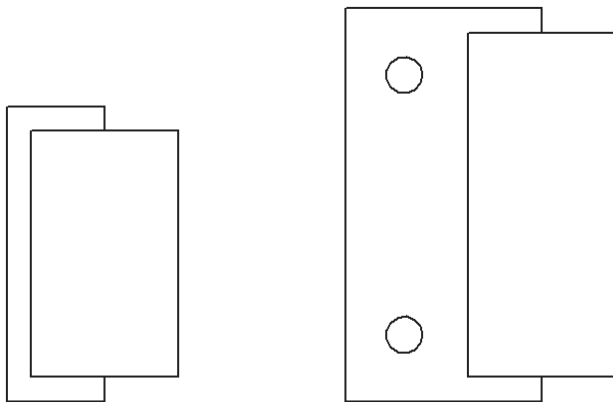


BP4
Linestop Baseplate W/
Lateral Limits
(See Note)

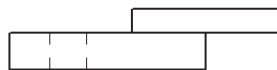
Figure O4: Guide Clips

Type FB1 is designed to limit horizontal (lateral or axial depending on placement) and vertical displacements. It is provided with our standard supports without slide bearings or lower base plates. It is designed for field welded installations.

Type FB2 is designed to limit horizontal (lateral or axial depending on placement) and vertical displacements. It is for use with our standard supports without slide bearings and lower base plates.



TYPE FB1



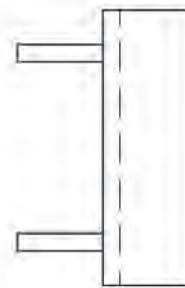
TYPE FB2

Type RGC1 is designed to limit horizontal displacements of riser piping. It is provided with our riser supports and is shipped loose for field welded installations.

Type RGC2 is designed to limit horizontal displacements of riser piping. It is designed for bolted installations and can be provided in lieu of the standard Type RGC1 upon request

Types GC1 is designed to limit horizontal (lateral or axial depending on placement) and vertical displacements. It is provided with our standard supports with slide bearings and is factory welded to the lower base plate. Upon request, it can be provided loose for field installation. The standard lower base plate can also be re-sized to allow for installation direct to the supporting structure.

Type GC2 is designed to limit only lateral and axial displacements and can be used with or without slide bearing or lower base plates. It allows for either field welded or bolted installations.



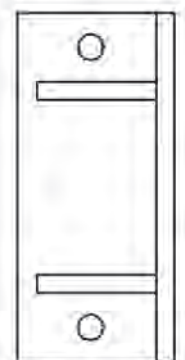
TYPE GC1



TYPE GC2



TYPE RGC1



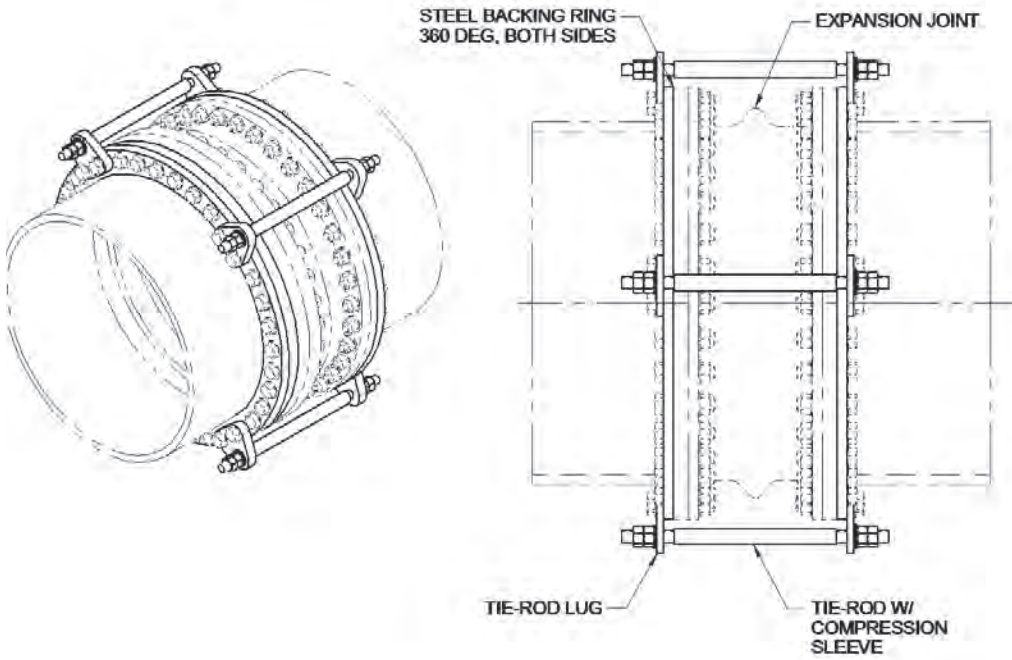
TYPE RGC2

Pipe Supports

Figure O5: Expansion Joint W/ Control Rods

The purpose of an expansion joint is to absorb the expansion and contraction of a pipeline between two anchoring points. A Control Unit Assembly is a system of tie rods placed across an expansion joint to minimize expansion and contraction thereby eliminating possible damage to the expansion joint. Control Unit Assemblies are also used when it is not feasible in the supporting structure to provide an anchoring system to control the expansion and contraction of the piping system.

An expansion joint Control Unit Assembly for an FRP piping system usually consists of sectional backing plates (360° coverage) to distribute the imposed loads around the pipe flanges, tie-rod lugs, tie-rods and compression sleeves. The number of tie-rods used in an assembly is determined on the basis of the actual design/test pressure of the system. Pipe flange strength must be considered to insure they are sufficient to withstand the total force that will be imposed.



Painting Specification

1.0 GENERAL

1.1. Scope

1.1.1. This specification covers the general requirements for cleaning, surface preparation and painting of steel structures and equipment.

1.2. References

1.2.1. Coatings and their application shall comply with the latest revision of the following referenced publications unless otherwise specified.

SSPC Steel Structures Painting Council

1.3. Painting Requirements

1.3.1. All coating materials shall be the product of a single manufacturer. Not substitutions or additives from different manufacturers are allowed without approval by the Owner.

1.3.2. If pipe support rubber lining if installed, remove and re-apply after painting is completed.

1.3.3. Remove all fasteners and other threaded hardware prior to blasting and painting.

1.3.4. Protect all non-metallic surfaces such as PTFE slide bearings during blasting and painting operations.

1.3.5. Galvanized surfaces shall be prepared with Carboline Rust Bond and painted with the appropriate paint system requirements.

2.0 PAINT MATERIALS

2.1. Paint System Selection

2.1.1. This section is applicable to the painting of non-insulated surfaces for steel fabricated equipment.

2.1.2. The following paint systems service and usage are described as follows:

Paint System	Service	Usage
Type 1	Severe corrosive service	Material located in a highly acidic environments and exposed to splashes, spills and outdoor conditions
Type 2	Moderate corrosive service	Material located in a mild to moderate acidic environments and exposed to outdoor conditions
Type 3	Mild to non-corrosive service	Material located in a mild to non-corrosive environments and not exposed to outdoor conditions

3.0 PAINTING SPECIFICATION

3.1. Paint

3.1.1. Paint systems consist of the following primer and finish paints:

Paint System	Type 1	Type 2	Type 3
Primer	Carboline	Carbomastic 615HS	Not Required
Finish	Carboline Carboguard 890	Carboline Carboguard 890	Caroline Carboguard 890

3.1.2. Colors shall be determined by Owner.

4.0 EXECUTION

4.1. Cleaning of Surfaces

4.1.1. Prior to blasting, all surfaces shall be thoroughly cleaned of oil, grease and other contaminants by solvent washer per SSPC-SP 1.

4.1.2. Weld splatter and mill scale shall be removed by mechanical means in accordance with SSPC-SP2, Hand Tool Cleaning or SP3, Power tool cleaning.

4.1.3. Metal surfaces shall be abrasive cleaned in accordance with the SSPC-SP6, Commercial Blast Cleaning.

Pipe Supports

4.2. Surface Conditions Prior to Painting

- 4.2.1. Surfaces after blasting shall be cleaned by vacuum or blown off with compressed air that is free of oil and water. All surfaces must be cleaned and dried.
- 4.2.2. Surface temperature must not be 5°F (2°C) colder than ambient temperature. Surface temperature must be at least 40°F minimum to 110°F maximum when relative humidity is above 85% or when the surface or air temperature is within 5°F of the dew point.
- 4.2.3. For sandblasted surfaces, the anchoring pattern must be 1.5 to 3 mils deep.

4.3. Mixing and Thinning

- 4.3.1. All paints shall be thoroughly mixed prior to use (preferably with a mechanical mixer) in accordance with the paint manufacturer's instructions.
- 4.3.2. Paint shall be diluted only with products recommended by the paint manufacturer and in accordance with the paint manufacturer's instructions.
- 4.3.3. All additional ingredients shall be mixed in accordance with the paint manufacturer's mixing proportions and instructions.

4.4. Painting Application

- 4.4.1. Conform to SSPC-PA1 standards (shop, site and maintenance painting) and to painting manufacturer recommendations. Prime surfaces immediately after cleaning to avoid rust formation.
- 4.4.2. The primer shall be fully cured prior to the application of the finish coat.

4.5. Paint Thickness

- 4.5.1. Dry film thickness (DFT) must be as follows:

Paint System	Type 1	Type 2	Type 3
Primer	1.5 to 2.0 mils	1.5 to 2.0 mils	N/A
Finish	2.0 to 2.5 mils	2.0 to 2.5 mils	2.0 to 2.5 mils

4.6. Inspection

- 4.6.1. Supplier shall provide an inspection report for each painting operation. This report shall include:
 - 4.6.1.1. Wet film thickness measurements per coat
 - 4.6.1.2. Dry film measurements per coat in accordance with SSPC PA2, Method for Determining Dry Film Thickness of a dry film using magnetic gauge
- 4.6.2. Supplier shall submit inspection reports prior to shipping equipment.

5.0 FIELD TOUCH UP FOR SHOP APPLIED COATING SYSTEM

- 5.1. Where only finish coat damage has occurred; power tool clean and feather edges and recoat using the specified finish coating material.
- 5.2. Where coating is damaged with bare metal exposed; power tool clean and feather edge each coating layer and recoat using the specified finish starting with primer and then finish coat.

Pipe Supports



RPS Composites Inc.

740 Main Street

P.O. Box 299

Mahone Bay, Nova Scotia

Canada B0J 2E0

Tel: (902) 624.8383 | (800) 343.9355

Fax: (902) 624.6395

www.rpscomposites.com

